For copies write:
The International conference on Creative Technology
Rajamangala University of Technology Krungthep
2 Nanglinchi Road, Tungmahamek,
Sathorn, Bangkok 10120, Thailand

About this publication:
Title: Proceedings of the 1st International conference on Creative Technology (CreTech2013)
Editors: Kornkamon Sriduandao, Chaiyan Chaiya, Alisara Suriyasomboon and Wuttiwat Kongrattanaprasert
Publishers: Rajamangala University of Technology Krungthep, Bangkok 10120, Thailand
Date Published: August 2013
Welcoming Message

On behalf of the Honorary Chair of the First Annual International Conference on Creative Technology 2013 (CreTech 2013), we would like to extend our warmest welcome to all of the participants joining us for this event at Rajamangala University of Technology Krungthep (UTK). CreTech 2013 has brought together a rich diversity of researchers, engineers, scientists, experts and students from companies and universities around the globe to share ideas and new perspectives on a wide range of creative technology issues, including breakthroughs in innovative educational methods and the use of practical technologies. These issues are essential to serve society, particularly with regard to economic development in Thailand and throughout the region. We are grateful to our international colleagues for their collaboration and we are extremely proud to have the conference at UTK, as this year marks a number of important events.

We are also very proud to welcome our distinguished keynote speakers who will join us at UTK for the conference and this good start should be encouraging for all of us. With your continuing contributions, CreTech will certainly grow to become a leading annual conference in the field of creative technologies.

I would like to take this opportunity to express our sincere gratitude to our colleagues, without whom this conference could never have happened, namely Ms. Nichapa Yoswee and Associate Professor Dr. Sanong Ekgasit. I would also like to thank the General Chair, Dr. Jiraporn Saptanon, the General Co-Chair, Assistant Professor Arporn Bangcharoenpornpong, Dr. Sukit Nitinai, Ajarn Khanittha Duangpattra and Assistant Professor Pramote Anunvarapong, and all of the members of the Organizing Committee who have worked tirelessly to put together CreTech 2013.

Welcome once again to CreTech 2013 and I hope that you will enjoy all of the forums and the activities we offer.

Yours sincerely,

Dr. Sathit Puttachaiyong
President of Rajamangala University of Technology Krungthep
Honorary Chair, CreTech 2013
Organizing Committee

- **Honorary Chair**
  Sathit Puttachaiyong
  *Rajamangala University of Technology Krungthep, Thailand*

- **General Chair**
  Jiraporn Saptanon
  *Rajamangala University of Technology Krungthep, Thailand*

- **General Co-Chairs**
  Arporn Bangcharoenpornpong
  *Rajamangala University of Technology Krungthep, Thailand*
  Sukit Nitinai
  *Rajamangala University of Technology Krungthep, Thailand*
  Khanittha Dongpattra
  *Rajamangala University of Technology Krungthep, Thailand*
  Pramote Anunvarapong
  *Rajamangala University of Technology Krungthep, Thailand*

- **International Steering Committees**
  Tomoo Kamakura
  *The University of Electro-Communications, Japan*
  Krick Scott
  *University of Alaska Anchorage, USA*
  Kazuaki Maeda
  *Chubu University, Japan*
  Parvinder S. Sandhu
  *Rayat & Bahra University, India*
  Alfred H. Miller
  *Fujairah Women's College, UAE*
  Zuriati Ahmad Zukarnain
  *University of Putra Malaysia, Malaysia*
  Kyuya Nakagawa
  *Kyoto University, Japan*

- **Technical Program Chair**
  Warakorn Charoensuk
  *Mahidol University, Thailand*
  Chaiyapon Thongchaisuratkrul
  *King Mongkut’s University of Technology North Bangkok, Thailand*
  Det Kedcham
  *Mahidol University, Thailand*
Wanchalorn Chawwang  
*Mahidol University, Thailand*

Paiboon Kiattikomol  
*King Mongkut’s University of Technology Thonburi, Thailand*

Thaweesak Yingthawornsuk  
*King Mongkut’s University of Technology Thonburi, Thailand*

Pichet Moungnoul  
*King Mongkut’s Institute of Technology Ladkrabang, Thailand*

Chanchai Thongsopa  
*Suranaree University of Technology, Thailand*

Tomoaki Sato  
*Hirosaki University, Japan*

Hideyuki Nomura  
*The University of Electro-Communications, Japan*

Nittaya Sumrethphon  
*Rajamangala University of Technology Krunthep, Thailand*

Kornkamon Sriduanado  
*Rajamangala University of Technology Krunthep, Thailand*

Chaiyan Chaiya  
*Rajamangala University of Technology Krunthep, Thailand*

Alisara Suriyasomboon  
*Rajamangala University of Technology Krunthep, Thailand*

### Local Arrangement Chair
Jiraporn Saptanon  
*Rajamangala University of Technology Krunthep, Thailand*

### Sponsor Chairs
Pramote Anunvarapong  
*Rajamangala University of Technology Krunthep, Thailand*

### Publication Chairs
Kornkamon Sriduanado  
*Rajamangala University of Technology Krunthep, Thailand*

Chaiyan Chaiya  
*Rajamangala University of Technology Krunthep, Thailand*

Alisara Suriyasomboon  
*Rajamangala University of Technology Krunthep, Thailand*

Piyaporn Kampeerapappun  
*Rajamangala University of Technology Krunthep, Thailand*

Kanchit Kumlungha  
*Rajamangala University of Technology Krunthep, Thailand*
Wuttiwat Kongrattanaprasert  
*Rajamangala University of Technology Krungthep, Thailand*

- **Financial Chairs**
  - Watjana Nimwacharomchuen  
  *Rajamangala University of Technology Krungthep, Thailand*
  - Nopparat Paivimut  
  *Rajamangala University of Technology Krungthep, Thailand*

- **Registration Chair**
  - Nopparat Paivimut  
  *Rajamangala University of Technology Krungthep, Thailand*

- **General Secretariat**
  - Nittaya Sumrethphon  
  *Rajamangala University of Technology Krungthep, Thailand*
  - Kornkamon Sriduandao  
  *Rajamangala University of Technology Krungthep, Thailand*
  - Chaiyan Chaiya  
  *Rajamangala University of Technology Krungthep, Thailand*
  - Alisara Suriyasomboon  
  *Rajamangala University of Technology Krungthep, Thailand*

- **Reviewers**
  We would like to thank the following individuals for their efforts in the review process of CreTech2013.

  - Asst. Prof. Arporn Bangcharoenpornpong
  - Dr. Sukit Nitinai
  - Dr. Jiraporn Saptanon
  - Asst. Prof. Pramote Anunvarapong
  - Kornkamon Sriduandao
  - Asst. Prof. Dr. Chaiyan Chaiya
  - Dr. Kanchit Kumluanghai
  - Dr. Wuttiwat Kongrattanaprasert
  - Dominick Cartwright
  - Asst. Prof. Arunee Kiatgungwalgeai
  - Dr. Chamnong Kaewpet
  - Simon Mciver
  - Dr. Hathaikorn Paungum
  - Dr. Alisara Suriyasomboon
Asst.Prof.Dr.Kittipong Sophonthummapharnn
Dr.Kunakorn Waiyawutt

External Reviewers

- Assoc. Prof. Dr. Krismanth Whattananarong
  King Mongkut’s University of Technology North Bangkok
- Assoc. Prof. Dr. Piyabutr Wanichpongpan
  King Mongkut’s University of Technology Thonburi
- Assoc. Prof. Dr. Supachai Suraphan
  Thammasat University
- Assoc. Prof. Dr. Vittaya Thipsuwanpomn
  King Mongkut's Institute of Technology Ladkrabang
- Asst. Prof. Dr. Apiwat Muttamara
  Thammasat University
- Asst. Prof. Dr. Sirichai Torsakul
  Rajamangala University of Technology Thanyaburi
- Asst. Prof. Dr. Kittipong Kimapong
  Rajamangala University of Technology Thanyaburi
- Asst. Prof. Dr. Soranat Raibhu
  Mahidol University
- Dr. Kumpanan Sirivedin
  King Mongkut’s University of Technology North Bangkok
- Dr. Kritsada Prasopchaichana
  Burapha University
- Asst. Prof. Prasert Reubroycharoen
  Chulalongkorn University
- Asst. Prof. Chanatitis Samart
  Thammasat University
- Dr. Srisuda Sae-ung
  Burapha University
- Assoc. Prof. Dr. Yuthachai Bunternghcit
  King Mongkut’s University of Technology North Bangkok
- Asst. Prof. Dr. Teeradej Wuttipornpun
  King Mongkut’s University of Technology North Bangkok
- Prof. Emeritus Dr. Achara Chandrachai
  Chulalongkorn University
- Assoc. Prof. Dr. Pakpachong Vadhanasindhu
  Chulalongkorn University
- Thaweesak Yingthawornsook
  King Mongkut’s University of Technology Thonburi
## Papers

### Innovative education
Room: L-603 (13.00-14.00)
Session chair: Kornkamon Sriduandao
Co-chair: Satita Dejtongpong

**Development of AR-Media Program for Medical Training**
Siwat Suksri, King Mongkut’s University of Technology Thonburi

**English Lesson: Zoo Animals for First Year Elementary Students on Smart TV**
Patcharee Tiensritanachote and Teerapong Boonlar, King Mongkut’s University of Technology Thonburi

**Marketing Innovation in MICE Management**
Chaiyapon Tundhiphurinidtr, Rajamangala University of Technology Krungthep

### Service technology
Room: L-603 (14.00-14.40)
Session chair: Kornkamon Sriduandao
Co-chair: Satita Dejtongpong

**Need Status Analysis in 3D cadastre, Thailand**
Vuttinan Utesnan, Rajamangala University of Technology Krungthep

**IPhone Application for Travelling by State Railway of Thailand**
Warisara Pardee and Patiyuth Pramkeaw, King Mongkut’s University of Technology Thonburi

### Innovative business and management
Room: L-603 (15.00-16.20)
Session chair: Asst.Prof.Dr.Kittipong Sophonthummapharn
Co-chair: Dr.Alisara Suriyasomboon

**User-Cocreation in New Product Development Process A Case of Developing a New Weight Control Product from *Ocimum canum* Seed**
Alisara Suriyasomboon, Rajamangala University of Technology Krungthep and Amorn Petsom, Chulalongkorn University

**Global Outsourcing of Manufacturing: A Case Study of Danish Agricultural Firm**
Kittipong Sophonthummapharn, Rajamangala University of Technology Krungthep and Jens Graff, International Business

**Usage of SAMS: Study of user workarounds at an Australian and a Thai university**
Cherngchai Suwannakoot, Rajamangala University of Technology Krungthep, Pradip K. Sarkar and Martin Dick, Melbourne Institution of Technology University
Innovative English Education to Improve Students’ Outcomes at the International College
Chaiyapon Tundhiphurinidtr and Gregory J. LaBarre, Rajamangala University of Technology Krungthep

**Innovative technology**
Room: L-604 (13.00-14.40)
Session chair: Asst.Prof.Dr.Pichai Janmanee
Co-chair: Dr.Lerdluk Kaewvimol

A new proposed large-scale hydrogen liquefaction plant
Songwut Krasae-in, Rajamangala University of Technology Krungthep

**Simulation of orifice pulse tube cryocooler**
Songwut Krasae-in, Rajamangala University of Technology Krungthep

Effect of Shielding Gases on Corrosion Properties of Austenitic Stainless Steels Grade AISI 201 Produced by Plasma Arc Welding
Wichan Chuaiphan Loeshpahn Srijaroenpramong Dumrongrit Pinpradub and Somporn Piyaphan, Rajamangala University of Technology Krungthep

**A Study Comparative of Surface Roughness During Milling Machining of Mold Steel AISI1050 with AISIP21**
Pichai Janmanee and Somchai Wonthaisong, Rajamangala University of Technology Krungthep, Somsak Ithisoponakul and Banjoong Feungfoo, Rajamangala University of Technology Thanyaburi

**Quality Development on Acrylic Engraving of CNC-laser by DOE**
Oris Maneesai and Parinya Srisattayakul, Rajamangala University of Technology Krungthep

**Propionic Acid Production by Coimmobilized Cultures of Propionibacterium acidipropionici TISTR 442 in Combination with Lactococcus lactis TISTR 1401**
Rutairat Suttisuwan, Rajamangala University of Technology Krungthep

**Study of Wear of Diesel Engine Valve Seat MITSUBISHI FUSO FM 527MA with Applying Natural Gas Vehicle (NGV)**
Teerayut Kanchanasangtong and Piyapong Kumkoon, Rajamangala University of Technology Krungthep
An Investigation of Effect of Parameters During Wire Electrical Discharge Machining of Mold Steel SKD 11
Kamonpong Jamkamon, Dollatham Araganont, Pichai Janmanee and Rattikorn Saodaen, Rajamangala University of Technology Krungthep

Data Hiding for QR Code Based on Fragile Video Watermarking
Thittaporn Ganokratanaa, Patiyuth Pramkeaw and Mahasak Ketcham, King Mongkut’s University of Technology Thonburi

A Hough Transform Based Lane Detection for Driving System
Thittaporn Ganokratanaa and Mahasak Ketcham, King Mongkut’s University of Technology Thonburi

Class Participation Checking System Based on Face Recognition Algorithm
Poonpon Anawatpongpun, King Mongkut’s University of Technology Thonburi

The 1-Year Overall Survival Outcome Among 221 Imaging-Diagnosed Cholangiocarcinoma Patients in ROI-ET Province, Thailand, 2012
Auttakiat Karnjanapiboonwong, Det Kedkham and Supattra Srivanichakorn, Mahidol University

Analysis of Spectral based Vocal Parameters for Classifying Suicidal States in Clinical Depressed Patients
Thaweesak Yingthawornsuk, King Mongkut’s University of Technology Thonburi

Charge Equalizing System for Two-unit Serially Connected Battery String Using Forward Converter Topology
Charnyut Karnjanapiboon, Rajamangala University of Technology Lanna Nan and Saichol Chudjuarjeen, Rajamangala University of Technology Krungthep

The Simulation Technique of Variable-Frequency Asymmetrical Voltage-Cancellation Control of Series Resonant Inverters in Induction Cooking by PSPICE Programs
Jirapong Jittakort and Tanit Boonsai Rajamangala, University of Technology Thanyaburi, Saichol Chudjuarjeen, Rajamangala University of Technology Krungthep and Samart Yachiangkam, Rajamangala University of Technology Lanna
An AC to AC Resonant Converter for Induction Heating
Panom Towdee, Kasetsart University and Saichol Chudjuarjeen, Rajamangala University of Technology Krungthep

An Induction Cooking using Current Source Inverter
Vichien Hathairatsiri Wiroj Pechpunsri and Saichol Chudjuarjeen, Rajamangala University of Technology Krungthep
Development of AR-Media Program for Medical Training

Siwat Suksri
Department of Media Technology,
King Mongkut’s University of Technology Thonburi
Tel. 02-470-7606, E-Mail: siwat.suk@kmutt.ac.th

Abstract
This paper presents the development of Augmented Reality Media (AR-Media) for medical equipment. Secondly, to increase the interesting of usage of a new medical technology and to introduce this technology to student or medical persons who would like to use it as well. The AR-Media is created to present the 3D virtual model of human internal organs, cardiac, circulatory and digestive systems. The key role of AR-Media is the Marker which is based as an output unit. Finally, this medical training was evaluated by four experts based on thirty sample subjects to determine quality and satisfaction, respectively.

Keywords: Medical Augmented Reality, Marker, 3D Medical Media, AR-Model

1. Introduction
Anatomy, the study of the structure of the human body, is fundamental to medical education. Teaching anatomy is difficult and often a large amount of effort is expended, e.g., when creating illustrations and plastic model of anatomy or by utilizing 3D computer graphics. Various complementary methods have been out of date and changed over the nature of anatomy education. The explosion of image technology during the last few decades has brought anatomical education into a new world. 3D visualizations have opened up a new view for anatomical education. The new media have become widely used tools in medical instruction today.

Augmented Reality (AR) is a technology which user’s view of the real world is enhanced or augmented with addition in formation generated by computer via webcam, mobile and computer with a computer language Action Script 3.0 and using software such as 3D MAX, Adobe Photoshop which display in a 3D image, such as people, animals, objects, etc., with a view to 360 degrees can be rotated in any direction. It turns out that virtual reality.

For this reason the application of this technique in the development of teaching and learning in the form of 3D media, AR-medical book for learning the human body in the different systems. Make learning interested and accurate can be easily understood with a view to learning more in the new format.

2. Methodology
2.1 Augmented Reality (AR)
Augmented Reality (AR) is a technology developed in the Human-Machine Interface (HMI) to computer technology and virtual reality with the virtual objects which mix between the real world in 3D and real time display. This technology consists of three systems. Tracking system is a system image to create a 3D object by Tracking (camera) to get the image data into the form, position and direction of the processing system is used to interpret and visualize 3D came out in the position and the direction that camera captured[1]. AR technology can be categorized by image analysis was divided into 2 categories[2], including Marker based AR and Marker-less Based AR. Marker based AR is an image analysis-based marker. Marker-less Based AR were analyzed using image features in the image (Natural Features) were analyzed to calculate the 3D Pose position to further use. Marker based AR process which can be divided into three phases: Image Analysis, Pose Estimation and 3D Graphic Rendering, shown in Figure 1.

Overall, the Image Analysis and Pos Estimation will be referred to as Visual Tracking . The research for this thesis were selected for the study tools that are widely known in the field of Augmented Reality (AR) is FLARToolKit [3]. Then, the contents of the Image Analysis and Pose Estimation process is described by the fundamental principles of FLARToolKit.
2.2. Pose Estimation

Pose Estimation is the process of calculating the positions in the three-dimensional (3D Pose) Marker, when compared with the webcam. This value is expressed in matrix 4 x 4 (TCM), to identify the relationship between the Camera Coordinated Frame and Marker Coordinated Frame shown in equation (1).

\[
\begin{bmatrix}
X_c \\
Y_c \\
Z_c \\
1
\end{bmatrix} =
\begin{bmatrix}
R_{11} & R_{12} & R_{13} & T_1 \\
R_{21} & R_{22} & R_{23} & T_2 \\
R_{31} & R_{32} & R_{33} & T_3 \\
0 & 0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
X_M \\
Y_M \\
Z_M \\
1
\end{bmatrix} = T_{CM}
\begin{bmatrix}
X_M \\
Y_M \\
Z_M \\
1
\end{bmatrix}
\]  

Camera Coordinated Frame referred to any of the webcam and the Marker Coordinated Frame. Coordinated Frame is used to refer any of the Marker, which is shown in Figure 2.

The relationship between any point \((X_c,Y_c,Z_c)\) on Camera Coordinated Frame with corresponding points \((x_l,y_l)\). Ideal Screen Coordinated Frame is Perspective Projection as shown in equation (2).

\[
\begin{bmatrix}
x_l \\
y_l \\
h
\end{bmatrix} =
\begin{bmatrix}
s f_x & 0 & x_c & 0 \\
0 & s f_y & y_c & 0 \\
0 & 0 & 1 & 0
\end{bmatrix}
\begin{bmatrix}
X_c \\
Y_c \\
Z_c \\
1
\end{bmatrix} = C
\]  

By C is a 3x4 matrix which contains the values \(s, f_x, f_y, x_c, y_c\). Basically, these are collectively known as the Camera Parameters which is calculated from the procedure Camera Calibration [4]. The relationship is the connection between any point on the Ideal Screen Coordinated Frame \((x_l,y_l)\) with Observe Screen Coordinated Frame \((x_0,y_0)\). The picture is shown in Figure 3 and described as shown in equation (3).

\[
d^2 = (x_1 - x_0)^2 + (y_1 - y_0)^2 \\
p = \left\{ 1 - f d^2 \right\} \\
x_0 = p(x_1 - x_0) + x_0, y_0 = p(y_1 - y_0) + y_0
\]  

By \(x_0, y_0\) is the center of the Distortion (Center Coordinates of Distortion) and f is the Distortion Factor. These are derived from the Camera Calibration.

Figure 4 Process calculates the 3D Poses
When we know the value of the TCM. Marker positions of the four points on the Observed Screen Coordinates in images taken from a video webcam. Especially where it can be found from this value to calculate the response function of the error (Error Function) as shown in equation (4). We use the technique to find appropriate value (optimization), which is an iterative process.

\[
err = \frac{1}{4} \sum_{i=1,2,3,4} \{(x_i - \hat{x}_i)^2 + (y_i - \hat{y}_i)^2\} \tag{4}
\]

by \(x_i \hat{y}_i\) expressed by

\[
\begin{bmatrix}
  h_x_i \\
  h_y_i \\
  h
\end{bmatrix} = C. T_{CM} \begin{bmatrix}
  X_{Mi} \\
  Y_{Mi} \\
  Z_{Mi} \\
  1
\end{bmatrix}
\]

\(i = 1,2,3,4\)

2.3. The 3D rendering

The 3D rendering is to augment matchings information that we need, which is typically a 3D model into the images from a video webcam at the position of the Marker detected. Image analysis using the position of the three-dimensional calculations of the Pose Estimation. The 3D Rendering refers to the process of the sessions 2D from 3D models and 3D models to describe the object or environment, one would want to create the image. Due to the wide range of 3D rendering techniques. However, in this report we study techniques using the 3D Rendering Scene Graph.

2.4. FLARToolKit

FLARToolKit (Flash Augmented Reality ToolKit) [5] is a tool that incorporates various functions required in the development of AR applications. The Library can support a variety of platforms and try to reduce the difference of the Library to make it easier to apply different and efficiently platforms. Shown in Figure 5.

The simulation of virtual computer graphics via the browser, which uses a webcam to capture Marker. It is potential applications in industry and research is FLARToolkit versions AS3 (Action Script3).
3D Rendering is the process of Augmented Reality to add Augment information. In general, the 3D models into the images from a video webcam at the image position marker. That is detected by the Image Analysis using the linear three-dimensional computed from the procedure Pos Estimation.

3.2 Evaluation

Determination of the quality of the system. The research sample for both trial and evaluation of the system response. By the quality of the system was tested for the following.

A) Software Interface
B) Information Description & Presentation
C) Usability
D) Accompanying Media Material

Assessment has been designed to be used with two groups of four experts and thirty users. Information to improve the integrity of the system.

The results of the evaluation for experts and users. Use statistical principles to help in the conclusion of the test, performance. By calculating the average of the test results for each side to assess the system that has developed in various quality levels in any the detailed criteria for the evaluation into five levels: Excellent, Very Good, Good, Fair and Poor.

4. Experimental Result

4.1 The Display of System

4.1.1. The three-dimensional medical books media enhancement technology is Augmented Reality.

Each of three systems, the human body is the gastrointestinal system, cardiovascular system and circulatory system as shown in Figure 7.
4.1.3 The Marker on camera webcam for object 3D Model.

![Marker on Camera](image)

**Figure 9 Marker on Camera**

4.2. Evaluation Result

**Table 1 : Results Feeds evaluation by experts 4**

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Mean Level of Opinion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software Interface</td>
<td>3.6</td>
</tr>
<tr>
<td>Information Description &amp; Presentation</td>
<td>3.8</td>
</tr>
<tr>
<td>Performance of the program.</td>
<td>3.6</td>
</tr>
<tr>
<td>The media</td>
<td>4.3</td>
</tr>
</tbody>
</table>

**Table 2 : Results Feeds at users general evaluation by 30 people**

<table>
<thead>
<tr>
<th>The assessment</th>
<th>Mean Level of Opinion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software Interface</td>
<td>4.5</td>
</tr>
<tr>
<td>Information Description &amp; Presentation</td>
<td>4.5</td>
</tr>
<tr>
<td>Usability</td>
<td>4.3</td>
</tr>
<tr>
<td>Accompanying Media Material</td>
<td>4.5</td>
</tr>
</tbody>
</table>

5. Result

Test of the three-dimensional media are true medical technology Augmented Reality application which can display three-dimensional models clearly. The content is simple to understand. Patterns of interest. Have been prepared by an evaluation of the project. The number 4 can be evaluated by an expert evaluation as follows. The format of the media three-dimensional medical supplement reality with technology Augmented Reality quality of the program content of the media three-dimensional medical supplement reality with technology Augmented Reality quality of the application performance of the media three-dimensional support. Medical Augmented Reality technology enhances the quality of the materials and the use of three-dimensional media. Medical Augmented Reality technology adds true quality and satisfaction of the project. Rating sample Student, Department of Media Technology, number 30, which details the assessment. The format of the program is very positive. Performance of the program was good. The media and the active level is considered to be very good.

6. Conclusion and Futurework

6.1 Lighting should be bright white in the report. It should not be in the room that is too bright will display correctly.

6.2 Papers used to print symbols (Marker) should use general copy paper or cardboard from the backing. The test will add more convenience.

6.3 The 3D model is smaller and lower resolution. It allows to load and display faster.

6.4 Many symbols (Marker) affects the operation first. The developers have suggestions on development of source code to get application running faster.

Reference


English Lesson: Zoo Animals for First Year Elementary Students on Smart TV

Patcharee Tiensrithanachote¹ and Teerapong Boonlar¹
¹Department of Media Technology, Faculty of Industrial Education and Technology, King Mongkut’s University of Technology Thonburi
Tel. 02-470-7606, E-Mail: 52217541@st.kmutt.ac.th, Teerapong.boon@kmutt.ac.th

Abstract
The objectives of this study are to develop English Lesson: Zoo Animals for the First Year Elementary Students via Smart TV and to measure the first year elementary student’s satisfaction through the lesson. The designed lesson consists of two major parts which are Smart TV and English Lesson: Zoo Animals for the First Year Elementary Students program. In lesson, contents were separated into three portions and each portion has specific purposes: 1) Pre-test is designed to test student’s memorizing skill on vocabulary from animal pictures. Students can choose vocabulary from animal pictures to boost their skills. 2) Zoo animals main chapter consisting of all six types. Students can learn animal pictures from vocabulary with observation, memorizing, listening skill and reading skills. 3) Post-test is designed for students to choose animal pictures matching vocabulary to boost the student’s memorizing skill. The results from testing state based on a sampling group of thirty first year elementary students from Khajornroajwittaya School show an outstanding score from evaluation.

Keywords: English Lesson, Zoo Animals, Smart TV

1. Introduction
These days, societies are developing rapidly. English plays a vital role in human lives. Especially, Education is essential to development of the country. The advance of technology and education is playing a key role for new developments teaching and learning for English language in Thailand in this decade. [1]

The designed English lesson will help first year elementary students to learn by themselves. Student-centered learning in this case means students do not have to attend classes. This approach to learning on the English Lesson: Zoo Animals for First Year Elementary Students program encourages students to learn and retain greater interest. Using multimedia to assist in delivering content attracts First Year Elementary students attention and helps them to understand.

Objectives of this study are to develop English Lesson: Zoo Animals for First Year Elementary Students via Smart TV and to measure the first year elementary student’s satisfaction through the lesson.

2. Population and Sample
The population and sample group of thirty first year elementary students from Khajornroajwittaya School by purposive sampling and choose students who are interested in English.

2.1 Design guideline have been chosen.
The chart network content validated by experts is used to determine the division and sequencing into units of study and is presented as lessons in a Course Flow Chart Drafting [2][3]

Create English Lesson: Zoo Animals for First Year Elementary Students via Smart TV Chart Drafting. In this stage, the course management system is designed for control of the learning process using the instructional package. This includes remembering users and ten highest total scores. It is also useful for raising students awareness of the lessons.

2.2 Data analysis
Data analysis is as follows:
a. The analysis of the system evaluate by Content experts and multimedia experts using the formula 1 and 2

Arithmetic Mean (x-bar)

\[
\bar{x} = \frac{\sum f x}{\sum f}
\]

(1)

Remarks: \(\bar{x}\) = Arithmetic mean, \(f\) = frequency, \(x\) = score
Standard (S.D)

\[ S = \sqrt{\frac{\sum f x^2 - (\sum f x)^2}{N(N-1)}} \]  

(2)

Remarks: \( S = \text{standard}, f = \text{frequency}, x = \text{score}, N = \text{number} \)

b. The satisfaction analysis of the system evaluate by teachers using the formula 3  

Arithmetic Mean (x-bar)

\[ \bar{x} = \frac{\sum_{i=1}^{n} f x_i}{n} \]  

(3)

Remarks: \( \bar{x} = \text{Arithmetic mean}, f = \text{frequency}, x_i = \text{score}, N = \text{number} \)

3. Results

The results can be classified as follows:

The result of designed lesson consists of two major parts which are Smart TV and English Lesson: Zoo Animals for First Year Elementary Students program. In lesson, contents were separated into three portions and each portion has specific purposes: 1) Pre-test is designed to test student’s memorizing skill on vocabulary from animal pictures. Students can choose vocabulary from animal pictures to boost their. 2) Zoo animals main chapter consisting of all six types. Students can learn animal pictures from vocabulary with observation, memorizing, listening and reading skills. 3) Post-test is designed for students to choose animal pictures matching vocabulary to boost the student’s memorizing skill.

3.1 Quality Analyses

After the project is complete, the evaluation of the system evaluate by experts and project success was measured by First Year Elementary Students and satisfaction of the program showed in Table 1-3.

Assessment of multimedia lessons is evaluated by a query scale estimation questionnaire (Rating Scale) using a Likert's scale, in which 4.50 to 5.00 quality is very high, 3.50 to 4.49 quality is high, 2.50 to 3.49 quality is average, 1.50 to 2.49 quality is fair and 1.00 to 1.49 quality is poor. [4]

### Table 1. Show result of content quality by Content experts

<table>
<thead>
<tr>
<th>Assessment Items</th>
<th>( \bar{x} )</th>
<th>SD</th>
<th>Quality level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Context</td>
<td>4.60</td>
<td>0.54</td>
<td>very high</td>
</tr>
<tr>
<td>2. Graph and Sound</td>
<td>4.07</td>
<td>0.48</td>
<td>high</td>
</tr>
<tr>
<td>3. Interactive</td>
<td>4.20</td>
<td>0.39</td>
<td>high</td>
</tr>
<tr>
<td>4. Structure of instructional</td>
<td>4.27</td>
<td>0.57</td>
<td>high</td>
</tr>
<tr>
<td><strong>Averages</strong></td>
<td><strong>4.29</strong></td>
<td><strong>0.62</strong></td>
<td><strong>high</strong></td>
</tr>
</tbody>
</table>

Remarks: \( \bar{x} = \text{Arithmetic mean} , \text{S.D.} = \text{Standard} \)

### Table 2. Show result of multimedia quality by Multimedia experts

<table>
<thead>
<tr>
<th>Assessment Items</th>
<th>( \bar{x} )</th>
<th>SD</th>
<th>Quality level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Images</td>
<td>4.67</td>
<td>0.36</td>
<td>very high</td>
</tr>
<tr>
<td>2. Texts and Fonts</td>
<td>4.53</td>
<td>0.39</td>
<td>very high</td>
</tr>
<tr>
<td>3. Animations</td>
<td>4.30</td>
<td>0.28</td>
<td>very high</td>
</tr>
<tr>
<td>4. Sound</td>
<td>4.60</td>
<td>0.44</td>
<td>very high</td>
</tr>
<tr>
<td>5. Interactive</td>
<td>4.27</td>
<td>0.66</td>
<td>high</td>
</tr>
<tr>
<td><strong>Averages</strong></td>
<td><strong>4.57</strong></td>
<td><strong>0.42</strong></td>
<td><strong>very high</strong></td>
</tr>
</tbody>
</table>

Remarks: \( \bar{x} = \text{Arithmetic mean} , \text{S.D.} = \text{Standard} \)

### Table 3. Show result of English Lesson: Zoo Animals for First Year Elementary Students via Smart TV

<table>
<thead>
<tr>
<th>Assessment Items</th>
<th>( \bar{x} )</th>
<th>SD</th>
<th>Quality level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Content experts</td>
<td>4.29</td>
<td>0.62</td>
<td>high</td>
</tr>
<tr>
<td>2. Multimedia experts</td>
<td>4.57</td>
<td>0.42</td>
<td>very high</td>
</tr>
</tbody>
</table>

Remarks: \( \bar{x} = \text{Arithmetic mean} , \text{S.D.} = \text{Standard} \)
3.2 Satisfaction Analysis

User’s satisfaction questionnaires use a Likert’s scale. The five levels are 4.00 to 5.00 very high satisfaction; 3.50 to 4.49 good satisfaction, 2.50 to 3.49 moderate satisfaction, 1.50 to 2.49 very little satisfaction, and 1.00 to 1.49 least level of satisfaction show in Table 4.

Table 4. Result of user's satisfaction on English Lesson: Zoo Animals for First Year Elementary Students via Smart TV

<table>
<thead>
<tr>
<th>Assessment item</th>
<th>$\bar{X}$</th>
<th>S.D.</th>
<th>Satisfaction level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Content</td>
<td>4.60</td>
<td>0.45</td>
<td>very high satisfaction</td>
</tr>
<tr>
<td>2. Character of Animations</td>
<td>4.73</td>
<td>0.33</td>
<td>very high satisfaction</td>
</tr>
<tr>
<td>3. Senses</td>
<td>4.45</td>
<td>0.33</td>
<td>good satisfaction</td>
</tr>
<tr>
<td>4. Fonts</td>
<td>4.60</td>
<td>0.32</td>
<td>very high satisfaction</td>
</tr>
<tr>
<td>5. Techniques</td>
<td>4.47</td>
<td>0.25</td>
<td>good satisfaction</td>
</tr>
<tr>
<td>6. Sound</td>
<td>4.40</td>
<td>0.49</td>
<td>good satisfaction</td>
</tr>
<tr>
<td>Average</td>
<td>4.54</td>
<td>0.51</td>
<td>very high satisfaction</td>
</tr>
</tbody>
</table>

Remarks: $\bar{X} =$ Arithmetic mean, S.D. = Standard

4. Conclusion

The development of English Lesson: Zoo Animals for First Year Elementary Students via Smart TV can be concluded as follows:

Quality analysis using pre-test and post-test evaluation of thirty first year elementary students from Khajornroajwittaya School by Content experts and Multimedia experts. The results from testing state based on their understanding the zoo lesson show an outstanding score from evaluation.

The learners’ satisfaction is evaluated by the questionnaire after the post-test. The learners’ satisfaction to the leaning package was evaluated toward the introduction, content, enhanced learning, test evaluation and summary of lessons. The result from satisfaction evaluation was found to be effectively high.

References


Marketing Innovation in MICE Management

Chaiyapon Tundhiphurinidtr

1 Department of Marketing, International College, Rajamangala University of Technology Krungthep
Tel. +6689.925.5454, E-Mail: chaiyapon.t@rmutk.ac.th

Keywords: MICE, event, management, marketing, innovation, reservation

Abstract

MICE business is developing and growing continuously for the last 10 years, in this research paper, the researcher uses the opportunities to study how technologies could ease the organizers or business players in MICE business industry to improve their business operation. The researcher also studies the utilization of MICE events as part of the advertising channels to communicate sponsors’ brands to the target audiences.

Keywords: MICE, event, management, marketing, innovation, reservation

1. Industry Outlook

Thailand travel industry is a key contributor to the national gross domestic product (GDP) equal to 11.6%. ([1]). Meeting Incentive Convention and Exhibition (MICE) business sector has grown significantly at the average rate of 14% since 2003 from 700 Million Thai Baht to 2 Billion Thai Baht. The total numbers of MICE visits have increased from 378,449 persons in 2003 to 799,450 persons in 2011 and still growing in 2012. The average spending per person of MICE visitors are equal to 3,267.4 USD per visit and the average length of stay 5.626 days. ([2])

2. Research Methodology

This research is focus on business process improvement in MICE industry base on the result of MICE participants that experienced the marketing innovation approach by software, programs, online media, out of home media and other advertising exposure through organizer’s business process from pre-event reservation, event management and post-event public relations and follow-up that measure the success of the organizer in using this Marketing Innovation approach to manage the participants. Total 300 sets of specific questionnaires were given to the participants of MICE activities in Queen Sirikit National Convention Center (QSNCC) for both domestics and internationals participants. The data has been collected and process using excel table to extrapolate and interpret the analysis.

3. Findings

The results of the questionnaires analysis show that the participants are 54.05% Female and 45.95% Male. Prior to participating in the MICE event 60% have received the information about the meeting, incentive, convention and exhibition via email, 22% by direct mail, 11% by phone and fax, remaining 6% received information from other methods. The findings show also the organization size of the participants 34% is smaller than 50 people, 31% is larger than 500 people, 15% is in the range of 51-150 people, another 15% is in the range of 151-300 people, only 5% is from the organization size of 301-500 people.

From the questionnaires, the researcher is identifying various media that participants use for their decision making to join the MICE activities or not prior to the booking as shown in Figure. 1:

![Fig. 1 Media exposure when participants are looking for MICE events](image)

The organizer used all Integrated Marketing Communication Channels both online and off-line [3] to communicate to all participants prior to the MICE event period for 3 consecutive months and results was found that 21% of the participants they have received email prior to the MICE event and join the event,
whereas 18% join because they have received invitation card, nonetheless, the target participants group who decided to attend MICE events from Poster, Leaflet and Newspaper are at 11% equally. There is only 9% who has seen the advertising from internet and decided to join the event, although the friend recommendation and invitation option are substantial standing at 8%, all of the remaining participants join the event because they have heard from TV, Radio and another media and decided to join-in.

From the interview, the organizer mentioned that the database is mostly in a middle to top management of Small and Medium Enterprise (SME), Multinational companies and Public listed companies. Moreover, according to the data collected from the organizer, the researcher found that the promotional channels for marketing in which the organizer used are divided into 5 categories namely email 60%, direct mail 22%, telemarketing 2%, fax 4% and other promotional channels 11%. The Fig. 2 below shows the media exposure from the organizer perspectives in order to illustrate the effort make for the pre-event promotion for 3 months prior to the MICE event date.

![Fig. 2 Media exposure from the organizer perspectives](image)

The researcher finds that when the participants decided to join the MICE event from domestics or overseas they have to make a reservation by login to the participant subscription page then choose to register as participants of a specific MICE events and all the customers’ information will be kept in the organizer’s customer database. The following screen captured shows the process from customer login page, as well as the result of the customer database has been kept in the organizer’s server. The last page shows the details of the selected MICE event that participants would like to join and payment details to the organizer in which the participants can choose to pay online or pay by bank transfer or credit cards.

![Fig. 3 Process of an online reservation system link with database and online payment system](image)

### 4. Interpretation and Analysis

#### 4.1 Media Promotional Channel

From the findings Fig. 2 and Fig. 3 it shows that majority of participants have received information from email and direct mail and decided to join the MICE events Therefore it is correlated result from the answer of the questionnaires that participants know and receive the information of the MICE event prior to the event date via email and direct mail total of 39% with the effort of the organizer to promote the event at 82%, which yield the factor of 0.47561 gives ratio of ½ effort to promote participants to join the event. In which the other printed media such as Poster, Leaflet and Newspaper contribute 33% of the participants attendance and the organizer has exposed 11% of their effort for this media, which yield the factor of 0.33333 gives ratio of 1/3 to promote participants to join the event. The marketing efficiency ratio indicates good...
performance for marketing spending [4]. The remaining percentage of participants come from other media and the efficiency of the exposure and result of the attendances are lower than 1/3 ratio.

4.2 Customers Database
The findings show that the online software adapted and used in MICE event management for registration and payment process helps the organizer to shorten the time process of managing the physical registration by collect customers database online and cross check it on the event date to prevent mismatch at the registration counter. This is the concept of Customer Relationship Marketing customer database development [5] to identify customers group, store and maintain updates their customers in the database.

4.3 Business Process Improvement
The MICE management has similar characteristics and process with an event management process [6]. From the findings, the result is proven that if the preparation time and management period at the event are reduced the cost of operating MICE business will reduce its cost tremendously. Refer to the research findings that the MICE business organizer has significantly reduce the process and time of participants’ reservation during pre-event, it also cut down the operation and mismatch registration at the front desk during enrollment registration of the MICE event.

4.4 Branding and Marketing Communication
Refer to Fig. 3 the sponsors has benefits greatly from the organizers thru media communication in various media channels. The MICE events also interact as part of the advertising channel to the target participants and marketing effort for sponsors of the event to get their Brands across to the participants [7].

5. Conclusion
The MICE business is a growing industry from the last 10 years various organizers and business players are enter into the MICE industry have adopt various methods and technologies to ease the convenience of the participants. The research questionnaires and interview shows that by using the online reservation and payment shorten the business registration time and mismatch of enrollment on the event date. Moreover using technologies assist the organizers and brands sponsors to use the MICE event as channel of Media Promotion and communicate brands to the right target audiences. Finally the organizers and business players can use these marketing channels – event to develop the customers’ database and improve the customer base as well as business process for participants.

6. Acknowledgment
Thank you for Queen Sirikit Convention Center (QSNCC) to allow researcher to do survey and collect data.
In addition, thank you to Thailand Convention and Exhibition Bureau (TCEB) statistics to give researcher understand the overview of the industry.
Finally, thank you for the organizers that provide the information, participant survey and questionnaires result.

References
[1] Pimratchada, “Key Economic Indicator”, Bank of Thailand, GDP - Table 2, 2012
Need Status Analysis in 3D cadastre, Thailand

Vuttinan Utesnan
Department of Surveying, Faculty of Engineering, Rajamangala University of Technology Krungthep

Tel. 02-287-9628 Ext. 2126, E-Mail: vuttinan.u@rmutk.ac.th

Keywords: Cadastral system, 3D cadastre, Land code, Condominium Act

Extended Abstract
Currently, with high population densities in are, 3D property situations with high property values are created in common law to secure the legal rights and/or fair taxation. Those situations have to be an unambiguous and clear registration of 3D situations. The developments at Cadastral organizations in many countries should be provided for better 3D-support due to the increasing complexity of infrastructures and densely built-up areas including Thailand. They require a proper registration of the legal status, private and public, which only can be provided to a limited extent by the existing 2D cadastral registrations. 3D property situations are different property units are located on top of each other or constructed in even more complex structures, i.e. engaging one another. It has become a challenge to register those situations and to be able to define and manage the juridical representation in 3D situations. Has Thailand a true 3D-Cadastre? Due to the functionality is always limited in some manner; e.g. only registering of volumetric parcels in the public registers, but not included in a 3D cadastral map, or limited to a specific type of object with ad hoc semi-3D solutions; e.g. for buildings or infrastructure (Peter VAN OOSTEROM, 2011)

In earlier research, especially the FIG joint commission 3 and 7 working group on 3D-Cadastrales, there are investigation in inventory of the status of 3D-Cadastrales by answer via questionnaire. The reporting are shared these information and exchange of experiences to support future developments in different countries and cadastral jurisdictions. The case from reports are used in a working the scope of the future 3D-Cadastre in a Thailand.

Land Code
Thailand, the Civil and Commercial Code(1932) has been dealing in private land under the Land Code(1954) that contains the main legal provisions covering tenure and administration of land. Under this code the Department of Land (DOL) is responsible for all cadastral surveys, including subdivision, for maintaining the land registers and for issuing land title document.

There are two types of rights to private land. The first is the right of possession (possessory right) i.e. people who possess and use the benefit of land will have the right to possess such land under the civil and commercial code. The second is ownership by a person who has a title deed and documents concerning the land. A title deed is vital in purchasing land in Thailand to protect the investment and avoid land disputes. There are many different types of land titles in Thailand, the majority of which do not allow for the legal right to build on that land. Chanote is a certificate for ownership of land. A person having their name shown on the deed has the legal right to the land, and can use it as evidence to confirm the right to government authorities. The title deed has been issued by using GPS to set the area and boundaries of the land, which is a very accurate method. Any legal acts may be done immediately, as per the right of ownership. Land partition of more than nine plots must be carried out according to the land allotment law, section 286. This is the most secure type of land title and is highly recommended.
Condominium

The Condominium Act (no.4) was passed and in 2008. The Act makes a large number of changes to the way in which condominiums are managed through the Condominium Juristic Person, and gives greater protection to the rights of condominium unit owners.

Registration of a condominium: To register a building as a condominium, the following documents must be submitted:

1. The title deeds.
2. Building map, including the roads for entry and exit to public roads.
3. Description of the condominium units, personal property, and common property including its area, its features, and other details in accordance with regulations.
4. The ownership ratio of the common property.
5. Evidence to show that the building sought to be registered is not mortgaged, except where such mortgage was made on the building jointly with the land.
6. The draft Condominium Juristic Person regulations.
7. Other evidence as prescribed by Regulations.

Advertising and photos, etc deemed to be part of sale agreement: When the owner of the land and building had advertisements made to sell the condominium units, he must keep copies of the articles, pictures or prospectus advertised to the public, in the operations office, until the condominium units have been sold, and must deliver copies to the Condominium Juristic Person for retention.

In sales advertising relating to the matters that have to be registered, the articles or photos must be the same as those submitted for registration and must specify the common property clearly.

It will be deemed that the articles, advertising photos or prospectus are part of the conditional sale agreement or sale agreement, and if there are any conflicts between the articles or photos in those agreements, then such conflict will be interpreted in favor of the buyer.

Sale agreement must conform with regulations: The conditional sale agreement or sale agreement must be in the form prescribed in regulations. Any part of the agreement which does not comply with regulations, and which does not benefit the buyer, will not be enforceable.

Ratio of unit ownership: The ratio of unit ownership in the common property of must follow the ratio between the area of each condominium unit and the total area of the units in that condominium

Extension of definition of common property: The list of items defined as common property is extended; the new full list is below:

1. Land on which the building is constructed
2. Land provided for common use
3. The structure and construction of the building to protect the condominium against damage
4. The building or part of the building and equipment provided for common use
5. Machinery and tools provided for common use
6. Facilities and services provided for common use
7. Other property provided for common use or for common interest
8. The operations office of the Condominium Juristic Person.
9. Improvable property purchased or received by the CJP
10. Building constructions or systems built to give security or to protect the internal environment of the condominium, e.g. the fire alarm system, lighting system, ventilation system, air conditioning system, water distribution and treatment system and waste processing system.
11. Property paid for by common area contributions.

Separate entrances and commercial activities: Where areas are used for commercial purposes, there must be a system to enter and exit the premises separately, in order to maintain the unit owners’ normal lifestyle. No one may conduct commercial activity in the condominium, except in the commercial areas allocated.

Contribution to common expenditure: Unit owners must share payment for taxes in the ratio of each person’s ownership in the common property. They must also share expenditure in relation to communal services and tools or equipment, including all communal facilities there for use and which give communal benefit, and share the cost of maintenance and management of the communal property, in the ratio that each unit owner has in the communal property, or by using the ratio of its benefit to the unit, in accordance with regulations.

Owner must pay contributions for unsold units: The owner of the land/buildings is deemed to be the owner of the units that have not had title transferred, and must share the costs under the paragraphs above.

Registration of transfer and expenditure for common property: In registering transfer of unit ownership, the applicant must submit a Certificate of Expenditure issued by the CJP manager for expenditure incurred, and certify that the condominium unit being transferred is free from outstanding debt. Transfer of the condominium unit will be made only when the unit has no outstanding debt. The CJP manager must issue the Certificate of Expenditure to the unit owner within 15 days from receiving the application and the unit owner has paid all the expenditure due. These provisions do not apply to a transfer made before registration of the CJP.

Contents of condominium regulations: Condominium regulations must contain at least the following information:

1. The name of the condominium with the words “condominium juristic person” in it.
2. The objects of the CJP approved by the unit owners.
3. The location of the CJP’s operating office, which must be in the condominium.
4. The amount of money that the unit owners must pay for advance expenditure.
5. Management of communal property.
6. Use of individual and communal property.
7. Ownership ratio of each unit owner in the communal property, in accordance with the condominium registration.
8. The ratio for sharing expenditure of unit owners.
9. Any other matters, as prescribed in regulations.
Powers and duties of committee members: Committee members have the following powers and duties:

1. To control the management of the CJP.
2. To appoint one committee member to be manager, where there is no manager or the manager is not available for more than seven days.
3. To hold a committee meeting at least every 6 months.
4. To act for any other purposes, as specified in regulations.

Matters requiring a majority vote by unit owners: A resolution regarding the following matters must be passed by not less than half of the total votes of unit owners:

1. Purchasing or accepting immovable property that is related to communal property.
2. Selling communal immovable property.
3. Permitting a unit owner to do construction work, decoration, improving, changing or extending his/her condominium unit at his/her own expense, which affects the communal property or the exterior of the condominium.
4. Amending or changing the regulations of the condominium in relation to the use or management of the communal property.
5. Amending or changing the expenditure sharing ratio.
6. Construction work that changes, extends, or improves the communal property.
7. Causing the communal property to gain benefit.

Where the unit owners attend a meeting but a quorum was not constituted, the meeting must be adjourned and reconvened within 15 days from the date of the previous meeting. At the new meeting a resolution concerning any of the matters above must be approved by not less than one third of the total votes of the unit owners.

Matters requiring not less than 25% of the votes of unit owners: A resolution regarding the following matters must be approved by not less than one quarter of the total votes of unit owners:

1. Appointing or removing the manager.
2. Prescribing activities that a manager can delegate.

Enforcement and punishment: The Act contains detailed provisions granting powers or entry and investigation to officials, and a scheme of fines and imprisonment for breach of duties imposed by the Act. These administrative punishments apply to managers and others, and should therefore be studied very carefully.

Comment: The practical problems of ensuring good management of buildings in multiple occupation causes difficulties in many countries. It is to Thailand’s credit that these changes have been made in the interests of ensuring good management, by imposing duties not only on the manager of a condominium and the Condominium Juristic Person, but also on individual unit owners to govern their relations between themselves.

Inventory status of 3D cadastre, Thailand
The FIG joint commission 3 and 7 working group on 3D-Cadastres (2010-2014) questionnaires are filled of 3d cadastre information distributed to public via internet, Thai code act printing, and
visiting DOL office for interview. A certain question is not relevant and will leave the field blank.
The following nine groups of questions were indentified:
1. General/applicable 3D real-world situations to be registered by 3D parcels, the types of 3D geometries to be valid 3D representations for these parcels.
2. Infrastructure/utility networks, the situation is considered to be defined within the cadastre, e.g. underground network to construct for leasing space, to run cabling, and to be a real estate object.
3. Construction/building units refer to constructions and condominium buildings.
4. X/Y Coordinates
5. Z Coordinates/height representation
6. Temporal Issues
7. Rights, Restrictions and Responsibilities
8. DCDB (The Cadastral Database)
9. Plans of Survey (including field sketches)
The last 6 groups are represented the Thailand- evident to have different procedures and public concerned to be in the situations currently, 3D parcels within one surface (2D) parcel.

Results of the Thailand questionnaire

1. General/applicable 3D real-world situations
In Thailand, there is only condominium as 3D parcel contained to be with one surface (2D) parcel. It is necessarily one parcel without the volumetric dimension supporting on cadastral system. The 3rd dimension of a 3D parcel is represented on 2D plans by height descriptions on the deed title. Ambulatory boundaries are not permitted in the vertical dimension. If there is some kind of this situation in the horizontal representation, the evident must be declared serious by DOL surveyor official field investigation. It is allowed to have 3D parcels not related to physical constructs or objects and do not refer to constructions (buildings, subway, tunnel). There is generic legislation (law and/or regulations) for 3D descriptions of parcels, the Condominium Act (no.4). So that natural resources (groundwater, mining rights) and polluted are to these space are not considered as 3D parcels, they must be registered of real right of national resource which the law declares to be property separate from the land, if they are existing. The cadastre system does not include spatial development as 3D parcel in any formal model.

2. Infrastructure/utility networks
This refers to the situation where an infrastructure network is considered to be defined within the cadastre. For example in some jurisdictions, an underground network might be privately constructed for the purpose of leasing space in it for other organisations to run cabling. In this case, a network, or part of that network may be considered to be a real estate object.

There are no registration network parcels in Thailand, any underground network, railway network or a network of cable communications are currently immatriculated in the Register of real right of State resource development which the law declares to be property separate from the land on which it is exercisable. These kinds of objects are not necessary represented in the cadastral plan and no database of those, even a private networks.

3. Construction/building units
Only condominium buildings, the individual units are defined by the actual walls and structure of a building, rather than by metes and bounds. E.g. “unit 5 on level 6 of … building” and must be registered 3D construction/building units with the most important types, private area and common area, in the jurisdiction. The 3D boundaries in an condominium are: middle of the wall and
floor/ceiling, or walls, floors/ceiling as neutral/shared 3D space including the external boundary of the walls, the floors and the ceiling. The land on which the apartment is built is part of the common property.

4. X/Y Coordinates

The plans of survey guarantee X/Y coordinates on some area with UTM relative system but on drawings are stored in an absolute spatial reference system with the cadastral database coordinates served for cadastral operation. The parcel are define by the walls of a building with no recorded geometry, in the case of internal common parts such as walls they act as a boundary instead of X/Y coordinates without the spatial reference system for X/Y Coordinates.

5. Z Coordinates/height representation

The Z coordinates of 3D parcels are not relative to local ground on the title plans and on the vertical profile the Z coordinates are height relative to ground floor but not an orthometric altitude (geoid) and H (height) relative to the altitude standard datum. The earth surface (height) explicitly is not stored in the DCDB or other accessible register.

6. Temporal Issues

Temporal limits are part of the definition of a parcel 2D and 3D by only resurvey field checking at registration procedure date. Therefore there are not any attempt to integrate 3D space and temporal representations, into a single 4D space/time representation?

7. Rights, Restrictions and Responsibilities

Range of RRR on 3D parcels are specific rules although those related to co-ownerships. The immatriculation of the private and common portions of a vertical divided co-ownership may take place before the foundation and main walls of the building in which they are situated allow measurement of their boundaries that are only allowed in 3D and not valid for 2D by specific legislation defining 3D RRR types. The 3D sub-surface/above-surface parcel can not be owned by someone other that the person owning the land parcel, it is what we call right of superficies.

8. DCDB (The Cadastral Database)

The DCDB do not contain representation of 3D parcels, as explained before, but only they are represented (in the DCDB) as 2D polygons and specific identifying presented on cadastral “maps” including screen presentations. The constraints/rules defined for valid 3D objects closed volume, no overlap, no gap in 3D are controlled manually and referred at having no overlapping between vertical and horizontal geometry. The internal and external user can not query and visualize the 3D content supporting rotating, slicing, transparency, perspective (3D web/view service, 3D pdf documents,...), just only the 3rd dimension currently available via paper plan or 2D PDF image file and tag showing vertical profiles.

The only way to query 3D objects is by the regulation number, by getting 2D polygon and some information about the lots attached to it without no direct access to 3D objects.

9. Plans of Survey (including field sketches)

The survey plans carry 3D parcel representations, firstly the survey plans are not available to users, secondly they do not contain 3D representations but only vertical profiles of the properties. There is specific legislation (regulations) describing the requirements for Plans of Survey in 3D.

Land surveyors are doing some visual and manual control.
**Status Analysis of 3D cadastre to FIG contexts**

In Thailand context, right on land is supported a heaven to centre of earth on parcel. The restricted right is in the form of ownership rights or encumbrance in the strata, even the rights or encumbrances in strata are sub-divided, not amalgamated or nullified. However, distinction made between a 2D parcel plan and building construction are used to represent strata in the various level details as attributes, just above the ground.

2D parcel in Thailand can be subdivided to shown 3D ownership in vertical direction and not affect the status of the 3D parcel which they may span several 2D parcels under leasing existed on part or the whole of a 2D parcel. All 3D parcels are constrained to be within one surface (2D) parcel this does not exclude that the building to which the right refers may be situated on several land parcels. 3D parcel may have full or partial overlap with another interest.

3D rights are permitted as in the case of 3D easements, limited height parcels or building only. A condominium unit cannot be demolished with the owners rights alone for a replacement on the same level. The replacement may be done by its location in space without distrusted to any construction. The registered right compulsory must refer to an existing construction or a building permit issued for future constructions before a 3D property can be registered.

The cadastral survey requirement is quite explicit in that the 3D parcel boundaries to be formed must be measurable or definable mathematically. Building drawing plans deal with strata quite differently in an absolute height without reference to datum with an isometric drawing provided in advertisement or public. A parcel is a plan provides an outline of the surface parcel details of each unit for distinguishing between common property and areas of each unit. Generally the boundaries of 3D parcels refer to walls, ceilings and floors. The z-axis (height) appears in the systems on this issue existed in registration which is made to a height relative to ground level.

3D registration is supported by the titling system and 3D parcels are registered as building drawing. No the digital cadastral database, the strata are shown as description and all 3D related information exists in the plan as strata title. 3D data is not represented in the viewing tools of the database. The description of the 3D space will be found in the survey plans or in the legal documents, not in cadastral map.

Cable and pipeline networks, a number of ways network parcels are not registered in Thailand. Some 3D easements can be created others subdivide the surface parcels without restriction on the minimum cross-section size of a 3D parcel. These networks often extend over several land parcels and have height or depth of the structure, a 3D character of their own. They are not displayed on the cadastral plan and can not be found in the cadastral database.

**Developments in the future**

The purpose of this paper is not only to make inventory of the status of 3D-Cadastre at this moment by the FIG Working group questionnaire, but also to get trend development for the future. The cadastral system under DOL, Thailand is currently handle a 2D cadastral map represented registered the legal situation, which can be used as entry to the legal and administrative information on a title document for existed the 3D situation in one by one document. The DOL store 3D information with surveying approached on hard copy. That is future development in digital formation on database or 3D geographic information system linked to legal information. The users can view the 3D information closer to the real world situation the same 2D information framework,
moreover they can check on neighbor unit correctly represented no overlap or gaps between those unit in 3D space. In order to be able to obtain these results a number of problems have to be solved, the individual property objects have to be converted into 3D geo-objects in the Database in coordinate position to be linked to the administrative and legal information that is registered for the 3D properties. For the causes, to improve the registration of condominiums by truly including the height information and moving from a 2D map model to a 3D cadastral model. These objects can be of different type; e.g. Unit, Common Element, Limited Common Element, Lake, Outlot, some of which can be 3D in nature.

CONCLUSION

This paper presented the cadastral registration in Thailand, which is characterized by its highly centralized for the nation-wide and uniform access to real property information on the transparency of the market and the legal security of real property, especially in urban area as real estate objects of difference owners are righted only on top of each other requiring more detail third dimension in cadastral registrations. It has been invented already a more progressive cadastral registration in operation as condominiums act. Moreover these situations: the skywalk system, networks and cables, and the subsurface ownerships, will be investigated in complicate issues to be improved through the application of the true 3D cadastral registration. Maybe case by case of 3D real estate objects: underground shopping malls or parking garages, tunnels, pipelines, 3D mining rights, etc should be investigated for specific cadastre acts.

Technical technology investments and required knowledge levels for 3D cadastral system are more complicate than the current 2D cadastral base system due to the data ownership and maintenance responsibility remaining at the current level. This will include the increasing need of 3D functionality. The centralized case of a 3D cadastral system could be much more effective to jointly set-up a system similar to many country’s status for the good practice.
IPhone Application for Travelling by State Railway of Thailand

Warisara Pardee and Patiyuth Pramkeaw
Department of Media Technology,
King Mongkut’s University of Technology Thonburi
Tel. 02-470-7606, E-Mail: Patiyuth.pra@kmutt.ac.th

Keywords: Application, iPhone, Train, Macbook, Xcode, Objective-C, Adobe Photoshop CS5

Abstract
This application is to support customers who travel by State Railway in Thailand. The first step of application development is to search and collect all relating information for design and building iPhone application. The design of the application was made accordingly to the analysis based on the users opinion toward features of developed application. The application can be selected into two languages - Thai or English. The users can search for information which is linked directly to the official website of State railway of Thailand. The application was designed and developed using Xcode program on a Macbook. The language used in developing application is the Objective-C. This application mainly targets on people who have iPhone device and internet is needed in association with application, otherwise only partial information can be displayed on iPhone device.

Keywords: Application, iPhone, Train, Macbook, Xcode, Objective-C, Adobe Photoshop CS5

1. Introduction
Nowadays, Thailand serves as a gateway to Asia. It is a center of many businesses and popular tourist destinations in the world and neighbor countries. In each year foreigner have been travelling in Thailand and roost before visiting other neighboring countries. Not only foreign tourists who are interested in travelling to Thailand but Thai people also, especially during holidays, long weekend and summer. Most streets are crowded with travelers’ car. For this reason, Thailand needs public utilities and standard public services, it is also transportation in Thailand. Modes of transportation include land (car, coach, bus, motorcycle, bicycle, taxi, train, MRT, BTS), water (boat) and air (airplane, helicopter). It helps foreign and domestic tourists to travel in country easier.

In present, communication systems have been developed to help finding information faster through online system available today. No matter how far or close to where we can access online application by our smart phone. A very most popular portable electronic device in these days is iPhone. It is a smart phone which this study is based on Innovation Internet Research Thailand that iPhone users have accessed to website more than other mobile version regarding statistics of people using the internet in Thailand over 25 million in February 2555. Using smart phone can reach to information easily and quickly then it has a program applied we know as application. Application is a program that designed to be used within only a browser. The advantages of application are quick installation and updating all the time that help users update correctly and accurately. From the above, it can indicate transportation in the country and using communication device if we combine these reasons together to be an application for travelling in Thailand. This application can be useful for foreigners who travel in Thailand including Thai people because most people use car to travel. However, if required public transportation they may lose their ways. This study will use the train service problem. It is public transportation which people use a lot. Train transport is mass transportation for shipping and carrying for long distance.

The State Railway of Thailand has created a website for user to view itinerary including booking tickets. So, researchers have an idea to create application about the State Railway of Thailand on iPhone. This application will help user to reach information easily and quickly more than find in website. It will feed information from the State Railway of Thailand on the screen of user’s iPhone directly and precisely according to updating of the State Railway of Thailand. For
example, time schedule for train departure and arrival in Thailand. Present, the State Railway of Thailand has run for distance 4,346 kilometers of from center area in Bangkok, users can view schedule for train and share to social network on Facebook, Twitter and E-mail.

2. Method description

Thai Train is an application on IPhone to be facilitated, quickly, correctly and accurately for train service user. It helps to find route and emergency contact phone numbers and address that is appropriate for everyone. From our study according to information, we found less people use train in each year. For this problem, we must have applied software for user to reach more information and train services. The organizers have organised theory, information on website, books and related research below.

2.1 Transportation in Thailand

Transportation is a communication between local areas. It starts from small place to big place such as is village, district, province and country. In present, Thailand is the gateway to Asia. It is center of many businesses also it has tourist destinations in the country and neighbor countries. In each year foreigner have traveling in Thailand and roost before visit to other neighboring countries. Not only foreign tourists who are interested to travel in Thailand but Thai people also, especially during holidays, long weekend and summer. Most streets are crowded with cars of travelers. For this reason, Thailand needs public utilities and standard public services, it also transportation in Thailand. Modes of transportation include land (car, coach, bus, motorcycle, bicycle, taxi, train, MRT, BTS), water (boat) and air (airplane, helicopter).

2.2 IPhone

iPhone is a smart phone developed by Apple Inc [1], who designed Mac computer. iPod Touch is similar iPhone but it cannot be used as a phone.

2.3 Development of application for IOS devices

Development of application for iOS devices (iPhone iPod and iPad) uses Xcode program and Objective-C. In present, IOS App development has opened up without any attachment to the SDK (Software development Kit) or the development of Apple however, iOS SDK is still the highest development kit and has operating system (OS). Mac OS is operating for Mac [2].

2.4 Application design

2.4.1 Program used in design

- Conceptual Mock-Up, it is a program to simulate project for developer to illustrate clearly.
- OmniGraffle Professional is diagramming program used to create diagrams, flow charts and illustrations.

2.4.2 User Interface

User Interface for iPhone design to be easy to use and more appropriate for display on limited device. Everything is Vitual Botton shown on screen and Multi-touch. It is one thing of iPhone different from computer. UI Control in iPhone designed for small devices.

2.4.3 Multi-touch

Multi-touch refers to a touch sensing surface's ability to recognize the presence of two or more points of contact with the surface, makes it possible to design Gesture or movement commands. In past, we can only press and stylus but we take Multi-touch to using, we can use two fingers extend into expand things in screen or inward to zoom out or use two fingers to rotate things in screen. When we combine Multi-touch and Accelerometer to check application it is distinct from other mobile device.

2.4.4 Conceptual design

Conceptual design called Model-View-Controller (MVC) by

- Model is important to operate program as object to calculate various processing.
- View requests from the model the information that it needs to generate an output represented to the user.
- Controller can send commands to its associated view to change the view's presentation of the model (e.g., by scrolling through a document). It can also send commands to the model to update the model's state (e.g., editing a document).
3. The Development Process

Design and create application for train travels on iPhone are divided into main parts there are Main menu, usability and Screen design.

3.1 Population and sample for survey interview

Population and sample for this research are people have been used train services 92 persons and people haven’t been used train services 38 persons, total there are 130 persons by using random sampling and collect data to be primary data. It is random and crawling directly sampling by use questionnaire in form Yes or No which is a convenience sampling.

3.2 Survey tools

3.2.1 Questionnaire about creating application for travelling by train in Thailand on IPhone

Step to create questionnaire about creating application for travelling by train in Thailand on IPhone [3].

Step1: Study about theoretical concepts of creating the questionnaire. Study form and type of various questionnaires in website and related project.

Step2: Set project variable to complete objective of project.

Setting project variable of questionnaire in each part must accord to objective of project. The organizers of project have been set a title from studying information about travelling by train to design the questionnaire to ask sampling regarding requirements of travel by train on iPhone application.

3.3 Design and create application

When we open to access program will be loading before back to main menu which we can choose 2 types of languages, Thais or English. Main menu is divided into 5 buttons for user to choose.

1. Time table, telling schedule to leave and out for each train.
2. Check Time, find especially route.
3. Fine Me, find location themselves.
4. Knowledge, telling information that you should know about the State Railway of Thailand.

Information presented in application is taken from website of the State Railway of Thailand there are,
- Train station, to show important data of each station that can select from 454 stations which show pictures and phone numbers of each station.
- Knowledge, to show general information such as type of train ticket, type of convoy and guidelines while using train service.
- Tourism, to show attraction from the State Railway of Thailand which come from their website.
- Contact us, to show emergency number and important station. You can dial a phone number immediately.
- More information, to show contact data and map of the State Railway of Thailand from their website.

5. Share, tell story about journey of train service in Thailand through application on IPhone. You can share on social
network. It also has Facebook, Twitter and E-mail connections.

4. Preliminary Result
Development application on iPhone that bring information to design and create application for facilitating train services. We manage to create application for travelling by Thailand train on iPhone.

4.1 Result of data analysis from survey
From the survey of create and develop application for travelling by Thailand train on iPhone result shown as follows.

<table>
<thead>
<tr>
<th>Report</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Timetable</td>
<td>98</td>
</tr>
<tr>
<td>2. Check Timetable (Origin-Destination)</td>
<td>96</td>
</tr>
<tr>
<td>3. Map search current place</td>
<td>95</td>
</tr>
<tr>
<td>4. Map close current place e.g. hotels, train station, attractive places.</td>
<td>90</td>
</tr>
<tr>
<td>5. Service point images e.g. public relation, ticket office.</td>
<td>75</td>
</tr>
<tr>
<td>6. Platform images.</td>
<td>78</td>
</tr>
<tr>
<td>7. Station plan</td>
<td>83</td>
</tr>
<tr>
<td>8. Type of tickets</td>
<td>95</td>
</tr>
<tr>
<td>9. Type of trains</td>
<td>95</td>
</tr>
<tr>
<td>10. Regulation of train services</td>
<td>96</td>
</tr>
<tr>
<td>11. Call center</td>
<td>97</td>
</tr>
<tr>
<td>12. Share information and picture on social network</td>
<td>89</td>
</tr>
<tr>
<td>13. Save essential information and send to E-mail</td>
<td>78</td>
</tr>
</tbody>
</table>

Table 4.1 Show amount and percentage of survey.

4.2 The Result of development application for travelling by Thailand trains on iPhone
Application for travelling by Thailand trains on iOS system designed user interface to easy to use and appropriate group of user. Design elements that transmit to meaning of travel and tourism in Thailand by emphasize color relaxation e.g. Blue and Yellow. It helps users feel like a leisure traveller. The purpose of design is benefit to organizers accentuate in picture and language to mutual recognition as well.

4.2.1 Main Menu
Configuration design of Main Menu have motion picture for user attractive and use map to indicate Thailand otherwise we use relaxation tone color like Blue, Yellow and Green.

Compositions of Main Menu there are divided into 6 parts.

A. Timetables
B. Check Timetables and Fares
C. Find Me
D. Knowledge
E. Share
F. TH-EN

Fig. 2 The app shows loading of application.

Fig. 2 The app shows Main Menu of application.
4.2.2 Sub Menu

You can select language and view the following information.

A. Timetable: The symbol is clock image, it refers to the time that show schedule of train to leave and arrive. Information presented in application is taken from the State railway of Thailand website there are Northern line, Southern line, Northeastern line, Eastern line, Commuter Train, Wongwian Yai-Mahachai, BanLaem – Mae –Klong , Siriraj Hospital – Salaya.

B. Check Time: The symbol of routes finding is glasses, it refers to finding routes by filling origin station and destination. Information presented in application is taken from the State Railway of Thailand website.

C. Find Me: The symbol of Find Me is eye image, it refers to seeing and finding own address.

D. Knowledge: The symbol of Knowledge is a image of question mark, it refers to question which has answer about things of the State Railway of Thailand. Information presented in application is taken from the State Railway of Thailand website.

5. Conclusion

IPhone Application for Travelling by State Railway of Thailand that begins from Xcode programming. It uses for writing application on IPhone that we applied and developed to benefit for tourism. This application will help traveller to find routes, emergency numbers and more. The results of design and writing application written in Xcode programming on Macbook by Objective-C. In illustration design works through Adobe Photoshop CS5. This application particularizes for IPhone users and must connect the internet to access all data but without connecting this application will show some part of information this study provides the supplement to travelers on Thailand state Railway.

6. Acknowledgment

This study has been financially granted by the Department of Media Technology at King Mongkut’s University of Technology Thonburi.

References


User-Cocreation in New Product Development Process
A Case of Developing a New Weight Control Product from
*Ocimum canum* Seed

Alisara Suriyasomboon 1*, and Amorn Petsom 2

1*, Department of Business Management, Faculty of Business Administration, Rajamangala University of Technology Krungthep
2 Department of Chemistry, Faculty of Science, Chulalongkorn University
* Corresponding author Tel. 02-228-9673, E-Mail: alisara.s@rmutk.ac.th

Abstract
Obesity is a serious worldwide problem and associated with the risk of developing many diseases. In the past 20 years, the rates of obesity had increased in developing countries that adopted a Western lifestyle. Dietary fiber might also be one useful for weight losing or weight controlling. Dietary fiber is thought to function in a simple way by filling the stomach and causing a feeling of fullness, while providing little to no calories. *Ocimum canum* is a natural plant product, strengthen in dietary fiber. This study is mainly to search for new areas of opportunities, which typically involve the trend of consumers needs in weight control products. In order to develop successful new weight control products, it is important to gain a deep understanding of the voice of the consumer. Therefore, the result of this study will be the customer information, which using to develop a radically new weight control products from *Ocimum canum*, in the further research.

Keywords: *Ocimum canum*, weight control, dietary supplements, herbal medicines, consumers

Introduction
Obesity is a serious worldwide problem and is associated with the risk of developing diabetes. Today, more than 1.1 billion adults worldwide are overweight, and 312 million of them are obese [1]. In the past 20 years, the rates of obesity have tripled in developing countries that have adopted a Western lifestyle, facing the greatest increase. Many previous studies have shown that dietary patterns and lifestyle factors are associated with mortality from all causes, coronary heart disease, cardiovascular diseases, and cancer. Clinical studies have shown that sustained moderate weight loss achieved through lifestyle intervention lowers blood pressure, improves glucose control, and prevents diabetes. The benefit of modest weight loss achieved by lifestyle intervention on diabetes prevention was demonstrated in a study by Wing et al. [2]. Weight change was achieved by diet (decreasing calories and fat intake), exercise, or the combination of diet and exercise.

Dietary contributors to obesity are not well understood. Dietary fat was considered a leading cause of overeating and weight gain until other dietary composition factors began to emerge as potentially important modifiers of energy intake. These include carbohydrate, protein, fiber, and energy density. Increasing dietary fiber may help reduce energy intake by decreasing overall energy density and absorption of energy-yielding nutrients, and enhancing satiety. High fiber intake is often correlated with other key dietary factors such as low fat, and low energy density [3]. Higher fiber intake is statistically associated with lower body mass index (BMI) or less weight gain [4]. Dietary fiber might also be one useful for weight losing or weight controlling. It is thought to work in a simple way by filling the stomach and causing a feeling of fullness, while providing little to no calories. Dietary fiber might also interfere with absorption of fat.

The term dietary fiber is still controversial. Dietary fibers are the indigestible portion of plant foods that move food through the digestive system, absorbing water and easing defecation. Almost all forms of fiber come from plants and none is digested in the human stomach or small intestine. There are two kinds of fiber: soluble fiber, which swells up and holds water, and insoluble fiber, which does not. Pectin, gums, and mucilage are found inside and around plant cells.
They glue plant cells together. These dietary fibers can dissolve or swell when put into water and thus are called soluble fibers, more formally called viscous fibers. Soluble fiber is found in *Ocimum canum*, psyllium seed (sold as a laxative). Soluble fiber undergoes metabolic processing via fermentation, yielding end-products with broad, significant health effects. Soluble fiber is also found in *Ocimum canum* seed, which is a popular supplement used in drinks and desserts in Thailand [5]. The seed is small, black, and oval and contains 80% dietary fiber with about 8.8% viscous fibers [6]. Similar to psyllium seed preparation, *Ocimum canum* seeds are soaked in water causing a gelatinous coat to form. Psyllium seeds are expensive and must be imported from other countries, making *Ocimum canum* seeds a better alternative as a supplement in Thailand.

New product development (NPD) can originate from new technology or new market opportunities. But irrespective of where opportunities originate, when it comes to successful new products it is the consumer who is the ultimate judge [7]. Radically new refers to products requiring research and development efforts that give rise to new technologies (new knowledge). These technologies serve as a base for know-how in production, patent and as strategic resource. In order to develop successful new products, companies should gain a deep understanding of the voice of the consumer. It is most widely applied consumer research during the development, testing and launch stages. The goal of this stage is to search for new areas of opportunities, which typically involve the unmet needs and wants of consumers. In this way, it helps to avoid working on a new product that has a low probability of success. Gathering consumer understanding with the help of formal consumer research methods has the advantage that the results can more easily be disseminated across departments in an organization.

In order to develop successful new weight control products, it is important to gain a deep understanding of the voice of the consumer. Therefore, the goal of this study is mainly to search for new areas of opportunities, which typically involve the trend of consumers needs in weight control products. Hence, the result of this study will be the customer information, which using to develop a radically new weight control products from *Ocimum canum*, in the further research.

**Materials and Methods**

The goal of this study is mainly to search for new areas of opportunities, which typically involve the trend of consumers needs in weight control products. In order to develop successful new weight products, it is important to gain a deep understanding of the voice of the consumer. Thus, the result of this study will be customer information, which using to develop a radically new weight control products from *Ocimum canum* using a new technology [8] (Fig 1).

In order to develop successful weight control products, it is important to gain a deep understanding of the voice of the consumer. Therefore, the goal of this study is mainly to search for new areas of opportunities, which typically involve the trend of consumers needs in weight control products. Hence, the result of this study will be the customer information, which using to develop a radically new weight control products from *Ocimum canum*, in the further research.

**Survey potential customers with product demonstration**

The participants attended in the seminar of “From R&D of potential food products to commercial market” were asked for willingness to answer questionnaire. In the seminar, there were presentations and panel discussion of several food products such as abalone, herbal teas, and *Ocimum canum* powders. Two questionnaires were given to the participants during the seminar. The first questionnaire was used, in the sense of investors, to evaluate the potential of the business projects, which including the feasibility of market potential, production potential, and financial potential. The second questionnaire was used, in the sense of customer who known details and/or tested the product, to evaluate the perception of testing of *Ocimum canum* powders. Moreover, the type and characteristics of supplementary food products, especially for weight control products, were examined.

**Survey potential customers who have overweight condition**

In this study, the population under investigation can be defined as general consumers, food purchase decision-makers, weight concern, body mass index (BMI) greater equal 25, and aged from 18-75, resident of Bangkok. The second questionnaire was used with target customers who have over weight condition to evaluate the perception of *Ocimum*.
canum, and potential to use Ocimum canum products. Self-adjustment was also used to select the demographic difference among the samples. The survey was carried out during the time period from August to September, 2008.

**Statistic procedure**

The data was handling and analyzed using SPSS for Windows version 16 (SPSS Inc, Chicago). The descriptive values were presented as mean±SD.

**Results**

**Survey potential customers with product demonstration, and potential customers with overweight condition**

In total, there were 77 out of 150, the first, questionnaires received from the participants. The likate scale, from 1 to 5, was applied for evaluating the feasibility of market potential, production potential, and financial potential of Ocimum canum seeds. There was moderate potential for all three factors of 3.17, 3.33, and 3.07, respectively. The second questionnaire was used to evaluate the perception of Ocimum canum. This questionnaire was provided to two groups. The first group was the potential customer with product demonstration in the seminar, and the second group was the potential customer with overweight condition (from random sampling). The number of questionnaire received from the first group and the second group were 77 and 200, respectively. There were 72 out of 200 persons, in the second group, who have body mass index (BMI) greater equal 25 (BMI $\geq$ 25 is overweight condition). In both groups, there were 26% and 41% of the respondents who had experienced in weight control within last 6 months. Moreover, there were the same proportion in both groups, 16% and 13%, had experienced of using Ocimum canum for weight control purpose.

Respondents were asked to choose the source of believable information which can choose more than one choices. The proportion of source of believable information were scientific research, ministry of public health, successful user, research from university, and health professional were similar in both groups (group 1: 68, 61, 45, 39, and 39 %; group 2: 51, 55, 51, 39, and 42, respectively). Moreover, the purchase criteria for weight control products were presented in Table 1. The favorable criteria were weight control benefit, safety guarantee, and price in both groups. However, the proven from scientific was relatively weak criteria for purchase weight control products.

**Table 1 Percentage of respondents who reported the purchase criteria for weight control products.**

<table>
<thead>
<tr>
<th>Purchase criteria for weight control products</th>
<th>Group 1 Potential customer with product demonstration (n=77)</th>
<th>Group 2 Potential customer who have over weight condition (n=72)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight control benefit</td>
<td>46 24.0</td>
<td>51 75.0</td>
</tr>
<tr>
<td>Safety guarantee</td>
<td>38 19.8</td>
<td>44 64.7</td>
</tr>
<tr>
<td>Price</td>
<td>32 16.7</td>
<td>46 67.6</td>
</tr>
<tr>
<td>Prove from scientific</td>
<td>29 15.1</td>
<td>17 25.4</td>
</tr>
<tr>
<td>Convenient use</td>
<td>22 11.5</td>
<td>30 44.1</td>
</tr>
<tr>
<td>Taste</td>
<td>23 12.0</td>
<td>16 23.5</td>
</tr>
<tr>
<td>Other</td>
<td>2 1.0</td>
<td>2 2.9</td>
</tr>
</tbody>
</table>

In both groups, the respondents were likely to use a new weight control product from Ocimum canum: 66% and 71%, in group 1 and 2, respectively. The proportion of perceive benefit of Ocimum canum in both groups were similar. The generally perceivable of Ocimum canum were dietary fiber, prevent constipation, prevent lipid and glucose absorption, and laxative (group 1: 75, 58, 41, and 38, respectively; and group 2: 60, 41, 36, and 36, respectively, Table 4). Moreover, the preferable form of new weight control product were fiber drink, tablet, and water soluble powder 62, 27, and 26% in group 1, and 51, 45, and 25% in group 2, respectively.

**Discussion**

This study investigated the potential of developing and marketing of a new weight control product from Ocimum canum seed. The results showed that the technology in producing weight control product from Ocimum canum seeds was feasible. The process for production Ocimum canum seeds powder with low fat content by using supercritical fluids technology was currently extended from laboratory scale to commercial scale. However, the disadvantage of using this technology was the cost of the machine was quite expensive (data not shown).

The marketing results revealed that the market opportunities for weight control products...
producing from *Ocimum canum* seeds were possible due to many reasons. Firstly, the overall market, production and financial feasibility of *Ocimum canum* products were moderate to good (data not shown). Secondly, Thai people were known and families with *Ocimum canum* seeds. Moreover, the *Ocimum canum* seeds powder were natural product, and can produce within the country. However, the form of using *Ocimum canum* seeds powder was still doubt. Because *Ocimum canum* seeds powder should be soak with water before eating or using. Thus, further study is required to elucidate the suitable form of *Ocimum canum*.

In conclusion, our data have demonstrated that *Ocimum canum* seeds were possible to developing a new weight control product. The technology for producing *Ocimum canum* seeds powder was robustness and applicable for commercial scale.

References


Global Outsourcing of Manufacturing: A Case Study of Danish Agricultural Firm

Kittipong Sophonthummapharn\(^1\) and Jens Graff\(^2\)

\(^1\)Department of Marketing, Faculty of Business Administration, Rajamangala University of Technology Krungthep
\(^2\)Associate Professor in International Business

Tel. 08-9011-1295, E-Mail: kittipong.s@rmutk.ac.th

**Keywords:** starch, production quotas, outsourcing, Vietnam, decision making

**Abstract**

This research provides a better understanding of sourcing problems, especially when sourcing from a different culture. A case study has been implemented and the decision maker of a Danish company’s sourcing decision in Vietnam has been interviewed. Besides, the company’s homepage, different company material, and press articles have also been used. The case reveals several problems with the company’s decision to source from Vietnam. Some of the problems can be characterized as cross-cultural problems, some as managerial problems, and some as external factors.

**Keywords:** starch, production quotas, outsourcing, Vietnam, decision making

1. Introduction

In general, firms outsource or offshore of cost saving reasons. They can produce material and components at lower costs abroad than at home. Sometimes the reason for extending the global supply chain is to get cheaper or better warehousing and customer care services and increasingly, to get access to expertise in new product development, research and development, design expertise and IT expertise. Increasingly, outsourcing becomes strategic as the competence of receivers of outsourcing climb up the value chain and become more and more capable in their activities.

Outsourcing is not always rooted in the wish for cost savings. Other reasons can be lack of workers with the right skills expertise or it can be lack of raw materials. In this case study the main reason for outsourcing was the still tighter quota system in the home country that meant that future growth mainly could take place offshore.

In offshoring and outsourcing there are many risks. A major risk is loss of quality. Often, outsourcing companies have not extensive knowledge of the production set-up in the host country and no knowledge of how the production process really works in daily life. There can be differences in work ethics and product safety. There can be risks related to intellectual property rights and parallel production of the outsourcing companies designs.

This research examines the problems with global outsourcing of production of agricultural products. A Danish firm that has outsourcing internationally has been used as a case study for this research.

2. Literature Review

2.1 Outsourcing Concepts

“Outsourcing can be defined as turning over all or part of an organizational activity to an outside vendor.”[1]. Outsourcing is generally considered to be very potent means for cutting costs and improving performance. The automobile industry delivers a good example of widespread outsourcing as automakers today outsource a large percentage of their component manufacturing to their suppliers. Earlier, automakers were much more vertical integrated with own production of components, own assembly, and own design. Related to outsourcing is offshoring, which means “transferring production from one country to another, with or without outsourcing to a supplier organization.”[1]. The case described in this research is of this type, as the Danish Company went into a joint-venture with a company with production in Vietnam. Reference [2] describes outsourcing decisions along a continuum from a single purchasing decision to a joint venture with still higher company/supplier involvement.
The company should be aware of possible gaps and make insurance arrangements accordingly. There is a list of rules to consider before deciding on offshoring/outsourcing. The rules include 9 checklists: 1) Make an outsourcing decision based on strategic goals, not just tactical urgency 2) Retain domain knowledge 3) Design an exit strategy 4) Communicate fully with current employees 5) Build joint company-vendor teams 6) Invest in a robust selection process 7) Define appropriate performance measures 8) Provide the right incentives and 9) Assess insurance coverage. This rule is a good starting point in designing a feasibility study and later go into a partnership involving offshoring/outsourcing [3].

However, there are many hidden costs of offshoring, among which are productivity of foreign workers, using raw material less efficiently, indirect costs of moving an operation out of the home country, extra supervision and training, more product inspections, more local security, higher costs of freight to deliver products to customers at home, greater inventory in the supply chain, higher packaging, travel, and telecommunication expenses as some of the critical factors to consider before decision of offshoring takes place [4].

2.2 The chosen firm

KMC is a Danish starch producing company in Brande on the Jutland peninsula. It has 130 employees and is number three or four in the global market for starch from potatoes. It gets its products from three starch potato factories, which own KMC. The factories, in turn, are owned by farmers (potato growers). KMC market its product to more than 70 countries.

KMC has grown from being a supplier of starch in bulk to being a supplier of food ingredients with more value added products. KMC has invested more in research and product development, and realizes that custom making products for its customers is the way to succeed in the market and improve profitability.

2.3 Market Competition

The starch market is rapidly increasing, especially in developing countries with rising living standards. In South America, Africa, and the Far East, starch is produced mainly from tapioca root, also called cassava root, where the climatic conditions are ideal for tapioca.

The yearly production of tapioca roots is about 160 million tons. Roughly half of this is produced in Africa and roughly a fourth in Asia. In Asia, Thailand is the biggest producer, followed by Indonesia. These two produce two thirds of the tapioca roots in Asia. Vietnamese production is only about one tenth of Thai production. A big part of tapioca is used for animal feed and to produce alcohol for gasoline. The total production of tapioca for starch is about twice as much as that of starch from potatoes.

The main tapioca producers are found in Thailand, Indonesia, Vietnam, and Brazil. In Thailand the predominant supplier is Thai Wah Group (Rose brand), which is involved in eight native starch plants and at least one modified starch plant. The Roiet Group (Triple Triangle Brand) is involved in at least four plants. Whereas, Vietnam has 15 tapioca starch factories. The major producer is Vedan, with four plants. Thai Wah Group also has two plants in Vietnam.

Thailand is the world’s largest exporter of tapioca starch, with exports to Taiwan, Malaysia, Japan, and Hong Kong. These markets receive more than two thirds of Thailand’s exports. Additionally, exports to USA and Europe are also increasing.

3 Methodology

Exploratory research method is chosen, trying to find factors that create problems with global outsourcing of production. Exploratory research is usually conducted when the researcher does not know much about the problem and needs additional information or desires new or more recent information [5].

A case study is used for deep analysis of selected firm. The case study is based on narrative research. It is common in narrative research for researchers to interview people and then transcribe the interviews. Reference [6] has used a method of asking respondents to reflect and then write down their narratives instead of telling them orally to an interviewer. They call this method a complementary method for constructing meaning. This research use a method of interviewing, audio taping, and making resumes within 1-2 days after the interviews.

Besides, respondents have reported in writing some questions asked by the researchers. The resumes were sent to respondents for approval and any corrections made. In this way respondents had options of further reflections and
deepening which for some of the respondents resulted in further detailing by email.

Further, the case study is based on documentary analysis. Documentary analysis does not require engagement with human participants [7]. Content analysis is appropriate for analyzing the content of texts. Specifically, internal company documents, such as feasibility studies, emails, and minutes of meetings have been scrutinized to get insight in the decision process before the outsourcing decision was made [8].

The sampling method is judgment sampling. A Danish company producing starch from potato has locating part of its production in Vietnam, and it has struggled with several problems in this respect. It has been widely described in the Danish business press. Furthermore, the researchers had easy access to the company’s CEO, who had made the decision to invest directly in a production facility in Vietnam, and whom had lived with this decision until his retirement from the company in 2011.

This research project is based on qualitative research with case studies, and one cannot generalize from this (statistical generalization) regardless of the number of cases. They can, however, provide construct validity and internal reliability (analytical generalization) [9]. Future studies might show whether external validity and reliability can be achieved.

4. Discussion

A problem for European producers of starch from potatoes is that the EU has steadily reduced its subsidies for starch production, and that it plans to end them completely in 2012. KMC will lose subsidies of DKK 88 million. It is estimated that 40% of Europe’s production will fade away, so the existing starch producers must battle for survival. Also, the EU’s quotas for starch production have been repeatedly lowered.

In 2000 KMC concluded that it was feasible to produce starch from tapioca roots in Vietnam. KMC acquired 80% of shares in an existing starch producing company, which was owned and managed by a Singaporean company. KMC had an option for the last 20%. Both the feasibility study and the investment were partly funded by the Danish foreign aid organization DANIDA.

With the Vietnamese factory, KMC would secure its growth despite the cap on Danish production. KMC believed that the Vietnamese company had competence in producing starch, and it saw that the production capacity was underutilized. With improved technology and production processes, the Vietnamese factory could expand its production. The results, however, were not as expected, mainly due to problems in the supply of tapioca roots.

A major problem was that the supply of tapioca was uneven. Vietnamese farmers are gamblers, and when they believed the prices of tapioca roots would go up, they kept their tapioca roots, limiting the supply to the factory. To circumvent this problem, KMC Vietnam bought some fields to produce tapioca themselves, thus better controlling the supply of tapioca. They could also improve the tapioca roots so that the starch yield would be better. The feasibility study also found that Vietnamese farmers only produce 9 tons per hectare, where for example Thai farmers produce more than 15 tons per hectare. This difference is not caused by inferior climate conditions in Vietnam, but is merely a question of efficiency in farming (mostly use of fertilizers) and processing in the factory. The feasibility study also showed that there was idle land in the district to cultivate.

KMC Vietnam’s tapioca production was not successful. Vietnam is a communist country, and the bureaucratic procedures for establishing production proved to be very complicated. There were six levels in the decision process. The Government was to allocate land for production. The urban people they sent to the fields did not want to become farmers. In the end, the Government did not sell the land to KMC Vietnam as promised. The Danish Embassy in Hanoi was very helpful, but in the end it proved impossible.

It was difficult to source tapioca roots. KMC Vietnam insisted that the Government guarantee that the district’s tapioca roots be delivered solely to KMC Vietnam, because otherwise the farmers would shop at different starch producers to maximize their prices. A sudden new law split the region using new borders, meaning that KMC Vietnam’s location was now close to a border and not in the middle of the district as before. Logistics are an important part of economic starch production, so this border change was unfortunate for KMC Vietnam.

An additional problem with the KMC Vietnam factory is that it is an open factory. Insects and birds can easily fly into the factory.
and pollute the product. Therefore, it is not possible to get its production certified.

Demand has also shifted. The world’s demand for coffee and rubber has increased, so farmers have shifted from tapioca to coffee and rubber tree planting. Supply has also changed. The factory is just 80 km from Ho Chi Minh City, which makes it increasingly difficult to keep workers’ salaries modest, and also to get qualified workers.

All in all, it is the KMC experience that Vietnamese farmers are very opportunistic. They shop for better prices and don’t practice customer relationship management. Danish farmers are much more reliable. In the feasibility study preceding KMC’s investment in Vietnam, Vietnamese farmers stated much more modest prices for their tapioca roots than what they actually demanded after the factory was taken over.

KMC has considered selling its Vietnam subsidiary. A Nigerian company has shown some interest in buying it, and Thai and Chinese companies have shown interest in partnering in some form with KMC Vietnam.

KMC could also decide to close its Vietnamese subsidiary. This would, however, set off claims from workers for compensation pay. KMC Vietnam has leased the land where the factory is placed for a 50-year period. KMC Vietnam must also foresee a considerable increase in rent for the factory. Chinese developers have offered to build on the area making the land more valuable.

5. Conclusion

The all-embracing reason for KMC to source from Vietnam was the reduced subsidies of producing starch from potatoes in EU and the quota system, both of which prevented volume growth at home. By sourcing offshore the quota system could be circumvented. Seen in this light, the KMC decision to source from Vietnam seemed reasonable.

Often quoted problems with global outsourcing are lower productivity in host countries, lower skills of labor, and not so advanced production technology. When wages raise quickly in host countries the wage advantage will soon disappear. On the other hand, it is experienced that host country suppliers soon can achieve production competence and acquires advanced machinery. The problem can hereafter be that the outsourcing company has created a competitor and that it has lost its competence in producing the material or components.

In KMC’s case a major problem was the Vietnamese government’s inability to keep its promises to sell land to KMC for tapioca farming and secure a steady supply of the roots to the factory. It seems like especially communist countries have problems with honoring legitimate claims from private firms. The Swedish furniture maker, Ikea has had severe problems in Russia because of broken promises from government authorities and has stopped all expansion in Russia, until this attitude is change.

Besides the hidden costs in producing far away from home, it can be difficult to uphold the prescribed quality and keep it there. KMC had difficulties in getting the KMC Vietnam starch certified because of open factories that allowed insects and birds to fly in and contaminate the starch.

The KMC case study gives body to some of the recommendations in literature, for example the outsourcing checklist [3]. There have also been good illustrations in the KMC case for the policy recommendations of [4] which indicates that Location-decision processes are so complex and dynamic that they are often made on the basis of simple rules of thumb, rough estimates, or history. This seems to be the case for KMC too.

6. Limitation and Further Research

This research project has been based on one case only. It is obvious that more case studies would add to disclosing more problems in offshoreing and outsourcing. The case is furthermore based on offshoreing/outsourcing of agricultural production, and this narrows the scope of problems there might be in this form of collaboration. Probably, many of the problems described in this case are generic, but some can be industry specific.

References


Usage of SAMS: Study of user workarounds at an Australian and a Thai university

Cherngchai Suwannakoot ¹ Pradip K. Sarkar ² Martin Dick ²
¹ School of Information Systems, Faculty of Business Administration, Rajamangala University of Technology Krungthep
2 Nanglinchi Rd., Sathorn, Bangkok, Thailand, 10120, Tel. 02-286 3300
E-Mail: e1E73831@ems.rmit.edu.au

² School of Business Information Systems and Logistics, Faculty of Business Administration, Royal Melbourne Institution of Technology University
City Campus, Swanston Road, Melbourne, Victoria, Australia 3000, Tel. (03) 9925 5976
E-Mail: e2 pradipsarkar@rmit.edu.au, e3 martin.dick@rmit.edu.au

Abstract

Student and Administrative Management Systems (SAMS) have been widely implemented in educational institutions and universities worldwide. SAMS is specifically designed to assist and improve performed by administrators, academics, and students. In fact, users were facing more difficulty to use the systems due to such the misfits from the implementation and organisation setting. In many cases, workaround existed when users have been forced by system mandated to their tasks by organization which does minimizing the propose benefit expected of such system. Workaround hold implication not only with system administrators with the regard to requirement alignment and business process changes but also an in depth of improvisation nature of user workaround should be encourage.

Keywords: Student and Administrative Management Systems, Enterprise Resource Planning (ERP), systems usage, misfits, Australia university, Thai university, workaround

1. Introduction

According to Oracle's PeopleSoft Enterprise Application website, enterprise applications are comprehensive business and industry solutions, enabling organisations to increase productivity,

ERP claims that the benefits of system implementation would enhance the performance of organisations (including academic institutions) in their daily operations, and “increase staff and faculty productivity through automated process, and decreased service times”. Similar claims are made by SAP. However, these claims were found to be inconsistent with the experiences of the actual users of such applications, one of which is the Student Administrative Management Systems (SAMS), the focus of the paper. SAMS is designed to enhance the core business processes in academic institutions, involving administrators, teaching staff, and students.

The primary purpose of this research is to investigate individual experiences regarding to the usage of SAMS in universities in Australia and Thailand, with the aim of understanding the improvisation, and also aid system developer to understand how the system should provide user with the flexible to use as their needed. The secondary purpose of this study is to conduct a comparative study of SAMS use between a university in a developed country, Australia, and its counterpart in a developing country, Thailand.

As part of the study, two representative universities in Australia and Thailand respectively were chosen on the basis of the fact that both
institutions had implemented SAMS. The Australian university had deployed the application in 2005, while it was in 2006 that SAMS was implemented in the Thai university.

2. Literature Review

In recent years, adoptions of ERP systems have become widespread in higher education institution (HEI), as many universities worldwide have adopted ERP systems to replace their legacy service systems [8].

Many literatures reported that the IS implementation brought the change to the organisation. Business change and technology change constantly affect information systems [3], and their entire organisation. However, the misfits in data arise from incompatibilities between organisational requirements and the underlying data model, which could be compared to the architecture of the specific software [4]. In respond, an event encountered in IS use where information cannot be properly processed through existing IT functionality or process design, thus triggering improvisations [6]. Therefore, the ideal of improvisations is to support and minimise the problems or constraints from the system or IT implementation. Users may create their strategies to cope and handling these limitations that support for their needs. In most cases, employees who had to work around the existing technological and information system gaps were very aware of the excessive amount of time and resources they expended to gather and analyse the data they needed to perform their [7]. Therefore, workaround is not the idea but best user can do until the problem is properly fixed [2].

3. Research Methodology

The research present in this research study is based on qualitative study carry out in focus group interviews and individual interviews. The focus group and interview case studies are carrying out in two different countries: Australia and Thailand. The group size has range between 6 -7 participants, which is regarding to the user group. In preparation for the field study, the focus groups and interview are conduct to examine the appropriateness of our constructs. The focus group sessions and interviews, involving 50 participants, and semi-structure interviews with 2 IT/IS managers was conducted.

4. Empirical study: System usage

The categorization of users according to their frequency of interaction with a system, which includes: 1. Core users: users of the system as an important part of their work context, e.g. administrative staff. 2. Regular user: regular users, but not as part of their primary tasks, e.g. academic staff. 3. Sporadic user: who have limited interactions with the system, e.g. student. 4. Technical user: responsible for the day to day maintenance and updating of the administrative system, e.g. IS manager.

The usage’s activity is normally dealing with variety of services such as office clerical, customer service, and general management. For the purpose of maintaining organizational anonymity, stipulated in the University Research Ethics application, the Australian and Thai universities will be referred to as AU and TU in this paper.

5. Discussion of findings

Based on the research questions, the following issues emerged.

5.1 How are users dealing with SAMS usage in doing their works?

5.1.1 Workarounds

In AU, staff members complain about the limited access to the system and databases. Users are unable to find or use the information as they used to do. Users create the temporary processes in response to their access requirements. One of the administrative staffs in the school mentioned the constraint in SAMS usage as being unable to access and use the functionality for the information.

“Unfortunately, identify problem with people manipulating data that causing our problems, now, strictly to certain access or certain users.”
But this is what we have to do; we have to create other type of interfaces to try how to get new stand, how to get the information.”

In TU, constrain of system functionality have impacted to the users as the system was lacking of functions to support to the users e.g. students’ classes and scheduling. Therefore, staff created the workaround to extend the system capability and functional constraints. An administrative staff reported that:

“Now, we are developing SMS and mail function to add-on to the system which will enable administrative staff to send data, news, and information to students and other staffs.”

Consequently, both universities are different in term of using workaround to continue working with the system. In AU, staffs are employing workaround to get the information from of the system which is limited by the organisational control policy. While, at TU, the system is fail to deliver and support to the users and tasks which due to the system constraint.

According to similar results from the poor quality of systems, users find their ways of using system as workaround and adaptation methods to overcome the problem situations. However, the research also found that using manual as paper based is also the method that users have employed while using the systems. In AU, academic staff mentions that they are used manual method to prepare for the results. According to administration is the area where SAMS is mainly used for the tasks. However, administrative staffs mention that:

“We do keep files, paper based files. But unfortunately it may not always necessary be accurate, you need to be constantly updated so you have to use that.”

As the problems with the system condition is not always up to date and unreliable. Therefore, staffs still need the manual as alternative to prevent any error that can occur from the system. One of administrative staff commented that:

“I think one of the reasons that we cannot rely on the system, because we do not trust the system. It’s many times the system fail off that make us worried. That’s why we keep our own like traditional way ‘photocopy’ to keep the references.”

In this research, manual workaround has been found from most of the users which is regarding as an alternative method that still exists and employ in the university environment.

5.2 What are the factors that influence the SAMS usage in doing their works?

5.2.1 Inadequate of Resources

In organisation, workaround are more related to limited resources. Workarounds are also enabled by inadequate technology-use training and inadequate staffing [5]. Especially, ERP systems are extremely complex and demand rigorous training [1].

In AU, the lack of training to facilitate system usage affects to the users. Academics complained about the training were not suitable for them due to the time constraint. Therefore, many staff were not properly trained and found the systems were too complicated. In particular, admin staffs are required the training as they need to use SAMS more than other users. One administrative staff explained that:

“Depend of the direction of the university as the staffs mention before, we know the AMS is more current, more accurate. There are the positive of the AMS; we are restricted because there is no more training. So, a new comer who wants to do a job effectively will not be able to get that training to learn it.”

While, in TU, academic staffs need more supports for their system usages. However, poor and inadequate of help desk support has been reported
in schools and faculties. An academic staff said that:

“However, some of admin staffs may not be able to answer or support every question to customer for the particular problems.”

6. Conclusion

In the comparison to the SAMS usage, in AU, staffs employ workaround to circumvent the control and restriction from the system. The improvisation has emerged to response to the constraint issues which consider as process workaround. While in TU, users develop workaround to overcome the problems from the system and its functionalities. This improvisation creates as the adjustment to the use of an IT workaround which utilise the system in different way as it has designed. In addition, understanding of information systems usage is important and need for organisation to decide on an ERP implementation. Moreover, the lack of understanding of the users, tasks and systems by university are found to be the significant impacts to system usages.

<table>
<thead>
<tr>
<th>The differences</th>
<th>Australia university</th>
<th>Thai university</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improvisation type*</td>
<td>Process workarounds</td>
<td>IT workarounds</td>
</tr>
<tr>
<td>Resources</td>
<td>Inadequate of training</td>
<td>Inadequate of help desk support, hardware, network infrastructure, poor documentations</td>
</tr>
</tbody>
</table>

Table 1: Summary of the findings between AU and TU

7. Future research

The research can be continued to further explore into the other case study. Future research would include the additional of data set from the other groups of systems usage such as: direct observation method to explore and obtain deeply understanding of how the user groups perceive to systems usage when user employs the systems.

8. References

Innovative English Education to Improve Students’ Outcomes at the International College

Dr. Chaiyapon Tundhipurinidtr¹ and Gregory J. LaBarre²
¹Department of Marketing, International College
Rajamangala University of Technology Krungthep
²Department of International Affairs, International College
Rajamangala University of Technology Krungthep
Tel. 02-676-4311, e-mail: chaiyapon.t@rmutk.ac.th, ic@rmutk.ac.th

Keywords: EFL, English language testing, class size, international education, English proficiency

Abstract

The approach of the AEC in late 2015 gives intensified focus on the need to improve the English skills of students at the International College of RSMTK. A study of incoming students’ English-language proficiency and GPAs for the subsequent four semesters has been made of a group of students who entered the Program in 2011. Recommendations are suggested to improve the opportunities for success for the International College students by various means: increasing the time of study for English “remediation”, devoting more class time in the first year to the study of English, reducing language class size, imposing a minimum score level for College admission, and rethinking the re-admission policy of students who are “retired” (failed due to having fallen below the minimum required GPA).

Keywords: EFL, English language testing, class size, international education, admission

1. Introduction

English is the lingua franca of ASEAN, and among the ASEAN nations surveyed by Education First – a worldwide language instruction organization – Singapore and Malaysia ranked 12th and 13th in the “High Proficiency” category – Indonesia and Vietnam ranked 27th and 31st as “Low Proficiency” and Thailand ranked 53rd out of 54 surveyed countries as “Very Low Proficiency” [1]. English is the key to innovation and competitiveness [2]. With the realization of ASEAN Economic Community (AEC) by the end of the 2015, Thailand will be faced with an increasing need for its workforce to possess greater English-language skills to maintain competitiveness with the other ASEAN countries.

A similar phenomenon is reflected in many students applying for the International College programs at Rajamangala University of Technology Krungthep (RSMTK). In the institution’s viewpoint, it is imperative to focus on the improvement of all International College students’ outcomes in English skills and overall academic achievement. Assuring an increase of English skills for International College students will expand their opportunities for employment, especially with the looming inauguration of the AEC.

The International College of RSMTK (ICUTK) offers five Bachelor degree programs taught in English. While the textbooks used in the classroom are at university level – necessitating a level of English proficiency of at least an upper-intermediate, if not advanced, level – a majority (50%) of entering students score at “elementary”, or below, English level. English proficiency levels are determined through a pre-registration English examination, given to all applying students about two months before registration. The ultimate purpose of the exam is not to screen the students for eligibility to the Program; however, their scores are used to determine if they need to attend a 45 hour English remediation course, known as “Intensive English.”

An English Language Proficiency Examination (ELPE) is administered to all first-year applicants to the ICUTK within one to two months prior to freshman-year registration. The examination is proprietary to the ICUTK, and is used as an evaluation device to determine a student’s level of English knowledge. The test consists of one-hundred multiple-choice questions, and is used to evaluate the student’s English skills in listening, vocabulary, grammar, English syntax, reading comprehension and critical thinking. It has been developed over a ten-year period to reflect the student’s English language skills assumed to have been acquired during the high school years.
2. Research Methodology

The researchers analyzed the data from the entrance scores with the actual data from study results of the students in each year. Gathering and analyzing the Entrance scores and four semesters of GPAs of a group of students who entered the international college in 2011, were studied to understand the English proficiency of the students from entrance examination through graduation. Moreover, an informal survey was taken of language instructors at RMUTK asking questions regarding class size.

3. Findings, Data Illustration and Interpretation

Entrance scores and the English proficiency levels are shown in Fig. 1.

<table>
<thead>
<tr>
<th>Score range</th>
<th>Level of language proficiency</th>
<th>Adequate for university-level studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>70+</td>
<td>Upper-intermediate</td>
<td>Yes</td>
</tr>
<tr>
<td>60-69</td>
<td>Intermediate</td>
<td>Questionable</td>
</tr>
<tr>
<td>50-59</td>
<td>Low-intermediate</td>
<td>Yes</td>
</tr>
<tr>
<td>40-49</td>
<td>Elementary</td>
<td>No</td>
</tr>
<tr>
<td>35-39</td>
<td>Low-elementary</td>
<td>No</td>
</tr>
<tr>
<td>Below 35</td>
<td>Beginning</td>
<td>No</td>
</tr>
</tbody>
</table>

Fig. 1 ELPE Scores and proficiency equivalents

There is no established ELPE score threshold for admission or rejection from the International College; however, those students with low scores (under 50%) are required to enroll in a special English class, given in May, prior to the start of the first semester. (For admissions after the May intensive course, students take a semester-long “intensive” course.) To illustrate the issue with statistics and graphs, we have recently taken a look at a group of students who entered the Program in 2011. The English proficiency score averages were then compared to the Grade Point Averages over the subsequent four semesters (GPA 1/1, 1/2 etc).

Of the group of 82 students who took the English proficiency examination in April 2011, 58 students registered and began their first semester in June 2011. The entrance scores of these 58 registered students were arranged from high to low, and in each category of score range an average was taken. Fig. 2 shows the breakdowns by proficiency group aligned with four-semester GPAs.

The data shows that a poor “entrance” score is reflected in a correspondingly regressive GPA in the first four semesters; that is, the lower the entrance score, that group has a lower GPA. This also takes into account that low-scoring students theoretically had enrolled in and attended the 45 hour “Intensive” classes. In light of the information and the needs of the students, suggestions for improving the students’ outcomes are made at the end of this paper.

The researchers observed that students scoring 50% or higher in this “placement” exam have a fairly good chance at success during the four-year Bachelor degree programs, and that, conversely, those scoring below 50% have regrettably lower grades; i.e. the lower the score, the increased chance for D or F in English I, and lower grades in other subjects that are dependent on English abilities.

In addition, the students scoring below 50% on the entrance exam who have registered and paid for the “Intensive English” class have by the end of the first semester achieved a GPA on average quite lower than students scoring above 50%. In fact, the two sets of figures decline correspondingly from left to right, Fig. 4.
It is not insignificant, however, that in the following three semesters, those who remain in the Program do experience progressively higher (on average) scores, Fig. 5.

The researchers observed that students who scored below a certain acceptable threshold and who enrolled in the Intensive English course continued to under-perform in subjects requiring the reading and writing of English. It is marked that English classes taught in the first and second semesters are at the “Elementary” level. In spite of the many who have gone through the “Intensive” class, the class in this study achieved the following scores as illustrated in Fig. 6.

<table>
<thead>
<tr>
<th>Average Entrance Score</th>
<th>English Grade</th>
<th>Count</th>
<th>% Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>77</td>
<td>A</td>
<td>5</td>
<td>9%</td>
</tr>
<tr>
<td>69.2</td>
<td>B+</td>
<td>9</td>
<td>16%</td>
</tr>
<tr>
<td>56.4</td>
<td>B</td>
<td>7</td>
<td>12%</td>
</tr>
<tr>
<td>54.1</td>
<td>C+</td>
<td>8</td>
<td>14%</td>
</tr>
<tr>
<td>46.9</td>
<td>C</td>
<td>10</td>
<td>17%</td>
</tr>
<tr>
<td>36.9</td>
<td>D+</td>
<td>7</td>
<td>12%</td>
</tr>
<tr>
<td>34</td>
<td>D</td>
<td>6</td>
<td>10%</td>
</tr>
<tr>
<td>33.7</td>
<td>F</td>
<td>6</td>
<td>10%</td>
</tr>
<tr>
<td>58</td>
<td></td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>

Fig. 6 First Semester English Courses and Grades

In addition, an informal survey reveals results based on averages of all responses to the following questions.

What size of class would you consider?
- Ideal 21
- Uncomfortably large 36
- Impossibly large 46

What is the largest class you currently teach at RMUTK? 46

The truth is that many language classes currently taught at the university have as many as 50 or 60 students. Instructors are teaching “impossibly large” classes.

4. Improvement of English Education Solution

4.1. Establish a score threshold for admission to the International College

A threshold score should be determined and implemented for entrance to the International College program. We would recommend it not be lower than a 40% score. Since it is a fact that enrolled students who possess a stronger foundation of English will perform better, this will help to reduce the “retirement” (failing) rate of students, and enhance the overall atmosphere of the College.

4.2 Improve by Emphasis on more English courses in the first year

A 45-hour course to build a foundation of English is not a realistic approach. There is no “quick fix” or panacea in language-learning. An analogy in construction may illustrate this point. A large amount of time is devoted to the construction of a firm foundation of a building. Then, one notices that the floors go up at a much faster rate. Language acquisition is similar; with a strong foundation, more and more material can be introduced with greater understanding.

For those low-scoring students (under 60 score), we suggest an increase in the number of English preparatory courses during the first year of the program. While this would initially alter the curriculum structure of the students, their study program could still be achieved within a four-year period; however, if more time is needed, it is preferable for the sake of the student’s success. Looking at the International College of Mahidol University as a model [3], a minimum TOEIC score of 6.0 is required for admission. Since this is indeed a high benchmark, some students do not qualify for the program, but are enrolled in a year of preparatory English classes, and are then re-tested for admission. A similar type program could be instituted at the International College for those scoring below 50%; that is, their first two semesters would consist of at least three English courses per week. Concurrently, they might be enrolled in mathematics and accounting, subjects not requiring overly-demanding English skills.
4.3 Improve the quality of interaction between Teacher and Students by reducing English-Language class size

The researchers have stated that to improve the communication and interaction between the teacher and students for students of English, class size is one of the critical factors. A publication from the Association of Departments of Foreign Languages (ADFL) states that class size should not exceed twenty students to be effective in interaction between teacher and students and to develop listening, speaking, reading and writing skills. Nonetheless, for the International College of UTK, with substantial numbers of students per class for English Language, researchers would like to suggest a **class size of twenty-five** as one of the solutions for improving language proficiency.

Various research papers demonstrate that language learning in a large-sized class is ineffective; it is a negative experience as most of the students do not pay attention in class, are distracted, do other things or fall asleep. In smaller language classes, students pay more attention, are less disruptive and participate more; thus, more learning can take place. In a class-size research study, EFL teachers from many countries were surveyed, and the conclusion was that 38 is the number of students in a class where “problems begin”. In the study, the ideal recommended is no more than 21 in a class.

4.4 Incubating a new culture and attitude for re-admitted students with intensive learning of English

According to the findings, students re-admitted after having failed with a GPA below the acceptable level, run the risk of continuing the same behavior that led to the low GPA in the first place. In order to set the new standard for English proficiency level of the International College’s students, the policy of re-admitting the retired or failed students needs to be reconsidered. The English study, Intensive Program and the test for English proficiency are to be defined to match the new culture and attitude.

Implementation of these recommendations is seen as forming positive steps in the improvement of the students’ outcomes and success in the future.

5. Conclusion and recommendations

The researchers suggest the new procedures might be considered and implemented in recruitment, admission, and qualifying the students to the International College based on their English proficiency level. In order to have a new standard of students to improve the International College and student’s outcome, the researchers conclude and recommend as followed:

1) Establish a new English proficiency score threshold as a new test standard for International College admission.
2) Increase the amount of English-language instruction in the first year to strengthen the students’ foundation and to increase their chances of getting higher GPAs in the following years.
3) Engaging teacher and students to be more interactive and participative by reducing the number of students in the class, limiting class size to twenty-five students.
4) Develop new standards for an English proficiency policy, process and workflow to set a new culture and attitude for students at the International College.

Implementing the following process will yield a higher level of grades in English courses and other subjects, and can lead to creating a higher standard for the International College. A thorough study and research shall be conducted again to measure any changes after implementing the recommended processes. If indeed followed, the researchers expect overall improved grades in first-year English courses and higher GPAs in the following years.

6. References


Propionic Acid Production by Coimmobilized Cultures of Propionibacterium acidipropionici TISTR 442 in Combination with Lactococcus lactis TISTR 1401

Rutairat Suttisuwan
Division of Biology, Department of Science, Faculty of Science and Technology, Rajamangala University of Technology Krungthep
E-Mail: rutairat.s@rmutk.ac.th

Key words: Whey  propionic acid  free cell  immobilize cell

Abstract
Propionic acid production from whey by calcium alginate coimmobilized cells with cultures of Propionibacterium acidipropionici ATCC 4965 in combination with Lactococcus lactis TISTR 1401 was investigated. The maximum propionic acid concentration was obtained with a value of 28.28 g/l (batch 1 and batch 2 was produced 17.84 g/l, 10.54 g/l in 168 hours, respectively). This amount of propionic acid from coimmobilized cells was higher than from free cell mixcultures (17.27 g/l in 168 hours).

1. Introduction
Propionic acid is an organic acid that can inhibit the growth of molds, yeasts and bacteria with cause to food spoilage. Propionic acid is used as a biopreservative in foods and feeds [1], antiarthritic drug, perfumes, flavours [2] and used in the production of cellulose propionate. [3] Currently, using propionic acid was very important to feeds due to use of antibiotics as growth promoters in animal feeds has not been permitted in the member states of the European Union. Therefore, Using of antibiotic growth promoter (AGPs) was decreased and try to replace them by organic acid. Organic acid was penetrated in cell of colon and synthesize the secretin compound to release the gastric juice from the pancreas which is good for digestion. [4]

Propionic acid can be produced from either chemical production or biological fermentation. Commercial production is chiefly carried out chemically [2] but the cost in purification process is high. [5] Also the study to improve production of propionic acid from biological fermentation have to important which the biological fermentation cost can be reduced. However, the main disadvantages of this process lie on its long incubation time and low yield. [6] Thus, several approaches are introduced in order to improve the yield such as cell immobilization [7], mix cultures, and medium selection [8]. This study used coimmobilized of Propionibacterium acidipropionici TISTR 442 and Lactococcus lactis TISTR 1401 to produced propionic acid by used whey as substrate which this study is an alternative in studies with appropriate to produce propionic acid from biological fermentation.

Whey is a by-product from manufacture of cheese. Whey gives a rang of benefits such as have a bring to produce as a whey powder, whey concentrate and animal feeds. Whey contains about 5.0-6.8 % lactose, 0.74 - 0.8 % protein, 0.17 - 0.32 % salts and 0.3 - 0.6 % fat.

2. Materials and Methods

2.1 Strains
The organisms used in this study were Propionibacterium acidipropionici TISTR 442 and Lactococcus lactis TISTR 1401 received TISTR Culture Collection Bangkok Mircen, Thailand.

2.2 Media
Whey was received freshly from a cheese plant (Minor Cheese Limited) and refrigerated at 70°C until used. Whey was supplemented with 10 g/l yeast extract, 0.25 g/l K$_2$HPO$_4$, 0.05 g/l MnSO$_4$, 0.2 g/l MgSO$_4$, 10 g/l CaCO$_3$ [9]

2.3 Inoculum preparation
To prepare inocula Propionibacterium acidipropionici and Lactococcus lactis were propagated separately using 150 ml MRS broth in 250 ml Erlenmeyer flask. The culture Propionibacterium acidipropionici and
Lactococcus lactis were incubated at 30°C for 4 days and 37°C for 2 days, respectively. The cell culture of each bacterium was used when the optical density (OD₆₆₀) of the culture reached 0.5.

2.4 Cell immobilized

Inoculum size of 5% *P. acidipropionici* and 5% *L. lactis* [10] was centrifuged at 10,000 g for 10 min and spent broth was decanted. Pelleted cells were resuspended in sterile 0.85% NaCl solution and again centrifuged. After the NaCl solution was decanted, pelleted cells were mixed with sterile 0.85% NaCl solution and sterile 2% sodium alginate at a volumetric ratio of 10 : 3 : 20 (cells : saline : alginate). The mixture was extruded by peristaltic pump through the tube into 0.1 M CaCl₂ solution to form beads. For distance from the end of tube to the surface of CaCl₂ solution was 5 centrimetre, flow rate at 7 ml/min. The beads were cure in CaCl₂ solution at 4°C for 2 hours and washed thoroughly two times with sterile distilled water before use.

2.5 Batch fermentation and cells recycling

Study on advantage from whey to produce propionic acid by coimmobilized of *Propionibacterium acidipropionici* and *Lactococcus lactis* in 2 liters fermentor and cell recycle was fermented in a 2 liters glass fermentor. Add to media 1.4 liters (70%) which adjusted pH at 6.5 to contain in fermentor and sterilized at 121°C, 15 psig. for 30 min. Fermentation condition was controlled at 30 °C, agitaged at 150 rpm. and pH was maintained at 6.5 by automatic addition of the sterile 5M KOH. The sample was centrifuged at 10,000 g for 20 min. The supernatant was stored at 0 °C for HPLC analysis.

For cells recycling when fermented until concentration of propionic acid was stable, then the medium was drained from the fermentor and fresh medium was added to the beads which repeated batch fermentation was started.

2.6 Assay Methods

Propionic acid and lactic acid concentrations were measured by high performance liquid chromatography (HPLC) [2], [13]. The HPLC system was equipped with Inertsil C8-3 column and was operated at room temperature using 20 mM KH₂PO₄ (pH 3) as the mobile phase. The flow rate was maintained at 1 ml /min. Propionic acid was detected by the UV detector at 210 nm. The concentrations of propionic acid and lactic acid were calculated by comparing peak area with the standard graph. The amount of lactose was detected by the protocol of [14].

2.7 Data analysis

Data for the concentration of propionic acid of triplicate were used for statistical analysis by Duncan New multiple range test.

3. Results and Discussion

3.1 Effect of advantage from whey to produce propionic acid by coimmobilized compare with free cell mixcultures of *Propionibacterium acidipropionici* and *Lactococcus lactis* in 2 liters fermentor.

Study on propionic acid production by coimmobilized on free cell of *Propionibacterium acidipropionici* and *Lactococcus lactis* were give maximum lactic acid 4.93 g/l in 24 hours after that lactic acid decrease continuously and received maximum propionic acid 17.27 g/l in 168 hours. Initial of experiment have concentration of lactose 40 g/l after that decrease continuously until 192 hours without lactose in broth. For coimmobilized cell were give maximum lactic acid 5 g/l in 24 hours and received maximum propionic acid 17.84 g/l in 168 hours. Concentration of lactose reduced from 40 g/l to remain 0 g/l in 192 hours shown in Figure1. From this study to notice for propionic acid production of free cell mixcultures were propionic acid lower than using coimmobilized cell to produced propionic acid because using immobilized cell have stable more than free cell [15].

Similar to the experiment of Yang et.al. 1994 [16], study on propionic acid production from whey by immobilized cell of *P. acidipropionici*. This study was received propionic acid 20 g/l in 55 hours, which more than using free cell.

Yang and Huang. 1995[17], which study on propionic acid from immobilized cell of mixculture between *P. acidipropionici* ATCC 4875 and *L. lactis* (OSU stock culture #588) in 5 liters fermentor at 37°C, pH 6.5 adjust with NaOH determinated propionic acid and lactic acid with HPLC. The result can produced propionic acid and lactic acid was 17.4 g/l and 0.9 g/l, respectively.
Suwannakham and Yang. 2005[18], study on propionic acid production by *P. acidipropionici* ATCC 4875 compare with free cell and immobilized cell in fibrous bed fermentor. It was found that production by immobilized cell gave 71.8 ± 0.8 g/l propionic acid which higher than 20-59% of propionic acid production by free cell.

95% confidence level). As using coimmobilized cells to produced propionic acid better than free cell mixcultures because of coimmobilized cells can used cell to recycle for fermentation.

**Table 1** Comparison of propionic acid production by free cell mixcultures and coimmobilized cells at 168 hours

<table>
<thead>
<tr>
<th>Form of cell</th>
<th>Concentration of propionic acid (g/l)</th>
<th>Yield (g/g)</th>
<th>Productivity (g/l.h)</th>
<th>Residued lactose (g/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>free cell mixcultures</td>
<td>17.27 ± 0.16</td>
<td>0.443 ± 0.05</td>
<td>0.103 ± 0.001</td>
<td>1</td>
</tr>
<tr>
<td>coimmobilized cells</td>
<td>17.84 ± 0.17</td>
<td>0.446 ± 0.001</td>
<td>0.106 ± 0.004</td>
<td>0</td>
</tr>
<tr>
<td>p-value</td>
<td>0.294 ns</td>
<td>0.695 ns</td>
<td>0.878 ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

ns , p-value > 0.05 means no significantly different at 99% confidence level  
*, p-value 0.01 < p-value < 0.05 means significantly different at 95% confidence level

**3.2 Effect of fermentation by cell recycling with coimmobilized of *Propionibacterium acidipropionici* and *Lactococcus lactis* in 2 liters fermentor.**

From study on using coimmobilized cell for produce propionic acid missed can used cell recycle 2 rounds for fermentation. Fermentation in fermentor was control pH by KOH as gel which coat cell to occur collapse that couldn’t ferment for next cycle.

The second cycle (batch 2), propionic acid concentration was 10.54 g/l in 192 hours and can not produce lactic acid. Concentration of lactose reduced from 40 g/l until have 0 g/l at168 hours shown in Figure 2.
When compare concentration of propionic acid from batch 1 which bring to above experiment and batch 2 missed fermentation of first round (batch 1) receive propionic acid higher than second round shown in Figure 3. Using coimmobilized cell with coat cell by gel to become acid was produced can not to release completely from beads.

Similar to Rickert et.al.1998 [19], which study on propionic acid production by immobilized cell of Propionibacterium thoenii P20. Glucose and lactate were substrate, calculated of propionic acid used for statistical analysis with six sounds when used lactose 75 g/l and lactate 42 g/l for substrate were receive propionic acid 34 g/l and 22 g/l, respectively.

Ates et.al.2002 [20], study on citric acid from Aspergillus niger compare with free cell and immobilized cell. Fermentation by immobilized cell was received citric acid 13 g/l and consistent potential could recycle 4 rounds of fermentation but yield of citric acid was reduced. For free cell was received citric acid 4 g/l.

Table 2 Comparison of propionic acid production by immobilized cell for batch 1 and batch 2

<table>
<thead>
<tr>
<th>batch</th>
<th>Concentration of propionic acid (g/l)</th>
<th>Yield (g/g)</th>
<th>Productivity (g/l/h)</th>
<th>Residued lactose (g/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17.84 ± 0.17</td>
<td>0.446 ± 0.001</td>
<td>0.106 ± 0.004</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>10.54 ± 0.24</td>
<td>0.234 ± 0.008</td>
<td>0.063 ± 0.009</td>
<td>0</td>
</tr>
</tbody>
</table>

p-value 0.002 * 0.067 ns 0.065 ns

4. Conclusion

Propionic acid production by coimmobilized of Propionibacterium acidipropionici ATCC 4965 and Lactococcus lactis TISTR 1401 was produced propionic acid higher than fermented by free cell mixcultures. Coimmobilized cell was produced propionic acid 17.84 g/l at 168 hours, propionic acid yield was 0.446 g/g, productivity was 0.106 g/l/h and had consistent potential could recycle 2 rounds of fermentation. The second cycle was give propionic acid 10.54 g/l at 168 hours, propionic acid yield was 0.234 g/g, productivity was 0.063 g/l/h. For free cell was produced propionic acid 17.27g/l at 168 hours.

References

Microbiology and Biotechnology. 42 : 22 – 27.


Study of Wear of Diesel Engine Valve Seat MITSUBISHI FUSO FM 527MA with Applying Natural Gas Vehicle (NGV)

Teerayut Kanchanasangtong, Piyapong Kumkoon
Department of Industrial Engineering, Faculty of Engineering, Rajamangala University of Technology Krungthep
Tel. 02-287-9600 Ext. 9683, E-Mail: teerayut.k@rmutk.ac.th

Keywords: Diesel engine, Valve seat, Wear, Natural Gas Vehicle (NGV)

Abstract
This research is focus to study of wear of diesel engine valve seat MITSUBISHI FUSO FM 527MA with applying natural gas vehicle (NGV). The experiment was test and compare hardness, wear characteristics, microscopic analysis, elemental analysis of the quantitative and qualitative components. The results of structure of the valve seat after the change. Resulting in increased hardness 7.97% compared to valve seat that can’t be activated. The valve seat wear consistent with abrasive wear. And wear an identification with the fatigues on the surface. Cause wear and tear to the surface of the material.

Keywords: Diesel engine, Valve seat, Wear, Natural Gas Vehicle (NGV)

1. Introduction
Currently, engine that use natural gas as fuel is growing rapidly due to higher fuel prices cause consumers to switch to gas-engine fuel. Although gas-fired engines have features that are similar to the basic engine. But it needs to be developed and improved working properly. Because the engine is burning methane gas, which makes up the high demand. Reaction causes oxidation and nitration length, but the burning gas is soot. And the liquid to help lubricate the intake and exhaust valves. Cause wear of the valve and valve seat.

Generally is believed that a coating is usually formed on the exhaust valve seat; though very thin, this coating can be very effective in protecting valve seats from wear damage. However, usually show a bright metal surface due to lack of lubrication and have severe seat wear problems [1,2]. Intake valve seat wear is generally thought to occur by three types of wear: adhesive wear, abrasive wear, and plastic deformation controlled wear [3-5]. Engine design, environment, manufacture, and maintenance all contribute significantly to valve life [6].

The objectives of this study were to analyze wear of diesel engine valve seat MITSUBISHI FUSO FM 527MA with applying natural gas vehicle (NGV).

2. Experimental and Procedure
Specimen is diesel engine exhaust valves 76 mm. FM527MA MITSUBISHI FUSO models through the use of natural gas (NGV). In general most valves are made from a special alloy with hardness. Impact resistance and high heat in the combustion chamber. Embedded in the compression cylinder. General, the hard parts as the valves show in Fig. 1

Fig. 1 Engine valve seat

The research will test the hardness, wear analysis by scanning electron microscope (SEM), which is applied to the surface of wear surface. The study the effects that will cause wear on the particle. The study and analyze quantitative and qualitative components of an element and Energy Dispersive Spectrometry (EDS). Analysis is a core element in such specimens valve seat, and the various elements. Comparison between the valve seat through use of natural gas (a) with the
valve seat is not through use (b). The specimens, which were cut to the experiment show as Fig. 2

(a)  
(b)  

Fig. 2 Specimens valve seat

3. Results and Discussion

3.1 Hardness testing

As the results of experiments, the hardness of workpiece hardness of the valve seat. To test the Vickers Hardness Test (HV) as show in Fig. 3. Hardness testing method to test hardness Vicker Hardness. The conditions of measurement using 9,810 N applied load, 10 seconds. The hardness of the workpiece to a comparison of hardness between the valve seat does not operate, with the valve seat through use.

Fig. 3 Hardness of the valve seat

As mentioned above, found that the hardness of the valve seat through the use of the average is 265.45 HV and a valve seat is not through the use of the average is 286.45 HV. It can be concluded that through the use of a valve seat that has a hardness greater 21HV, up from 7.97% in comparison to the valve seat is not in use.

3.2 Analysis by scanning electron microscope (SEM)

Fig. 4-5 represents analysis of wear by scanning electron microscope (SEM), is divided into two zones as follows: Zone 1 is the wear and tear caused to the specimen shoulders down and Zone 2 is the contact of the exhaust valve.

Fig. 4 Specimen analysis of wear by scanning electron microscope (SEM)

Fig. 5 Edge on the surface of the valve seat wear

The workpiece similar to valve seat wear consistent with abrasive wear and adhesive wear with fatigue on the surface. Heat to affect the microstructure of the material and thus increase susceptibility to deterioration. Causing the wear mass loss on the surface of the material.

3.3 Analysis by element and Energy Dispersive Spectrometry (EDS)

Elemental composition analysis by EDS elemental analysis is a core element in such specimens. By comparing the various elements. The slave valve through use of wear and tear. valve seat with a valve and through the use of elements that have changed.
The analysis of the components of the elemental EDS showed that the valve seat is not through the use of a component of an element is iron, with a ratio of about 78.76%, followed by a 14.02% chromium and 4.73% carbon and the component elements of the valve seat at the wear and tear of the elements is found to contain iron by a ratio of about 56.60%, 10.41% molybdenum, followed by a 10.34% copper and many elements are shown in the table. It was found that the amount of wear on the valve seat with a variety of additional elements to blend in a lot. The actual amount of ingredients is reduced by the ratio show as Fig. 6-8

Experiments and analyze the results. Quantitative and qualitative components of an element of the valve that looks similar to the material composition of the elements in the composition of the elements in the valve wearing out. It can be concluded that the transfer material between the valve and valve seat.

4. Conclusion

The paper describes study of wear of diesel engine valve seat MITSUBISHI FUSO FM 527MA with applying natural gas vehicle (NGV). The following are the conclusion studied from this investigation:

1. Through the use of a valve seat that has a hardness greater 21HV, up from 7.97% as compared to a valve seat or valve seat through the use of a standard piece. It is obvious that this graph hardness.

2. The analysis of the wear and tear that happens to work with a Scanning Electron Microscope (SEM) showed that the valve seat through the wear characteristics of wear consistent with wear, abrasion and wear an identification with the fatigue. surface causing the wear mass loss or the surface of the material.

3. Experimental analysis of the elemental composition of the specimen found in the valve seat through the element that looks similar to the elements of the valve. It can be concluded that the transfer of material between the valve and valve seat.

5. Acknowledgment

This research was supported by the Research and Development Institute of Rajamangala University of Technology Krungthep for supply materials and equipments analysis.
References


An Investigation of Effect of Parameters During Wire Electrical Discharge Machining of Mold Steel SKD 11

Kamonpong Jamkamon* Dollatham Araganont Pichai Janmanee and Rattikorn Saodaen
Department of Mechanical and Industrial Engineering, Faculty of Engineering, Rajamangala University of Technology Krungthep
Tel. 02-287-9645, E-mail: kamonpong26@gmail.com

Keywords: WEDM, parameters, mold steel, Ra, SKD 11

Abstract
The objective of this research is to study fundamental parameter effecting capability of Wire Electrical Discharge Machining (WEDM) on tool mold steel by applying the JIS standard, tool steel SKD 11, thickness of 5, 10, 25 and 50 millimeters including Cu-Zn wire with a diameter of 250 micrometers. It depends on variable of parameter cutting speed, open circuit voltage, and frequency of spark. Evaluation of electrical discharge was conducted from cutting speed and kerf throughout Ra or Arithmetical Mean Roughness. The result was found that when thickness of base metal increased, cutting speed was decreased. Electrical open circuit voltage resulted in cutting speed fluctuation. Furthermore, the reduction of kerf was 347-352 micrometers (depended on thickness of material). The increase of frequency of spark affected cutting speed and the width of cut including roughness of base metal was diminished.

Keywords: WEDM, parameters, mold steel, Ra, SKD 11

1. Introduction
Tool steel SKD 11 material as the JIS standard, is popular steel used as punch in the die technology [1] due to much strength. It can be improved mechanical property of durability by using heat treatment so it is difficult for processing due to low machinability. The arc cutting with live wire is the processing of base metal by corroding from spark of electrical via gaps between surface of base metal and electrode wire [2,3] to occur fusion for base metal. It was dispelled in the form of solid, liquid, and gas [4,5] by semiconductor called dielectric. It covers around the surface of spark as shown in figure 1. Based on electrical discharge process by corrosion from spark, cutting tool material did not touch base metal resulting in the effect of gaps between cutting tool material and surface of base metal against accuracy of the base metal size. The cause happened from kerf was larger than the size of electrode wire. To make up the size of base metal for accuracy, fundamental parameter effecting capability of the arc cutting by machinability of WEDM) should be further studied such as kerf and surface roughness of base metal.

Fig.1 Schematic of WEDM process [5]

Fig.2 Experiment plan

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed :</td>
<td>Conditions table 1</td>
</tr>
<tr>
<td>Cutting speed adjust :</td>
<td>1, 2, 3, 4, 5 and 6 mm/s</td>
</tr>
<tr>
<td>Fixed :</td>
<td>Conditions table 1 and cutting speed 5 mm/s</td>
</tr>
<tr>
<td>Open circuit voltage adjust :</td>
<td>70, 75, 80, 85 and 90 V</td>
</tr>
<tr>
<td>Fixed :</td>
<td>Conditions table 1, and cutting speed 5 mm/s</td>
</tr>
<tr>
<td>Open circuit voltage :</td>
<td>80 V</td>
</tr>
<tr>
<td>Frequency spark adjust :</td>
<td>62500, 71429, 83333, 100000 and 125000 Time/s (duty factor 50 %)</td>
</tr>
</tbody>
</table>
experiment plan in figure 2. Base metal for the experiment was tool steel with thickness of 5, 10, 25 and 50 millimeters including electrode as Cu-Zn wire with a diameter of 250 micrometers. Cutting was conducted under coverage of Deionize Water (by using WEDM ‘Aristech’ WEDM 430 C). The characteristic of base metal and cutting way were designed as shown in figure 3 and the experimental condition was controlled as shown in the table 1.

**2. Variable of Cutting speed parameters**

Variable of Cutting speed parameters was the highest level and the machine could be moved while the base metal was being cut. The unit of movement was millimeter a minute by controlling other parameter as shown table 1. Variable of cutting speed parameters had 6 levels; 1, 2, 3, 4, 5 and 6 millimeters a minute and remained open circuit voltage by 80 volts. Cutting speed which was independent variable and cutting speed which was dependent variable had difference result because the cutting process depends on corrosion from electric reaction of discharge to increase heat from spark. The distance between the base metal and electrode wire for the stability of arc [6] as shown in figure 4. If the spark was instability, speed at that time was lower than the expected speed.

**2.2 Variable of open circuit voltage parameters**

Variable of open circuit voltage parameters as shown in figure 4 was variable of voltage level resulting in violence of electrical discharge due to the flow of voltage. The other parameter was controlled as shown in 1 and variable of open circuit voltage parameters for cutting was 70, 75, 80, 85, 90 and 95 volts and remained cutting speed by 5 millimeters a minute.

**2.3 Variable of spark frequency parameters**

The experiment of variable of spark frequency parameters was variable of connection between on-time and off-time per total cycle time (on-time + off-time) [7] as shown in equation 1. The design remained duty factor by 50%, cutting speed by 5 millimeters a minute, and open circuit voltage by 80 volts. Variable of on-time and off-time resulted in the frequency of spark as shown in the table 2.

\[
Frequency = \frac{1}{TotalCycleTime} \tag{1}
\]
Table 2. Frequency spark of adjust On-time and Off-time

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameters</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>On-time ([µs])</td>
<td>8, 7, 6, 5 and 4</td>
</tr>
<tr>
<td>2</td>
<td>Off-time ([µs])</td>
<td>8, 7, 6, 5 and 4</td>
</tr>
<tr>
<td>3</td>
<td>Frequency (Time/s)</td>
<td>62500, 71429, 83333, 100000 and 125000</td>
</tr>
</tbody>
</table>

2.4 Evaluation of WEDM process

Capability of cutting base metal by WEDM process was evaluated from cutting speed recording the cutting length (millimeter) per time (minute) as shown in equation 2. The experiment of distance and time could be recorded from the screen of machine working as shown in figure 5.

\[
\text{Cutting Speed} = \frac{\text{Length (mm.)}}{\text{Time (min.)}} \quad (2)
\]

Fig. 5 The screen shows the machine operation

Kerf was a gap from corrosion by electrode wire which had the width more than the size of electrode wire which was small and could not be measured by a basic tool. An optical microscope “Liaca EZ 40” was used with magnification by 35 times as shown in figure 6. Ra or Arithmetical Mean Roughness was measured by roughness machine “Marh PS1” as shown in figure 7 and used sampling lengths (Cut-off) 0.8 millimeters and 5 cut-off length for measuring a vertical and cutting edge.

Fig. 6 Measuring microscope the width of cut

3. Results and discussion

3.1 Cutting speed parameter

Regarding the cutting speed parameter to study the effect of WEDM, it was found that speed was direct variation with the highest cutting speed for base metal with thickness of 5 and 10 millimeters. When thickness of base metal increased, slope of cutting speed observed from base metal with thickness of 25 and 30 millimeters. Slope of variation was decreased when the highest cutting speed was more than 4 millimeters a minute and 3 millimeters a minute respectively as shown relation of the experimental result in figure 8.

Fig. 8 Maximum cutting speed affects the cutting speed
Fig. 9 Cutting speed affects to width of cut

Considering cutting speed against kerf from the experiment, it was found that kerf tended to reduce when cutting speed was increased as shown the experimental result in figure 9. It caused from higher speed and resulting in the quick movement of wire so the change of spark was occurred. When thickness of base metal increased, kerf reduces as well resulted from spreading of spark per an area [9]. It could be concluded that cutting speed or higher thickness resulted in density of decreased spark per an area. It effectd corrosion of surface and kerf was reduced. Regarding variable of cutting speed, it was found that it slightly affected arithmetical mean roughness of base metal and the average was 2.40-2.80 micrometers. It depended on cutting speed and thickness of base metal as shown the experiment in figure 10.

Fig. 10 Cutting speed affects to surface roughness

3.2 Open circuit voltage parameter

According to the experiment of cutting speed parameter to study the effect against electrical discharge of tool steel SKD 11, it was founded that open circuit voltage effected capability of electrical discharge. It depended on thickness of base metal as the relation in figure 11. It indicated that base metal with thickness of 5 and 10 millimeters had cutting speed equal to the highest determined speed by 5 millimeters a minute.

Fig. 11 Open circuit voltage affects to cutting Speed.

Base metal with thickness of 5 and 10 millimeters tended to be increased as open circuit voltage because difference level of 2 positions of electric charge. If open circuit voltage was more than discharge, violence of high spark was spread much amounts. Variable of open circuit voltage kerf parameter was demonstrated as figure 12. The experiment was found that kerf tended to reduce when the circuit voltage increased. It was not resulted from the circuit voltage but it caused from the increased tendency of cutting speed and appeared movement of wire. It electrode wire moved quickly, density of spark per an area was lower [9].

Fig. 12 Open circuit voltage affects to width of cut

Arithmetical Mean Roughness tended to decrease when thickness of base metal increased as shown the experimental result in figure 13. The effect from open circuit voltage resulted in the increase of Arithmetical Mean Roughness up to some level and the decrease of corrosion because spark was happened in a very small area so Arithmetical Mean Roughness was slightly affected as shown surface of base metal in figure 14.
3.3 Frequency spark parameter

According to the frequency spark parameter to study capability of WEDM from cutting speed, it was founded that base metal with thickness of 5 millimeters could not be cut by low frequency because wire was torn during base metal cutting (low frequency was resulted from on-time and off-time of 8 microseconds). Regarding base metal with thickness of 25 and 50 millimeters, cutting speed reduced when frequency increased as shown the experimental result in figure 15. It resulted from duty factor was used by 50%. The higher frequency indicated that on-time was element resulting in the decrease of heat energy from spark. High frequency tended to reduce kerf as shown the experimental result. The cause of decrease resulted from heat energy from spark so fusion was low and caused the decrease of surface. Frequency of spark was higher and affected the decrease of Arithmetical Mean Roughness.

4. Conclusions

According to the study effecting capability of Wire Electrical Discharge Machining (WEDM) on tool mold steel by applying the JIS standard, tool steel SKD 11, the resulted could be concluded as follows:

1) Cutting speed of base metal fluctuated as the highest cutting speed but inverted with thickness of base metal turned around. However, kerf decreased when cutting speed was higher and it slightly affected Arithmetical Mean Roughness.

2) The increase of open circuit voltage resulted in fluctuation of cutting speed. Kerf decreased and fluctuated with cutting speed, not open circuit voltage.
3) High frequency of spark was suitable for electrical discharge of slight base metal. Low frequency appropriated for electrical discharge of thick base metal. However, high frequency resulted in the decrease of cutting speed, kerf, and Arithmetical Mean Roughness.

Regarding to the experiment of this research, frequency of spark resulted from on-time and off-time parameter at 50% duty factor. High frequency of spark resulted from less on-time. It involved in collection of heat energy of spark resulting in corroding surface of base metal [7].

5. Acknowledgment

The author are grateful to the Research and Development Institute of Rajamangala University of Technology Krungthep for supply materials and equipments analysis.

References


A new proposed large-scale hydrogen liquefaction plant

Songwut Krasae-in
Department of Mechanical Technology, Faculty of Technical Education,
Rajamangala University of Technology Krungthept, Nanglinchee Road, Tungmahamek, Sathorn, Bangkok
10120, Thailand
E-mail addresses: songwut.k@rmutk.ac.th, krasaein@hotmail.com
Tel.: +66 2 2879639, ext. 9653, 1365; fax: +66 2 2879639, ext. 9653, 1365

Abstract
A new modified liquid hydrogen plant using a multi-component refrigerant (MR) refrigeration system is proposed. The plant is capable of producing 100 tons of liquid hydrogen per day is simulated and optimized. This paper is an improvement for more realistic large-scale plant cycle from a previous paper published a year ago. Importantly, the variables and constraints are preliminary studied together with how to adjust these to achieve optimal steady-state operation. The optimization problem has 23 variables and 26 constraints. It is the same that the MR system can be used to cool feed normal hydrogen gas from 25 °C to the equilibrium temperature of -193 °C. A simplified 5-component mixture of refrigerant suggested for the plant is found. But, the difference from the previous paper is that the transition of the equilibrium ortho-para hydrogen gas from -193 °C to -253 °C, a new proposed configuration four H₂ Joule-Brayton cycle refrigeration system with optimization is recommended. The plant optimization was also conducted with two more pinch temperatures (1 °C and 3 °C). Power savings is increased with a pinch temperature of 1 °C as compared to 3 °C. The simulated overall power consumption of the proposed plant is 5.91 kWh/kgLH₂ which is around a half reduction compared to the current plant in Ingolstadt that has an energy consumption of 13.58 kWh/kgLH₂. Pressure drops in heat exchangers are also employed in the simulation for the study, but it is shown that they don’t have much significant impact on the overall plant total power consumption.

Keywords: Liquid hydrogen, hydrogen liquefier, large hydrogen liquefaction, optimization

1. Introduction
Hydrogen has shown promise as an important energy vector for use in future transportation vehicles. One of the challenges in creating a hydrogen economy is the low efficiencies of the current hydrogen liquefaction plant cycles. Today process for liquefaction of hydrogen gas is very cost intensive. It requires a large amount of energy in operation. It is therefore important that the plant is both well designed and later operated close to optimum.

First, a literature review for the development of large-scale hydrogen liquefaction processes throughout the world from 1898 to 2009 was given by Krasae-in et al. [1]. Then, other papers [2-3] concerning utilizing small-scale laboratory mixed fluid refrigeration system to pre-cool hydrogen gas were published. Next, Krasae-in et al. [4] proposed a new large-scale multi-component refrigerant (MR) system (or generally is called mixed refrigerant cycle) with efficiency in excess of 50%. Finally, this paper proposes a more realistic improved cycle with optimization than the system proposed by the author [4] especially the one used to cool equilibrium hydrogen gas from −193 °C to −253 °C. The process considered in this paper is based on MR system that can be used to cool feed normal hydrogen gas from 25 °C to the equilibrium temperature of −193 °C. A simplified 5-component mixture of refrigerant suggested for the plant is found. But, the difference from the previous paper is that the transition of the equilibrium ortho-para hydrogen gas from −193 °C to −253 °C, a new proposed configuration four H₂ Joule-Brayton (J-B) cycle refrigeration system with optimization is recommended.

2. Process description
This paper contains a preliminary study on the optimum operation of a proposed cycle as the flow-sheet given in Fig. 1. The simulation result is in Tables 1 & 2. The cycle is from using C language programming. For more detail about the previous process is by Krasae-in et al. [4].
Fig. 1 – Simulation flow-sheet for the large-scale 100-TPD LH₂ plant utilizing MR and four hydrogen Joule-Brayton refrigeration cycles.
### Table 1 – Simulation data of the system’s energy consumption in Fig. 1.

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR compressors’ power</td>
<td>5,896 kW</td>
</tr>
<tr>
<td>Hydrogen compressors’ power</td>
<td>19,294 kW</td>
</tr>
<tr>
<td>Expanders’ total power</td>
<td>1,245 kW</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>1,100 kW</td>
</tr>
<tr>
<td><strong>Overall cycle energy consumption</strong></td>
<td>5.91 kWh/kg$_{LH2}$</td>
</tr>
</tbody>
</table>

### Table 2 – Simulation data of the proposed MR cycle.

<table>
<thead>
<tr>
<th>Stream number</th>
<th>Pressure (bar)</th>
<th>Temp. (°C)</th>
<th>Flow rate (kg/s)</th>
<th>Specific enthalpy (kJ/kg)</th>
<th>Specific entropy (kJ/kg·K)</th>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>21</td>
<td>25</td>
<td>1.157</td>
<td>175.87</td>
<td>76.12</td>
<td>H$_2$ cool gas</td>
<td>Superheated vapor</td>
</tr>
<tr>
<td>4</td>
<td>21</td>
<td>-46.00</td>
<td>1.157</td>
<td>-837.64</td>
<td>72.23</td>
<td>H$_2$ cool gas</td>
<td>Superheated vapor</td>
</tr>
<tr>
<td>4a</td>
<td>21</td>
<td>-46.00</td>
<td>1.157</td>
<td>-552.78</td>
<td>75.14</td>
<td>H$_2$ cool gas</td>
<td>Superheated vapor</td>
</tr>
<tr>
<td>5</td>
<td>21</td>
<td>-103.00</td>
<td>1.157</td>
<td>-1,377.43</td>
<td>70.95</td>
<td>H$_2$ cool gas</td>
<td>Superheated vapor</td>
</tr>
<tr>
<td>5a</td>
<td>21</td>
<td>-103.00</td>
<td>1.157</td>
<td>-1,373.83</td>
<td>70.98</td>
<td>H$_2$ cool gas</td>
<td>Superheated vapor</td>
</tr>
<tr>
<td>7</td>
<td>21</td>
<td>-198.00</td>
<td>1.157</td>
<td>-2,776.45</td>
<td>58.84</td>
<td>H$_2$ cool gas</td>
<td>Superheated vapor</td>
</tr>
<tr>
<td>7a</td>
<td>21</td>
<td>-194.75</td>
<td>1.157</td>
<td>-2,183.80</td>
<td>61.75</td>
<td>H$_2$ cool gas</td>
<td>Superheated vapor</td>
</tr>
<tr>
<td>7b</td>
<td>21</td>
<td>-213.15</td>
<td>1.157</td>
<td>-2,481.86</td>
<td>57.42</td>
<td>H$_2$ cool gas</td>
<td>Superheated vapor</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>15.00</td>
<td>36.11</td>
<td>317.25</td>
<td>9.12</td>
<td>MR cool gas</td>
<td>Superheated vapor</td>
</tr>
<tr>
<td>17a</td>
<td>6</td>
<td>25.00</td>
<td>36.11</td>
<td>327.80</td>
<td>8.89</td>
<td>MR cool gas</td>
<td>Superheated vapor</td>
</tr>
<tr>
<td>17b</td>
<td>6</td>
<td>25.00</td>
<td>36.11</td>
<td>327.80</td>
<td>8.89</td>
<td>MR cool gas</td>
<td>Superheated vapor</td>
</tr>
<tr>
<td>17c</td>
<td>6</td>
<td>25.00</td>
<td>0.00</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>25.00</td>
<td>36.11</td>
<td>220.82</td>
<td>8.28</td>
<td>MR cool liquid</td>
<td>Saturated liquid</td>
</tr>
<tr>
<td>19</td>
<td>18</td>
<td>25.00</td>
<td>36.11</td>
<td>220.82</td>
<td>8.28</td>
<td>MR cool liquid</td>
<td>Saturated liquid</td>
</tr>
<tr>
<td>20</td>
<td>18</td>
<td>25.00</td>
<td>26.49</td>
<td>279.01</td>
<td>8.71</td>
<td>MR cool gas</td>
<td>Saturated vapor</td>
</tr>
<tr>
<td>21</td>
<td>18</td>
<td>25.00</td>
<td>9.62</td>
<td>60.61</td>
<td>7.08</td>
<td>MR cool liquid</td>
<td>Saturated liquid</td>
</tr>
<tr>
<td>22</td>
<td>18</td>
<td>-46.00</td>
<td>9.62</td>
<td>-105.59</td>
<td>6.446</td>
<td>MR cool liquid</td>
<td>Compressed liquid</td>
</tr>
<tr>
<td>23</td>
<td>2</td>
<td>-50.86</td>
<td>9.62</td>
<td>-108.80</td>
<td>6.450</td>
<td>MR cold mixture</td>
<td>Mixture</td>
</tr>
<tr>
<td>24</td>
<td>18</td>
<td>-46.00</td>
<td>26.49</td>
<td>-35.79</td>
<td>7.52</td>
<td>MR cold mixture</td>
<td>Mixture</td>
</tr>
<tr>
<td>25</td>
<td>18</td>
<td>-46.00</td>
<td>13.258</td>
<td>51.66</td>
<td>8.536</td>
<td>MR cool gas</td>
<td>Saturated vapor</td>
</tr>
<tr>
<td>26</td>
<td>18</td>
<td>-46.00</td>
<td>13.235</td>
<td>-123.403</td>
<td>6.502</td>
<td>MR cool liquid</td>
<td>Saturated liquid</td>
</tr>
<tr>
<td>27</td>
<td>18</td>
<td>-103.00</td>
<td>13.235</td>
<td>-215.557</td>
<td>5.853</td>
<td>MR cool liquid</td>
<td>Compressed liquid</td>
</tr>
<tr>
<td>28</td>
<td>2</td>
<td>-106.62</td>
<td>13.235</td>
<td>-254.48</td>
<td>5.857</td>
<td>MR cold mixture</td>
<td>Mixture</td>
</tr>
<tr>
<td>29</td>
<td>18</td>
<td>-103.00</td>
<td>13.258</td>
<td>-198.98</td>
<td>7.257</td>
<td>MR cold mixture</td>
<td>Mixture</td>
</tr>
<tr>
<td>31</td>
<td>18</td>
<td>-198.00</td>
<td>13.258</td>
<td>-579.402</td>
<td>4.125</td>
<td>MR cold mixture</td>
<td>Mixture</td>
</tr>
<tr>
<td>32</td>
<td>2</td>
<td>-201.08</td>
<td>13.258</td>
<td>-585.116</td>
<td>4.145</td>
<td>MR cold mixture</td>
<td>Mixture</td>
</tr>
<tr>
<td>34</td>
<td>2</td>
<td>-111.04</td>
<td>13.258</td>
<td>-113.33</td>
<td>8.408</td>
<td>MR cold mixture</td>
<td>Mixture</td>
</tr>
<tr>
<td>35</td>
<td>2</td>
<td>-107.10</td>
<td>26.49</td>
<td>-183.84</td>
<td>7.142</td>
<td>MR cold mixture</td>
<td>Mixture</td>
</tr>
<tr>
<td>36</td>
<td>2</td>
<td>-55.71</td>
<td>26.49</td>
<td>50.136</td>
<td>8.383</td>
<td>MR cold mixture</td>
<td>Mixture</td>
</tr>
<tr>
<td>37</td>
<td>2</td>
<td>-54.96</td>
<td>36.11</td>
<td>7.785</td>
<td>7.868</td>
<td>MR cold mixture</td>
<td>Mixture</td>
</tr>
</tbody>
</table>
3. Optimization result

The total shaft work from all compressors is 25,190 kW. The optimal GH$_2$ temperatures out of HX1, HX2 and HX3 are: $-46$ °C, $-103$ °C, and $-198$ °C respectively. The proposed refrigerant is a mix of 4% hydrogen, 18% nitrogen, 24% methane, 28% ethane, and 26% butane by mole.

The mixed refrigerant composition is chosen so that it has an evaporation curve that matches the cooling curve of the pre-cooled hydrogen gas with minimum temperature difference. Small temperature difference reduces entropy generation; it improves thermodynamic efficiency and reduces power consumption. Usually refrigerant compositions selection has been done by trial-and-error and guided only by heuristics. It is similar to output of a proposed 10-component mixture: 1.2% hydrogen, 25.6% nitrogen, 13.6% methane, 15.2% R14, 10% ethane, 10% propane, 5.8% propane, 1.0% i-butane, 1.0% butane, and 10.8% pentane. The total power consumption from MR compressors due to the 10-component mixture is quite the same as the 5-component mixture. Therefore, the proposed 5-component mixture is selected for the large-scale plant instead of the possible complicated 6- to 10- or more-component mixtures because of its simplicity reason.

4. Conclusion

A new flow-sheet of 100 TPD large-scale hydrogen liquefaction plant by simulation is proposed with preliminary optimal study. The optimization problem has 23 variables and 26 constraints. An MR cycle is utilized to cool down feed normal hydrogen gas from 25 °C to equilibrium hydrogen gas at $-193$ °C with an energy consumption at 1.38 kWh/kg$_{LH2}$. More complexed e.g. from 6- to 10-component mixture yields slight improvement of efficiency, thus, a simplified 5-component mixture suggested for the plant is found consisting of: 4% hydrogen, 18% nitrogen, 24% methane, 28% ethane, and 26% butane by mole. The mixed refrigerant composition is adjusted from trial and error to match the cooling curve of feed hydrogen gas. For further cooling down equilibrium hydrogen gas from $-193$ °C to be liquid hydrogen at $-253$ °C, a new four H$_2$ J-B cycle refrigeration is recommended which consumes 4.24 kWh/kg$_{LH2}$. Thus, the overall power consumption of the proposed plant is 5.91 kWh/kg$_{LH2}$ which is a half compared to the current plant in Ingolstadt that has an energy consumption of 13.58 kWh/kg$_{LH2}$. The plant optimization was also conducted with two more pinch temperatures (1 °C and 3 °C) yielding less plant energy consumption. But 3 °C is recommended for actual plant. Pressure drops in heat exchangers are also employed in the simulation for the study, but it is shown that they don’t have much significant impact on the overall plant total power consumption.

References

Simulation of orifice pulse tube cryocooler

Songwut Krasae-in

Department of Mechanical Technology, Faculty of Technical Education,
Rajamangala University of Technology Krungthep, Nanglinchee Road, Tungmahamek, Sathorn, Bangkok
10120, Thailand

E-mail addresses: songwut.k@rmutk.ac.th, krasaein@hotmail.com
Tel.: +66 2 2879639, ext. 9653, 1365; fax: +66 2 2879639, ext. 9653, 1365

Abstract

This paper presents a simple one-dimensional numerical model of low frequency oscillating gas $^4$He flow inside the Single-stage Orifice Pulse Tube refrigerator in every component of the cooler: aftercooler, regenerator, cold end heat exchanger, pulse tube, hot end heat exchanger and reservoir. The continuity, the momentum, the energy and the state equations together with the real gas properties are used to analyze the heat transfer and the refrigeration mechanism.

From the experimental data that are, the sizes of the main components, the wall temperatures at aftercoolers, hot end heat exchangers, the cold end heat exchangers, and the pressure profiles in pulse tubes and reservoirs, are input into the program. In the pulse tubes, the comparisons are mainly focused on the cooling power, the gas temperature profiles, the gas velocity profiles and the gas displacements. For the other components, the results of simulation data are shown.

In the pulse tubes, the predictions of the simulation data compared with the experimental data give good results, that can prove the validity of the model that again can predict the fluid mechanisms of the other parts especially inside the regenerator. It takes a few minutes to run the program. The model is the fundamental concept and easy to understand, however there is lot of development for future work to improve the model to get a perfect tool to describe the cooling machine.

Keywords: Pulse tube, pulse tube refrigerator, regenerator; numerical simulation; cryocooler.

1. Introduction

The Low-frequency Pulse Tube refrigerator is a miniature cryocooler used to cool electronic sensors and components that operate at temperatures below 120 K and dissipate less than a few watts of heat [1]. This device is a recent innovation which is the variation of the Stirling refrigerator. It has significant advantages over other cryocoolers due to the elimination of moving parts at low temperature and due to the relatively low working pressure. Therefore it has great potential to be more reliable, simpler to construct and cheaper than the Stirling or GM cryocoolers [2].

Fig. 1. Commercial pulse tube cryocoolers.

Gifford and Longsworth [3] proposed a well-known initial theoretical explanation of pulse tube operation that was “the surface heat pumping”. They explained an ideal gas of thermodynamic relation between pressure and temperature. It is the first basic concept to make understand and to explain the heat transfer and refrigeration mechanism of the oscillating gas $^4$He flow inside the pulse tube of the Pulse Tube refrigerator.

Wu and Zhu [4] made the first attempt to numerically model the Orifice Pulse Tube refrigerator. The model included the regenerator and the pulse tube, however the model neglected the pressure drop across the regenerator and produced unsatisfactory results. However they initially gave the first good concept of how to think of the numerical model and how to apply the continuity, the momentum, the energy and the state equations in the model.

Storch and Radebaugh [5] derived the equations to predict the refrigeration power of the
Orifice Pulse Tube refrigerator, which identified the important parameters in the system including the role of the orifice and later the model was widely known, called and recognized as “the enthalpy flow theory”. Although the enthalpy flow model is practical to understand the refrigeration mechanism, it was later verified to over-predict the refrigeration power of a given operating condition by 3 to 6 times as the example of analysis of J.Yuan [6] was given. Anyhow this idea gives the basic understanding of refrigeration mechanism at the cold end of the Pulse Tube refrigerator.

2. Theory

Beginning with substituting:

\[ q_{\text{REG}} = \alpha_{\text{REG}} A_{\text{REG}} (T - T_{\text{REG}}) \]

neglecting gravitational effect term that is assumed to be very small, and then integrating each term by a discretized volume (void volume). Finally obtaining the equations for any a discretized void volume in the regenerator as shown below:

\[ \frac{\partial \tilde{m}}{\partial t} + (\tilde{m}_\text{out} - \tilde{m}_\text{in}) = 0 \]  

(1)

\[ \frac{\partial (\tilde{m} u)}{\partial t} + (\tilde{m}_\text{out} u_\text{out} - \tilde{m}_\text{in} u_\text{in}) = V_{\text{VOID}} \left( \frac{\partial \sigma_{\text{ss}}}{\partial x} \right) \]  

(2)

\[ \frac{\partial (\tilde{m} h)}{\partial t} + (\tilde{m}_\text{out} h_\text{out} - \tilde{m}_\text{in} h_\text{in}) \]

\[ = V_{\text{VOID}} \left[ \frac{\partial P}{\partial t} + u \frac{\partial P}{\partial x} + \sigma_{\text{ss}} \frac{\partial u}{\partial x} + k \frac{\partial^2 T}{\partial x^2} \right] \]

\[ - \alpha_{\text{REG}} A_{\text{REG}} (T - T_{\text{REG}}) \]  

(3)

In Eq. 2, the term of \( mg \) is neglected. Because from the experimental measurements show significant pressure drop along the regenerator. It means the momentum equation cannot be neglected.

In Eq. 3, because there is pressure gradient that makes velocity gradient, so the terms of \( \frac{\partial P}{\partial x} \) and \( \sigma_{\text{ss}} \frac{\partial u}{\partial x} \) are the terms that should be considered to have in the equation. But they were later found to have very small effect in the energy equation of low frequency operating in a cooler’s construction. However these terms may have big effect in other types of the cooler’s construction.

The terms of \( k \frac{\partial^2 T}{\partial x^2} \) and \( \alpha_{\text{REG}} A_{\text{REG}} (T - T_{\text{REG}}) \) are the two most important terms in heat transfer mechanism of the gas flow inside the regenerator.

3. Comparison with experiment

Comparisons are divided into four parts that are the comparison of temperature profiles, the comparison of velocity profiles, the comparison of gas displacements and the simulation results of temperatures, velocity profiles and gas displacements of an Orifice Pulse Tube refrigerator.

3.1 Comparison of temperature profiles

The simulation data are compared with the experimental data obtained from ref. [7] as they did and provide the experimental apparatus.

Fig. 2. Comparison between the simulation data and the experimental data from ref. [7] of gas temperature oscillations for typical positions along an apparatus and pressure oscillations at entrance of regenerator for an orifice pulse tube.

Fig. 3. Simulation data of pressure oscillations of gas inside a pulse tube and a reservoir.

3.2 Comparison of velocity profiles

The simulation data are compared with the
experimental data obtained from ref. [8].

Fig. 4. Comparison between the simulation data and the experimental data from ref. [8] of velocity of the smoke and the pressure oscillation during two cycles in the orifice pulse tube.

4. Simulation data of temperature profiles

The simulation result is from C language programming as below:

Fig. 5. The points of positions show simulation temperatures inside an orifice pulse tube refrigerator.

Fig. 6. Simulation data of temperature profiles of gas in several points along a regenerator.

Fig. 7. Simulation data of temperature profiles of gas in several points along a pulse tube.

Fig. 8. Simulation of temperature distribution of stainless steel screen-matrix material in different time along a regenerator.

5. The deviation of the simulation data from the experimental data

- The differences from the experimental data, first of all it is because of the errors from starring, reading and copying the pictures of pressure oscillations inside the pulse tube from the experimental measurements. The pictures are very small, so the copies of the pressure profiles are not exactly the same.
- The assumption that at the hot end and the cold end are both perfect heat exchangers, is not right. Equations must be used to analyze the heat transfer mechanism in the cold and the hot ends.
- The momentum equation and the friction between the fluid flow and the tube wall cannot be neglected as observed in the figure that there is phase and amplitude differences of pressure oscillation near the hot and the cold ends. There is a lot of mass flows in and out the reservoir, so there is a large effect in mass flow inside the pulse tube. Furthermore the another reason that the friction because of the large gas mass flow inside the small long tube where the orifice is located and connected between the reservoir and the pulse tube is neglected in the model.
- It’s possible that the errors are from that every term in Equations 1-3 is not included in the analysis.
- Two-dimensional analysis is not included in the program. Other effects due to the secondary flow and the orientation of the pulse tube are not analyzed.
• The errors due to the simple discretization methods to discretize the equations, it causes the errors in time and space. Crank-Nicolson scheme should be used to discretize the governing equations.
• High ability computer is necessary to compute if the whole volume of the pulse tube is separated uniformly into more than small 300 volumes to obtain the more correct simulation data. And to optimize the geometry of the pulse tube or if more work to do on the simulation.

6. Conclusions
6.1 General conclusions
• This paper presents the analysis and derivation of one-dimensional equations in a numerical simulation.
• The comparisons show the validity of the model compared between the simulation data and the experimental data.

6.2 Suggestions for the future work
This research work is only some parts of analyzing the pulse tube of the Pulse Tube refrigerator. There are a lot of works to do to develop the program to get more satisfied simulation results. The brief suggestions can be given as follows:
• Further developing the convective heat transfer coefficient between the gas and the inner surface of the tube wall.
• Further developing the convective heat transfer coefficient between the gas and the regenerative material.
• Friction due to the large mass flow through the small tube where the orifice located and connected between the pulse tube and the reservoir should be studied and include into the program.
• Every term in Eqs. 1-3 has to be included in the calculation to study exactly how big for each term to effect in each equation. Especially the momentum and friction between the wall and the gas in case of the operation of high frequency and big pulse tube.
• Temperature distribution and heat conduction in the tube wall steel material should be studied.
• The optimization of the geometry of the after-cooler, the regenerator, the pulse tube, the reservoir and the diameter of the orifice should be studied to have a program to obtain the right dimension of each part for the ideal cooler if the cooling power and the temperature at the cold end are known.
• Two dimensional form of the continuity, the momentum and the energy equations have to be studied to simulate the secondary flow, the effect due to the orientation of the pulse tube and others not-yet-discovered phenomenon that is the final work of the real world tool to predict the simulation data of the Pulse Tube refrigerator.

References
Effect of Shielding Gases on Corrosion Properties of Austenitic Stainless Steels
Grade AISI 201 Produced by Plasma Arc Welding

Wichan Chuaiphan 1 Loeshpahn Srijaroenpramong 2 Dumrongrit Pinpradub 2 and Somporn Piyaphan 2
1 Department of Industrial Engineering, Faculty of Engineering,
Rajamangala University of Technology Krungthep
2 Department of Metallurgical Technology, Faculty of Education,
Rajamangala University of Technology Krungthep
Tel. 02-287-9645 Ext. 1334, E-Mail: wichan.c@rmutk.ac.th

Keywords: Plasma arc welding, Nitrogen, Stainless steel, Delta ferrite, Corrosion

Abstract
Plasma arc welding was applied to join AISI 201 stainless steel sheets. Nitrogen was mixed in argon shielding gas to help control microstructure and improve corrosion property of the weld. It was found that increasing nitrogen in shielding gas from 0 to 14 \%v/v reduced the amount of delta ferrite in austenite matrix of the weld from 19 to 8.5 \%v/v. This indicated the role of nitrogen as an austenite stabiliser. From polarisation test in 3.5wt\% NaCl solution at 25 °C, increasing nitrogen in shielding gas nobly shifted a pitting corrosion potential from 152 to 192 mV vs Ag/AgCl. This corresponded to the increase of nitrogen content in the weld from 0.21 to 0.42 wt%.

Keywords: Plasma arc welding, Nitrogen, Stainless steel, Delta ferrite, Corrosion

1. Introduction
AISI 304 stainless steel is a widely used corrosion-resistant alloy because of the beneficial role of chromium that forms passive film on steel surface. Nickel is added in AISI 304 as an austenite former to help stabilise austenite phase in the steel and therefore promote its formability [1,2]. However, the price of Ni is relatively high and fluctuated. The attempt has then made to replace that element by the other austenite stabiliser, which is manganese. Adding the later element up to 5.5-7.5 wt\% leads to the development of a new grade - AISI 201 [1-3]. The present work investigated the possibility to weld the alternative material (AISI 201) by parameters that gave appropriate or improved microstructure and corrosion property of the weld. For the microstructure, it was reported that delta ferrite in austenite matrix of austenitic stainless steel weld should be higher than 3 \%v/v to prevent solidification crack [1,4]. It is, however, recommended that delta ferrite be less than 8-12 \%v/v to prevent formation of network between these two phases that could lead to brittle failure of the ferrite phase at temperatures below the transition one [1,4,10]. Furthermore, brittle sigma phase can be transformed from delta ferrite at high temperatures, and if the former phase is excessive it is detrimental for the weld [1,10]. To control phases of stainless steel weld, nitrogen has been mixed in shielding gas because it has a role as an austenite stabiliser [4-9]. Using the technique of mixing nitrogen in shielding gas was also found to help improve corrosion property of the weld [11,12]. However, the previous works [4-11] focused on welding of the same alloy. Application of that technique for AISI 201 welding has been conducted in our group [13], but with the use of gas tungsten arc welding. Because plasma arc welding is one of the attractive welding methods in controlling weld bead formation with a high depth-per-width ratio of the weld [14], this method combined with the technique of mixing nitrogen in shielding gas was then realised in the present work.

2. Experimental
2.1 Materials and welding process
The studied materials was AISI 201 (Fe-17Cr-7Mn-3Ni-0.04C). It was in a sheet
form and cut into the dimensions of $150 \times 250 \times 2$ mm. Square-butt joint was used in this study. Plasma arc welding was performed using the current of 140 A, voltage of 14 V and welding speed of 6.25 mm.s$^{-1}$. Shielding gas was argon mixed with nitrogen with the contents of 0, 3, 6, 10 and 14 %v/v.

2.2 Characterisation and corrosion testing
For metallographic examination, the sample was polished by SiC papers followed by alumina powders down to the size of 0.3 micron. Etching agent was prepared from hydrochloric acid, glycerol and nitric acid with the ratio of 30:30:10. Microstructure of the weld metal was observed using an optical microscope. Volume fraction of delta ferrite in austenite matrix was quantified according to ASTM E 562. Five images of the given weld metal were used for quantification. Nitrogen in the weld metal was measured using a nitrogen combustion analyser (Horiba EMGA-620W). For potentiodynamic test, a platinum-wire counter electrode and Ag/AgCl-type reference electrode were used. Testing solution was 3.5-wt% NaCl solution at 25 ºC.

3. Results and Discussion
Figure 1 shows the amounts of delta ferrite in austenite matrix of the welds produced using argon shielding gas mixed with nitrogen by 0, 3, 6, 10 and 14 % v/v. Microstructures of the welds produced using argon without and with 6%v/v nitrogen are exemplified in Figure 2. One can see delta ferrite dendrite in austenite matrix. From these two figures, it was observed that increasing nitrogen in shielding gas reduced delta ferrite in austenite matrix from ca. 19 to 8.5 %. Figure 3 presents nitrogen contents in the welds as a function of percentage of nitrogen in argon shielding gas. The increased nitrogen content in the weld with the increased nitrogen gas mixed in shielding gas was observed. Combining these results led to the discussion that increasing nitrogen content in shielding gas raised nitrogen content in the weld, and since nitrogen is an austenite stabiliser it reduced delta ferrite in austenite matrix of the weld.
Pitting corrosion potentials extracted from the polarisation curves are shown in Figure 4. It was found that increasing nitrogen in shielding gas positively shifted pitting corrosion potential from 152 to 192 mV vs Ag/AgCl. As a matter of discussion, many works have proposed mechanisms to explain the role of nitrogen on improving pitting corrosion resistance [12,15]. One of them proposed that existence of nitrogen in steel gave solution in the pit containing ammonium ion, and due to its basic effect corrosion resistance in the pit was improved [12,15]. The role of nitrogen on improving pitting corrosion resistance also appears in the empirical formula determining a pitting resistance equivalent number (PREN) of stainless steel as the following [2].

\[
\text{PREN} = (\text{wt.\%Cr}) + 3.3(\text{wt.\%Mo}) + 16(\text{wt.\%N})
\]

From this equation, one can see the strong effect of nitrogen on pitting resistance with the multiplying factor of 16. This means that higher nitrogen in stainless steel raises PREN and also provides higher pitting corrosion resistance.

4. Conclusion and Recommendation
In this work, the plasma arc welding AISI 201 stainless steels was carried out. Mixing nitrogen in argon shielding gas up to 14 %v/v could reduce the amount of delta ferrite in austenite matrix from 19 to 8.5 %v/v. It also increased pitting corrosion potential from 152
to 192 mV vs Ag/AgCl. This was due to the increased nitrogen in the weld metal which was from nitrogen in shielding gas.

However, even though using this welding method with the technique of mixing nitrogen in shielding gas up to 14 %v/v could reduce delta ferrite as concluded above, its amount was still higher than the generally recommended value of 8-12%v/v [1,4,10]. It is possible that increasing nitrogen in shielding gas higher than 14 %v/v might help increase nitrogen content in the weld up to its solubility limit and therefore reduce delta ferrite. Using other welding methods might also give the optimum results in terms of microstructure, mechanical and corrosion properties of the weld.

5. Acknowledgment

The authors would like to thank Department of Industrial Engineering, Faculty of Engineering, Rajamangala University of Technology Krungthep for supporting this project.

References

A Study Comparative of Surface Roughness During Milling Machining of Mold Steel AISI1050 with AISIP21

Pichai Janmanee1*, Somchai Wonthaisong2, Somsak Ithisponakul3 and Banjoong Feungfoo4
1, 2, Department of Industrial Engineering, Faculty of Engineering, Rajamangala University of Technology Krungthep
3, 4, Department of Industrial Engineering, Faculty of Engineering, Rajamangala University of Technology Thanyaburi
Tel.02-287-9645, E-mail:pichai@rmutk.ac.th

Keywords: Plastic mold, roughness, milling, end mill

Abstract
The objective of this research is to study and compare quality milling surface and effect between plastic mold steel “AISI-1050” and “AISI-P21” by milling process with various parameters based on the testing conditions such as feed rate at 45, 50, 55 mm/min, spindle speed of 510, 572 and 637 rpm, milling level of 3, 5, and 10 mm respectively by a 10 mm. two flute type end mill. The experimental result was found that Plastic mold steel which had the best quality of milling surface was Plastic mold steel “AISI-P21” and “AISI-1050” with roughness by 0.593 and 2.560 µm respectively. Quality milling surface milled by using the most suitable parameter feed rate by 55 mm/min, spindle speed by 637 rpm and level depth of cut by 3 mm for both tested grades. However, characteristic milling surface and wear of the end mill was directly influenced from the change of parameter for all testing conditions so Quality milling surface was changed.

Keywords: Plastic mold, roughness, milling, Ra

1. Introduction
Nowadays, a mold industry is great important for a production process. It rapidly has continued growing, particularly, the mold industry. The plastic mold called the mold was used for mass production [4,7]. A researcher has focused on considering a type of mold material since its property needs efficiency so the study to reduce defect of the finished product and to extend shelf life of mold making was conducted [1]. Many types of Plastic mold steel were compared quality milling surface against roughness (Ra) and materials had difference as suitability of milling molds for each one. It is necessary for the product to increase amounts, quality, and competitiveness [2]. The current factor effecting mold making is people truly do not understand quality milling surface of materials for mold making because it is important for plastic mold product. Therefore, this is a significant factor for consideration to get completed and high quality products. According to the actual utilization of mold making material, it depends on several components [2,5] such as spindle speed, feed rate, cutting speed, tools cutter, etc [3].

Thus, a researcher team has paid attention to this research so we studied quality surface of milling parameter effecting smoothness of plastic mold steel “AISI-1050” and “AISI-P21” by milling process by changing a method of milling and feed rate. Surface roughness was analyzed after shear test to apply information for the industry of mold making efficiently.

2. Experimental procedure
2.1 Materials and equipments
Materials of this experiment were mold steel “AISI-1050” and “AISI-P21” because they are popular in the mold industry. They are suitable for plastic mold milling in terms of quality milling surface, endurance, and strength. Properties of both plastic mold steel were shown in table 1. Regarding, OMER HSS-AL GROUND END MILLS DIN844 2F 10x10x22x72 mm [3], it was for purpose of milling material test.

A machine of this experiment was CNC Milling “CHEVALIER 2040VMC”. There was 3 axis controlled by a computer numerical control. A roughness measure “Mahr MarSurf PS1” used for measuring Ra of milling surface after milling of all conditions. Afterwards, milling surface was inspected by a stereo Microscope “Leica EZ 4D”
The materials of plastic mold steel “AISI-1050” and “AISI-P21” were 50 x 50 x 50 mm to fit a milling machine and measuring by an analysis instrument. The milling used feed rate at 50 45 and 55 mm/min, spindle speed of 572 ,510 and 637 rpm, level depth of cut of 5.3 and 10 mm based on determination and other conditions as shown in the table2 and the base metal from milling process shown in Fig.1. Then, the tested base metal was measured Ra. The Ra machine examined quality milling surface and chip by the microscope stereo and analyzed wear of the end mill by the scanning Electron Microscope (SEM) respectively.

**Fig. 1** The milling direction feed of the end-mill and machining experiment

### 2.2 Experiments

The materials of plastic mold steel “AISI-1050” and “AISI-P21” were 50 x 50 x 50 mm to fit a milling machine and measuring by an analysis instrument. The milling used feed rate at 50 45 and 55 mm/min, spindle speed of 572 ,510 and 637 rpm, level depth of cut of 5.3 and 10 mm based on determination and other conditions as shown in the table2 and the base metal from milling process shown in Fig.1. Then, the tested base metal was measured Ra. The Ra machine examined quality milling surface and chip by the microscope stereo and analyzed wear of the end mill by the scanning Electron Microscope (SEM) respectively.

### 3. Results and discussion

#### 3.1 Surface roughness

Ra was conducted from milling process of plastic milling steel “AISI-1050” and “AISI-P21”. The study was undertaken parameter according to the research condition to find out the best proper variable resulting in Ra. The experimental result could be explained as follows:

Fig. 2 Ra was demonstrated relations of plastic mold steel “AISI-1050” and “AISI-P21”. When milling was tested spindle speed at 572, 510 and 637 rpm, feed rate at 45, 50 and 55 mm/min, and milling level of 3 mm, it was found that the average surface roughness of plastic mold steel “AISI-1050” tended to increase more than plastic mold steel “AISI-P21”. When adding spindle speed and feed rate of milling for all conditions, the surface roughness also increased and the surface roughness of plastic mold steel “AISI-P21” was not much different. However, the average roughness of all conditions was less than material steel “AISI-1050” comparing with the same level of testing variable.
was the factor to increase Ra of plastic mold steel “AISI-1050” for all three milling levels obviously. However, the surface roughness of plastic mold steel “AISI-P21” in each condition was not different and probably based on properties of plastic mold steel types against different surface roughness.

The study and analysis of surface roughness from milling by using differences of milling level, feed rate, ad spindle speed milling resulted in different surface roughness based on the grade of plastic mold steel as shown the graph in Fig. 3 and Fig. 4 respectively. Parameter which had the least influence or resulted in the best quality milling surface for both plastic milling steel was feed rate at 45 mm/min, spindle speed at 637 rpm, and level of cut at 3 mm. The reason was the rate of end mill’s material shear was not much but spindle speed was opposite so the end mill could shear material thoroughly more than high feed rate and low spindle speed. It resulted in surface roughness of plastic mold steel “AISI-1050” and “AISI-P21” which was the lowest level by 2.560 µm and 0.593 µm respectively.

3.2 Quality of Surface milling

The study surface roughness after milling process based on parameter of all conditions of plastic mold steel “AISI-1050” and “AISI-P21” indicated that the average surface roughness of both plastic mold steel was much different at the same conditions of all variables. It resulted from

![Fig. 2: Arithmetic average roughness (Ra) provided level depth of cut 3mm](image)

![Fig. 3: Arithmetic average roughness (Ra) provided level depth of cut 5mm](image)

![Fig. 4: Arithmetic average roughness (Ra) provided level depth of cut 10mm](image)

![Fig. 5: SEM magnified 200x of the good surface quality for milling surface of AISI 1050](image)
many factors such as feed rate, spindle speed, and milling level which were main factors of the experiment. Quality milling surface was analyzed and obtained the lowest and highest value. It indicated good and bad quality milling surface of both steel grades. The inspection was conducted by using SEM with magnifying of 200x at the middle of milling surface as Fig. 5. It showed the lowest roughness of milling surface of both tested materials when milling was done by using speed of 637 rpm, feed of 45 mm/min and level depth of cut 3 mm. Regarding the primary examination of milling surface by the low magnifying power electron microscope, milling surface of plastic mold steel “AISI-1050” was thoroughly smooth. On the other hand, milling surface of plastic mold steel “AISI-P21” was small-curved lines as a range of tool cutter. When examining by SEM on surface of both materials in the positions of I and II, milling surface was metal remained from shear of tool cutter due to slide and friction of metal and tool cutter or called Burr metal as a picture of plastic mold steel “AISI-1050” in the position more than plastic mold steel “AISI-P21” (Focus II). Characteristic of milling surface was smooth throughout and Burr metal was not happened when the photo was examined by high magnifying power. However, the cause probably resulted from mechanic property of plastic mold steel and created better quality than plastic mold steel “AISI-1050” based on the test of such condition [6].

When comparing the highest roughness of quality milling surface of both steel grades tested by speed of 510 rpm, Feed of 55 mm/min and Level depth of cut 10 mm as Fig. 6, it was founded that surface of plastic mold steel “AISI-1050” (Fig 6 a) Focus I) had much Burr metal and large size including small wave according to the cycle of tool cutter more than surface of plastic mold steel “AISI-P21” (Fig 6 b) Focus II). It had constant Burr metal and small size. Comparing with the lowest roughness, surface had very small Burr metal resulting in the low or high roughness depended on different quality of surface. It demonstrated that low spindle, high feed rate and milling level were the factors resulting in surface and bad quality milling surface. When comparing with of milling surface used high speed, low feed rate and milling level, quality milling surface would be the best. It indicated relation and concordance of roughness and quality milling surface based on the same test condition [4,8].

### 3.3 Chip analysis

The factor which had influence against roughness and quality milling surface from milling both plastic mold steels were spindle speed, feed rate, and milling level. They were main factors of the experiment and resulted in quality milling surface and chip. A researcher studied chip of the lowest roughness or the best quality milling surface by testing feed rate of 45 mm/min, spindle speed of 637 rpm and milling level of 3 mm and the lowest quality milling surface by testing feed rate of 55 mm/min, spindle speed of 510 rpm and milling level of 10 mm, the result was found that chip of plastic mold steel “AISI-1050” was smaller than plastic mold steel “AISI-P21” due to better rolling. Thus, chip milling from milling process in the same condition of both plastic mold steel was different and showed chip milling as Fig. 7 a) and b).

Comparing chip milling from milling process by measuring parameter resulted in the highest roughness or the lowest quality surface of both plastic mold steels. Milling used spindle speed of 510 rpm, feed rate of 55 mm/min and milling level of 10 mm as Fig. 7 c) and d) and found that chip from milling process in the same condition of both materials was great different. Chip of plastic mold steel “AISI-P21” was short and slight rolling so it differed from chip of plastic mold
Feed rate 45 mm/min / Speed 637 rpm / Level Dept of Cut 3 mm

Feed rate 55 mm/min / Speed 510 rpm / Level Dept of Cut 10 mm

Fig. 7 The characteristic of chip machined

steel “AISI-1050” which had much rolling of chip. It demonstrated that low spindle speed of milling and high feed rate resulted in material shear of tool cutter could obtain great amount but less chip rolling due to speed of shear from feed rate [8].

4. Conclusions

Studying the most suitable parameter of milling process of plastic mold steel “AISI-PS20” and “AISI-1050” could be concluded as follows:

1) The most suitable parameter resulting in the low Ra of milling surface of both plastic mold steels were feed rate of 45 mm/min, spindle speed of 637 rpm, and milling level of 3 mm and plastic mold material steel “AISI-P21” had the lowest roughness of 0.593 μm

2) The front and beside quality milling surface were different depending on machining or removal of tool cutter of each side. Quality surface conformed to Ra influencing parameter of each condition.

3) Chip of plastic mold material steel “AISI-1050” and “AISI-P21” were different depending on machining or removal rate of materials and mold steel property of each type.

4) Machining or removal rate for milling of the end mill resulted in wear of tool cutter for all parts. Milling used low feed rate, high spindle speed, and low milling level resulted in wear of the end mill, low Ra and good quality surface.

5. Acknowledgment

We would like to express our gratitude to Rajamangala University of Technology Krungthep and Rajamangala University of Technology Thanyaburi for supporting this study.

References


Quality Development on Acrylic Engraving of CNC-laser by DOE

Oris Maneesai\textsuperscript{1} and Parinya Srisattayakul\textsuperscript{2*}
\textsuperscript{1,2} Department of Industrial Engineering, Faculty of Engineering, Rajamangala University of Technology Krungthep
tel. 02-287-9600 ext. 9683, E-Mail: parinya28@yahoo.com

Keywords: \textsuperscript{3k} factorial design, engraving, surface roughness.

Abstract
In this work, acrylic engraving by CNC-laser technique was systematically studied using designed experiments. The goal was to minimize the surface roughness. Three process parameters including power, focus and feed were simultaneously investigated using the \textsuperscript{3k} factorial design method. The surface roughness response was measured by surface roughness tester. All terms of main and interaction effects were founded statistically significant process parameter except the interaction term between focus with feed were not statistically important. Finally, an optimum operating condition for acrylic engraving by CNC-laser technique that produced a minimum surface roughness of 4.0467 \(\mu\)m was obtained at power of 4.7 w, focus of 1.5 cm, and feed of 9.0 cm/sec with the overall desirability of 79.56%.

Keywords: \textsuperscript{3k} factorial design, engraving, surface roughness.

1. Introduction
In modern manufacturing systems, CNC has become the core of advanced manufacturing technology, and is used in almost all industrial fields [1]. Tool path optimization in NC machining is a typical combinatorial optimization problem. The optimization goal is to minimize the distance of virtual travel in the part machining process [2].

Laser machining has a great number of applications in material processing industries, which use for machining a wide range of materials, such as metals, ceramics, polymers and composites. Good cutting quality is important especially if parts are going to be used for assembly [3]. Investigation the CO\textsubscript{2} laser cutting of polymeric materials, specifically applied to polyethylene, polypropylene and polycarbonate in order to provide potential future industrial users of this technology with exhaustive information on optimum power levels and cutting velocities as well as of the quality of the surfaces [4]. Parametric optimizations of acrylic cutting by CO\textsubscript{2} laser were founded the thickness 5 mm that were the lens 63.5 mm, the laser power 70\% and the feed 0.2 m/min. The thickness 10 mm used the lens 63.5 mm, the laser power 50\% and the feed 0.08 m/min. The thickness 15 mm used the lens 75 mm, the laser power 70\% and the feed 0.04 m/min. The thickness 20 mm used the lens 63.5 mm, the laser power 70\% and the feed 0.04 m/min [5].

In this research, the systematically studied acrylic engraving by CNC-laser machine model LRT 2022 (as shown in Figure 1) using designed experiments to minimize the surface roughness. Three process parameters including power, focus and feed were simultaneously investigated using the \textsuperscript{3k} factorial design method. The surface roughness response was measured by surface roughness tester and analyzed by response surface methodology (RSM).

![CNC-Laser Machine model LRT 2022.](image-url)

2. Experimental
The main objective of research was to improve the surface quality by determining the optimal operating condition of process parameters of acrylic engraving by CNC-laser. Low surface
roughness was preferred to increase the surface quality. Three main process parameters were controlled the acrylic engraving behaviors including power, focus and feed. The ranges of power, focus and feed were 3.5 w to 5.0 w, 1.5 cm to 1.7 cm and 8 cm/sec to 12 cm/sec, respectively. The 3rd factorial design for this research consisted 27 factorial runs with 3 replicate runs each factorial runs, such as this experiment had been 81 total runs. This included the main and interaction effect plots of significant process parameters and optimized condition using MINITAB® software package [6]. This software package provided a three-dimensional plot of the response surface and a two-dimensional plot of the contour for each response variable and overall desirability versus selected process parameters. MINITAB® used an optimization method developed by [7] described by [8].

![Fig. 2 A sample of measured surface roughness.](image)

There are several ways to describe surface roughness. One of them is average roughness, which is often quoted as Ra symbol. Ra is defined as the arithmetic value of the departure of the profile from the centerline along sampling length as shown in Figure 2. It can be expressed by the following mathematical relationships as shown in equation 1, where Ra is the arithmetic average deviation from the mean line; Y is the ordinate of the profile curve; L is the sampling length [9].

\[ Ra = \frac{1}{L} \int_{0}^{L} |Y(x)| \, dx \]  

(1)

Figure 3 illustrates photograph of acrylic specimen, which the normal dimension of specimen was 210 mm x 148.5 mm x 2 mm.

![Fig. 3 Specimen for experimental of acrylic engraving.](image)

3. Statistical Results

The analysis of variance (ANOVA) was summarized in Table 1. The \( R^2 = 66.69\% \), thus the model explained about 67% of the variability in the surface roughness. Note that the coefficient of determination \( R^2 \) provided the proportion of the total variation in the response variable explained by the process parameters included in the model [10]. Although, the \( R^2 \) value of 67% was considered quite low, it was generally acceptable. The low \( R^2 \) was the results of large response variation for a random process, which were unavoidable in some cases. This could be the case for surface roughness, because of its partly random nature. However, this model was statistically significant based on the \( P \)-value.

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SeqSS</th>
<th>Adj SS</th>
<th>Adj MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus</td>
<td>2</td>
<td>2.24199</td>
<td>2.24199</td>
<td>1.12501</td>
<td>18.82</td>
<td>0.000</td>
</tr>
<tr>
<td>Feed</td>
<td>2</td>
<td>0.87243</td>
<td>0.87243</td>
<td>0.43621</td>
<td>5.77</td>
<td>0.005</td>
</tr>
<tr>
<td>Power</td>
<td>2</td>
<td>0.97426</td>
<td>0.97426</td>
<td>0.48713</td>
<td>6.44</td>
<td>0.003</td>
</tr>
<tr>
<td>Focus*Feed</td>
<td>4</td>
<td>0.58455</td>
<td>0.58455</td>
<td>0.14614</td>
<td>1.93</td>
<td>0.113</td>
</tr>
<tr>
<td>Focus*Power</td>
<td>4</td>
<td>3.58037</td>
<td>2.58037</td>
<td>0.64509</td>
<td>8.53</td>
<td>0.000</td>
</tr>
<tr>
<td>Feed*Power</td>
<td>4</td>
<td>2.13726</td>
<td>2.13726</td>
<td>0.35342</td>
<td>7.06</td>
<td>0.000</td>
</tr>
<tr>
<td>Focus<em>Feed</em>Power</td>
<td>8</td>
<td>2.87763</td>
<td>2.87763</td>
<td>0.35970</td>
<td>4.76</td>
<td>0.000</td>
</tr>
<tr>
<td>Error</td>
<td>81</td>
<td>6.12653</td>
<td>6.12653</td>
<td>0.07564</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>107</td>
<td>18.39503</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ S = 0.275020 \quad R-Sq = 66.69\% \quad R-Sq(adj) = 56.00\% \]

The main effect plot was shown focus maximum slope, which it was maximum affected to surface roughness on acrylic engraving by CNC-laser as shown in figure 4. According, statistical analysis result was shown in table 1.

![Fig. 4 The main effect plot.](image)

In order to interpret interaction effect effectively, an interaction plot was constructed as show in Figure 5. According to Figure 5, the parallel lines of focus and feed were revealed that there were weak interactions between the two
process parameters. On other hand, the other terms were strong interactions.

Response surface methodology (RSM) was employed to solve the problem. RSM is one of the most widely used statistical methodologies for experimental design, because it is used to determine optimal operating condition of statistically significant parameters [8].

Response surface methodology (RSM) was employed to solve the problem. RSM is one of the most widely used statistical methodologies for experimental design, because it is used to determine optimal operating condition of statistically significant parameters [8].

### Table 2: Statistical results of optimum operating condition.

<table>
<thead>
<tr>
<th>Ra (μm)</th>
<th>Goal</th>
<th>Lower</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ra (μm)</td>
<td>Goal</td>
<td>Lower</td>
<td>Target</td>
</tr>
<tr>
<td>Global Solution</td>
<td>1.50</td>
<td>3.625</td>
<td>3.625</td>
</tr>
<tr>
<td>Predicted Responses</td>
<td>4.0467</td>
<td>desirability = 0.79558</td>
<td></td>
</tr>
<tr>
<td>Composite Desirability</td>
<td>0.79558</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RSM with desirability function was used to determine an optimum acrylic engraving by CNC-laser condition that minimized the surface roughness. From RSM analysis with desirability function an optimum operating condition for acrylic engraving by CNC-laser that produced a minimum surface roughness of 4.0467 μm was obtained at power of 4.7 w, focus of 1.5 cm, and feed of 9.0 cm/sec with the overall desirability of 79.56% as shown in Table 2 and Figure 6.

### 4. Conclusions

This research had systematically studied acrylic engraving by CNC-laser technique to surface quality using design of experiments. All terms of main and interaction effects were founded statistically significant process parameter except the interaction term between focus with feed were not statistically important. An optimum operating condition of the significant process parameters was obtained by means of RSM.

### 5. Acknowledgment

The authors would like to thank MEMs laboratory in Kasetsart University, Thailand for experimental of acrylic engraving by CNC-laser and Rajamangala University of Technology Krungthep for financial support for the research connected with this paper under an innovative research grant.

### References


Development (TISD-2010), Faculty of Engineering, KhonKaen University, Thailand, 4-6 March 2010.


Data Hiding for QR Code Based on Fragile Video Watermarking

Thittaporn Ganokratana¹, Patiyuth Pramkeaw¹ and Mahasak Ketcham¹
¹Department of Media Technology, King Mongkut’s University of Technology Thonburi
Tel. 083-555-9088, E-Mail: maoquee@hotmail.com

Keywords: Video Watermarking, QR Code Fragile, LUT-Table.

Abstract
Fragile video watermarking in a technique to embed and extract a digital watermark into video watermarking. Embedding and extracting processes base on look-up table with discrete wavelet transform in frequency domain. This paper proposes QR Code (Quick Response Code) is embedded an invisible video watermark. Watermark can be directly extracted via the look-up table, without using the original image. The experimental results the watermarking method performs well in both security and robustness to many digital signals processing.

Keywords: Video Watermarking, QR Code Fragile, LUT-Table.

1. Introduction
Currently, multimedia data have become widespread via the internet. It may be that the ease with which perfect copies can be made will lead to large-scale unauthorized. There has therefore been significant recent research into ‘steganography’ to copyright, such as Digital watermarking which has consequently been introduced as a complementary Copyright protection technology. The enormous growth of the digital world: Old analog audio tapes were substituted by digital disks, personal computers with internet connections took homes by storms and digital versatile disk (DVD) players invaded living rooms. Unfortunately, this has also raised many concerns regarding copyright protection since digital data can be perfectly duplicated and rapidly redistributed on a large scale. Today, even nontechnical users can exchange copyrighted material via peer-to-peer networks and multimedia content providers have requested security mechanisms before releasing their highly valued property. Many digital right management (DRM) frameworks rely on end-to-end encryption to make digital data completely unusable without the proper decryption key.

Barcode became widely known because of their accuracy, and superior functionality characteristics. QR Code is a kind of 2D (two dimensional) Barcode symbol which is categorized in matrix code. It contains information in both the vertical and horizontal directions, whereas a 1D (one dimensional) Barcode symbol contains data in one direction only. QR Code holds a considerably greater volume of information than a 1D Barcode. QR Code developed by Denso Wave [1] (a division of Denso Corporation) and release in 1994. QR Code can encode in many type of characters such as numeric, alphabetic character, Kanji, Kana, Hiragana, symbols, binary, and control codes. Approximate maximum capacity 7,089 characters can be encoded in one symbol and maximum version is 40. Features of QR Code are high capacity, and error correction. Error correction help to restored when symbol is dirty or damaged. The highest level can be roughly 30% of code words.[2] QR Code can decode easily by upload picture on web providers.[3] So, everybody who has a file of QR Code image, they can decode it all. QR Code is seen as a weakness in security.[4] This paper proposes method for adds watermark that is information hiding into QR Code. Digital watermark is a kind of information security and protection technology. Watermarking is mostly similar to steganography in a number of respects. The main idea of steganography is the embedding of secret information into data under assumption that others can not know the secret information in data.

The main idea of watermark is check the secret information embedded in data or not. Watermark is the embedding information in media for exchange the information within the group. Experimental results show the advantages in each method.

2. Method Description
2.1 Frame Differencing
Frame Differencing is an easiest simple method for finding objects which subtract from one frame to another, in which all the different objects of interest called foreground responsible for this process to be
applied to detect moving objects. In this method, the algorithms cannot be used because the frame differencing were not able to detect the object when it is stationary, even it intrude along the defensive line at that time.

2.2 Principle for splitting video into image

Video file is a computer file that contains digitized video. The video which has high motion will be having the high numbers of frames per second (frame rate). Video files can be splitted into each frame, used for process the image and stored in a three-dimensional array.

2.3 The Quick Response (QR Code)

QR Code is a two-dimensional bar code that is in the form of the Matrix Code. The QR Code has several advantages over the one-dimensional bar code, as shown in Figure 1 are more sensitive than in the QR Code Reader. Can hold more data. You can read the data on bar code is not complete.

Fig. 1. One-dimensional bar code.  Fig. 2. The QR Code

Fig. 3 shows the structure of a QR code, which includes the.

1) Finder Pattern is intended to be used to detect the position of QR Code for Application to the decoder.
2) Format Area is intended to store data, Data Type and Data Mask, which is involved in transcription.
3) Timing Pattern is intended to detect the coordinates of the symbol for decoding.
4) Alignment Pattern in the images in the tilt can be read correctly by Decoder Application.
5) Data Area is used to store data, QR Code, which is the most space.
6) Quiet Zone is a region of the spec demolishing the white space which helps to Boost the Finder Pattern to Detect quickly.

Components of the QR Code QR Code is based on the Version of the Alignment Pattern is displayed in the Version 2 or later.

2.4 Discrete Wavelet Transform

DWT transform is a typical scene for image processing and digital signal processing that can be defined assimilative as (1).

$$DWT(m,n) = \frac{1}{\sqrt{a_0}} \sum_{k} f(k) \psi\left(\frac{n-kh a_0^m}{a_0^m}\right)$$  \(1)$$

For $$a_0^m$$ is a scaling, $$nb_o a_0^m$$ is a shift position and $$m, n$$ are the positive integer. In operation, the coming signal is a type of sample that can be defined assimilative as (2).

$$DWT(m,n) = \frac{1}{\sqrt{2^m}} \sum_{k} f(k) \psi\left(\frac{n-k 2^n}{2^n}\right)$$  \(2)$$

For $$m, n, k$$ are a type of integer that $$n$$ is a number of data, $$m$$ is a number of scaling and $$k$$ is a number of shift position. When we are considering the fineness of partition, we decreased double the scaling \(a_o = 2, b_o = 1\) so that we defined discrete wavelet transform as (3).

$$DWT(m,n) = \frac{1}{\sqrt{2^m}} \sum_{k} f(k) \psi\left(\frac{n-k 2^n}{2^n}\right)$$  \(3)$$

3. Embedding Algorithm

Fig. 4. Block diagram of the Video Watermark Embedding
4. Experimental Results
In our approach, we are embedding and extracting a watermark through a standard encode and decode QR Code method. We use error correcting level L or 7% recovery codewords because we concentrate DWT in embedding and extracting. We use an QR Code sizes 64x64 pixels. In this paper, we choose Haar Wavelet Transform in discrete wavelet transform. and all can decode QR Code image. The PSNR is 67.058 dB and NC is 0.98.

The content is an information about data to encode and decode QR Code and PSNR value is the quantity of efficiency in embedding that defined as (4).

$$\text{PSNR} = 10 \log_{10} \left( \frac{255^2}{\text{MSE}} \right) \text{dB} \quad (4)$$

For MSE can defined as (5):

$$\text{MSE} = \frac{\sum (f_w(x, y) - f(x, y))^2}{n} \quad (5)$$

where, $f_w(x, y)$ is a data of QR Code image that is embedded watermark already, $f(x, y)$ is a data of original image and $n$ is size of pixel. Time is a period of time to embedding and extracting. NC value is the quantity of efficiency in extracting that defined as (6).

$$\text{NC} = \frac{\sum \sum W_{ij} - W'_{ij}}{\sum \sum \left[ W_{ij} \right]^2} \quad (6)$$

$W_{ij}$ and $W'_{ij}$ are represent an intensity of original watermark at position $(i, j)$ and watermark from extracting respectively.

5. Conclusion
In this paper we proposed a new method for data hiding for QR Code Based on Fragile Video Watermarking. The embedding is searched by using an fragile and robust technique. Experimental results reveal that if we simply use the concept of the existing algorithm, both the quality of the watermarked image and the NC value of the extracted watermarks after certain attacks will be poor.

6. Acknowledgment
The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by grants from National Research Council of Thailand (NRCT, Thailand).

References
A Hough Transform Based Lane Detection for Driving System

Thittaporn Ganokratana\textsuperscript{1} and Mahasak Ketcham\textsuperscript{1}
\textsuperscript{1} Department of Media Technology, King Mongkut’s University of Technology Thonburi
Tel. 083-555-9088, E-Mail: maoquee@hotmail.com

Keywords: Lane Detection, Decision-making, Hough Transform, Webcam Camera, Driving System

Abstract
A Hough Transform Based Lane Detection for Driving System has been developed to aid a driver in the lane departure decision-making, to reduce a loss of concentration and to prevent an accident while driving. In this paper, we propose a method for detecting the lanes by using a webcam camera to record the road as a video file (.avi) and using Hough Transform method to detect the lanes in an image. The results show the lane detection in various line road conditions. According to the results, the drivers can use this information to increase their safety of driving, especially when making the decision of lane changing.

Keywords: Lane detection, Decision-making, Hough Transform, Webcam camera, driving system

1. Introduction
Nowadays, the growing volume of the traffic all around the world requires higher levels of the traffic safety \cite{1}. On the road, there are so many unsafe driving cars that the driver requires more careful while driving. Important for driver is being careful when he/she must change lane, especially in new driver who absolutely cannot keep too much information at once and has no confidence for driving. \cite{2} Driver may be loss of concentration and control car. In fact, human behaviors are indeed hard to recognize, predict and handle by current available equipments. Therefore, a monitoring and warning system focusing on the vehicle behaviors is needed while the car is moving on the road \cite{3}. A Hough Transform Based Lane Detection for Driving System was developed to find the way that can reduce the loss of views to the front street. The Hough Transform, one of the easy techniques for image processing, is used for detecting lane road within an image. The system is designed to work in conjunction with the general principles of the webcam image processing \cite{4}. The paper helps the driver by increasing decision-making while driving \cite{5} in order to monitor the movement of vehicles through the lanes. In this paper, the lane detection algorithm is proposed by using information of camera and road. Firstly, the acquired video file is extracted to image frames. Secondly, the image frames are specifically divided into road part from the information of webcam camera. Thirdly, RGB color image is converted by image enhancement to grayscale image. Threshold is applied to evaluate the grayscale image into a binary image. Fourthly, the Hough transform method is developed to detect the lanes in the road image. Finally, several experiments are conducted to demonstrate the effectiveness of the proposed algorithm \cite{6}. The concept of this paper is to provide a computer to monitor the image of the road and detect its lanes in various areas for improving the safety driving.

2. Method Description
2.1 Frame Differencing
Frame Differencing is an easiest simple method for finding objects which subtract from one frame to another, in which all the different objects of interest called foreground responsible for this process to be applied to detect moving objects. In this method, the algorithms cannot be used because the frame differencing were not able to detect the object when it is stationary, even it intrude along the defensive line at that time.

2.2 Image Processing
Digital Image Processing converts image data into digital data. The system receives image data, calculates it, output digital image data and then store image data into the computer's memory that can be performed by reservation the memory of the machine in the form of an array. The value in each array represents the quantity of pixel. The position of the image is determined by the position of the array.

2.3 Principle for splitting video into image
Video file is a computer file that contains digitized video. The video which has high motion will be having the high numbers of frames per second (frame rate). Video files can be split into each
frame, used for process the image and stored in a three-dimensional array.

2.4 Cropping an image

Crop tool is used to extract road part within an image by using the imcrop function that can specify the size and position as parameters by specifying the crop rectangle as a four-element position vector.

![Original image](a), [Road part image](b) Fig. 1 The result of cropping road part image.

2.5 Image Enhancement

This process changes the color image (RGB) to a grayscale image. Its analysis detects objects in the image frames into the process. If using the color image in the work, the process will be slow because the process must access all of the chromaticity. Therefore, it would be easier to access the grayscale image.

2.6 Morphological operations

Morphological operations affect the form, structure or shape of an object in an image. Theirs operations are applied on binary images and used in pre or post processing. For this paper, Morphological operations assist segmentation. They are used to clean up the image including clear border objects, remove small objects and also reduce noises in the image.

2.7 Hough transform

The Hough transform is a popular technique which can be used to isolate features of a particular shape within an image. In this work, it is used for detecting line road as lane detection. There are 2 methods for computing the Standard Hough transform (SHT) of the binary image BW, which is an algorithm of parameter matrix whose rows and columns correspond to rho and theta values respectively. The first method is given below:

\[
[H, \theta, \rho] = \text{hough}(BW)
\]  

(1)

For detect lines in the image. The second method is adding parameter name and value pairs in the same equation as follow:

\[
[H, \theta, \rho] = \text{hough}(BW, \text{ParameterName}, \text{ParameterValue}).
\]  

(2)

When ParameterName is 'RhoResolution', specify a real scalar value between 0 and norm (size (BW)), to determine the spacing of the Hough transform bins along the rho axis. The default value is 1. When ParameterName is 'Theta', specify a vector of Hough transform theta values. The acceptable range of theta values is -90° ≤ θ > 90°.

![Fig. 2 Detect line road by using the Hough transform](image)

2.8 Houghlines

This method is used for extract line segments in the image based on Hough transform. There are 2 functions to describe the meaning of parameter and how to search the line segment. The first function is given below:

\[
\text{lines} = \text{houghlines}(BW, \theta, \rho, \text{peaks})
\]  

(3)

Where BW associated with particular bins in a Hough transform, thetas and rhos are vectors returned by function hough, peaks is a matrix returned by the houghpeaks function which contains row and column coordinates of the Hough transform. Secondly, using parameter/value pairs as follow:

\[
\text{lines} = \text{houghlines}(\ldots, \text{param1}, \text{val1}, \text{param2}, \text{val2})
\]  

(4)

It specifies the distance between two line segments with the same Hough transform bin. If its distance less than the value specified, the houghlines function will merge the line into a single line, and Minlength parameter which specifies whether merged line should be kept or left [6].

![Example of Hough lines](image)

3. Proposed method for Hough transform

In this paper, the main components of driving system detection based on the Hough transform are webcam camera and computer for storing image data. Firstly, the system saves image data from webcam camera and then transfers it into frame grabber process in the computer. Secondly, in recording data, real-time is applied to image data (.avi). Then the program
which analyzes the image data in a video signal will be taking the recorded data to further processing. The idea of this project is to provide a computer to monitor the image of line road that has intruded. The surveillance will be notified when car crosses the line. The processes are described below:

![Diagram](image)

**Fig. 4** Frame work of driving system detection based on the Hough transform.

The main components of driving system detection based on the Hough transform are described as below:

**Step1:** Receiving image: The developed system is able to acquire images from video files, which are already saved in a form of .avi video. The image will be the same size as the resolution of the camera that used to record without any additional configuration.

**Step2:** Splitting image: The system analyzes the video file to apply to the video frames splitting process by applying the data of video files and then the system specifies the variable to divide sub frames in the variable of array image to the frame.

**Step3:** Cropping image: Specifying the area of interest by using crop tool to extract the region of road part within the image. It can specify the size and position as parameters by specifying the crop rectangle as a four-element position vector.

**Step4:** Image enhancement (from RGB color to grayscale image): In this process, the system conducts the frame, which stored in the storage module, to convert RGB color image into grayscale image. After this process, we have the grayscale image. As shown in Fig 5.

![Images](image)

(a) Road part image  (b) Grayscale image

**Fig. 5** The results of image enhancement from converting RGB color image (road part) to grayscale image.

**Step5:** Converting grayscale image to binary image: Threshold is an appropriate method that uses to convert the grayscale image to binary.

**Step6:** Segmenting and removing objects: Using the opening operation, Morphological Operations, which can assist segmentation and remove objects which are not structuring element. As shown in Fig 6.

![Images](image)

(a)  (b)  (c)

**Fig. 6** The image received by Morphological Operations, (a) is cleaned image, (b) is image with clear border objects and (c) is all remaining connected regions. It was showed by color.

**Step7:** Defining the analytic area within the image: The system conducts the binary image to define detection or surveillance area within the image by using the Hough transform which can identify straight line. We set green color to detect line and red color to detect the longest line segment as shown in Fig 7.

![Images](image)

(a) red color  (b) green color

**Fig. 7** The results of final detected lines

**Step8:** Computing Hough transform: From step 7, the system operates the defined segment to analyze the Hough transform. The original image is determined by Hough function. After computing, we get the Hough transform in red color to show the line parameters of its algorithm in the image.

**4. Experimental results**

A Hough Transform Based Lane Detection for Driving System has been operated by setting the webcam camera to monitor the movement of vehicle
through the lanes, segmenting the video file to the image, converting RGB color image to grayscale, setting threshold to make a binary image, using Morphological Operations and defining the analytic areas by using Hough transform. In this section we will explore the experimental results of the performance of the lane detection algorithm in various environments and describe its algorithm based on its process. We test the lane detection while driving along the lanes which have 2 types of lanes: dashed line and solid line. It also has 2 colors; white and yellow lane color. We proposed test conditions as follows:

This test condition shows the detected lane boundaries which are highlighted by green color. The longest detected lane boundaries are highlighted in red color. From the experimental results, this algorithm can detect any kind of lanes with various test conditions.

This test condition shows the redline parameters in Hough transform. We show the original image in 2 situations; intruded lane and not intruded lane.

5. Conclusion
In this paper, we proposed a method for helping the drivers in the lane departure decision-making based on the Hough transform by detecting lanes. The adopted lane detection method was consisted of image processing, morphological operations, dynamical threshold, houghlines and Hough transform. Its advantages of Hough transform are easy to use, low cost and also effective in detect lines form the image. Experimental results reveal the efficiency of the performance of the lane detection algorithm in various environments. In further research, we will focus on how to detect the lane correctly in various situations, and how to arouse driver’s attention by setting the sensor in a car.

6. Acknowledgment
This research has been financially granted by the Department of Media Technology at King Mongkut’s University of Tecnology Thonburi.

References
Class Participation Checking System Based on Face Recognition Algorithm
Poonpon Anawatpongpun
Department of Media Technology, King Mongkut’s University of Technology Thonburi
Tel.02-470-7606, E-Mail: poonpon.ana@kmutt.ac.th

Abstract
This work is to develop Face Detection and Recognition System to detect human face. This system can be applied for class participation checking – in system. Theory applied in this work is based on Haar like-feature by searching for distinct feature from object rather than each single pixel. The development of program based on EmguCV which supports the Digital Image Processing and Microsoft Visual Studio 2010 with C# language. Haar like-Features process is a process with well tolerated and can detect and interpret relatively fast and accurate. Because of the quick face detection and recognition this technique is likely popular. During the development of system the developers have encountered problems and obstacles in detecting the eye of person. This process can provide more efficient and accurate by applying in conjunction with frame detection methods.

Keywords: Face Detection, Face Recognition, Haar Like-Feature, EmguCV

1. Introduction
In present class participation is important students to attend classes of at the university, but the regular class attention checking method is not much effective because the teacher checks each student's name. Therefore find a method to reduce the time in checking by using the webcam to face detection because the system is able to record webcam shape or character with different actions more accurate and faster.

In present the face detection and recognition are very well developed for reliable results. The system face is most widely utilized. Either within an organization or office user friendly. Or even some companies’ face in meeting note system to produce software for sale. Both economic and expensive can vary according to the equipment used in system. In many foreign countries have been registered in the face detection and recognition system to be installed in airports to prevent the criminals fled the country. And the system can used registered for face authentication in criminal cases. We also have been trying to develop a friendly note to face meeting due to the design and development of the national budget to be high. We have developed a computer vision help which is expected to be used in the police department so that police can identify the culprit in many cases accurately. And it may develop to the other side and further in the near future.

When use a webcam utilized in various fields, this will reduce the time to check students name in class. It also improves performance and precision for reduce students is escape from class.

2. Methodology

2.1 OpenCV is an open source computer vision library obtainable from http://SourceForge.net/projects/opencvlibrary
The library is written in C and C++ and runs under Linux, Windows and Mac OS X. There is active development on interfaces for Python, Ruby, Matlab, and other languages. OpenCV was designed for computational efficiency and with a strong focus on realtime applications. OpenCV is can take advantage of multicore processors [2].

2.2 Emgu CV is written entirely in C#. The benefit is that it can be compiled in Mono and therefore is able to run on any platform Mono supports, including Linux, Mac OS X, iOS and Android. A lot of efforts has been spend to have a pure C# implementation since the headers have to be ported, compared with managed C++ implementation where header files can simply be included. But it is well worth it if you see Emgu CV running on Fedora 10! Plus it always gives you the comfort knowing that your code is cross-platform [3].
2.3 **Face Recognition** was designed to compare the faces of people we do with the face that is in the algorithm used in the process of creating a template and the process of comparison may vary depending on the design of the system, but each period regardless of the algorithm employed in the process of creating a template and the process of comparing how the main functions of the system works. It will continue work as well.

![Diagram](image)

**Fig.1 Process diagram [4]**

2.3.1 **Import images** is the process of capturing human faces from the camera, both still snapshot and video cameras and scanning faces existing Login the proceeds will be applied to store into the database or applied to the comparative analysis.

2.3.2 **Create a template** images were collected in the first step and then to converted to a template (Template) that may be used to store the database in case of a face stored in the database. Or may be used to compare the next step in the faces of people. The work in this step will cut things out of the picture expect the face, called the face detection. Face Detection will start from the position of the head and then continue with skin detection for color of the face such as skin color, hair turban before leaving for the scheme by an oval face with a round to oval faces out. And finally applied to a section of the organ on the face, the rest of the image will be cut off.

2.3.3 **Compare** is a step of conversion of face into a template in the second stage, then compared with the templates stored in the database. Comparison will vary depending on the algorithm used to compare with that template. However, each algorithm is applied to find the template in the database similar to a template of the face we compared.

2.3.4 **Result (Display)** to display the results of the face comparison come out in the third stage.

2.4 **Haar like-Features** of Viola and Jones[1] method is a method to detect and interpret the principles of object within the image with Haar Wavelet for creating the triangle (Feature). The image below shows the difference between the areas white and black colors which vary in size and position used for the handle on the different images, such as line, circle, etc.. The calculated value of the feature is then used principally to compute the Integral image. Then Integral image is the sum of the values in every pixel at any position of (x, y) which is the time that the operation is O(1). It means calculations done fast.

![Diagrams](image)

**Fig.2 Pixel coordination.**

\[ P(X,Y) = \sum_{x' \leq x, y' \leq y} i(x', y') \quad (1) \]

The Haar like-Feature requires many sample images. Used in the selection of the desired characteristics of the detection and interpretation. The second characteristic is a positive image or object that is within and negative image or any object that we want it to be within the image.
Haar-like Feature Principle of AdaBoost (Adaptive Boost) [5][6], a procedure similar to that feature and different input images. For the classification of visual clutter. Weight to different parts of the image within the image on the Positive and Negative Object to determine the nature of the "yes" and "no" in different ways. This procedure has the following steps:
- Initial setting. Feature on the weight to run the sample.
- Find the area including parts we need.
- Add weight to the rest. Only that we want to have a phase manner.
- Do this repeatedly until we finally have all come together to find the area of the object which is in different parts within it.

Fig.3 Process of Adaboost

3. The Development Process

Fig.4 Flowchart of face detection.
- Get images from the webcam on laptop.
- Capture video from webcam as till image.
- After obtaining still image. Detecting a face area from image by Haar Cascade technique on the part of the face, then the program will create a make with squared shape around the face.
- After process the face image is already the program to resize the image to 100 x 100 pixels and converting RGB image to grayscale image in order to speed of process and reduce capacity of file images in storage.
- Training data are randomly selected as area in the images. Once the training data were found, all possible pairs of rectangles will be used to extract Haar-like features from those areas.
- After the system a face recognition can identify faces from the camera that captured from a person. When the system detects and classifies the faces and show a name of person to on screen.

4. Results

The results of this work by the theories mentioned above. Development of a program “Class Participation Checking In System Using Based on Face Recognition Algorithm” Has the following result.

Fig.5 Result of detected face with profile
The face detection and recognition system may have some problems with the low light conditions that create flare in camera. If a head tilt or turn will not be able to detect a face or detected sometimes with error. The test program is able to work well most accurate when the environment conditions of the light and the distance between the camera and the face are in appropriate. The precise distance that system works well is approximately 90 cm.

5. Conclusion

The Haar-like Features is an effective process to detect and interpret quickly depending on, the Positive and Negative required in large quantities. Training with different sample sizes. The disadvantage of this method is time consuming in. Training if more precision is required to use large sample and the time to train is longer and even though this method also detects and also cannot detect face at all. The proposed technique is based on frame-based capturing process which could be more effective is it performed in association with other commonly used detection methods.

References

THE 1-YEAR OVERALL SURVIVAL OUTCOME AMONG 221 IMAGING-DIAGNOSED CHOLANGIOCARCINOMA PATIENTS IN ROI-ET PROVINCE, THAILAND, 2012

Auttakiat Karnjanapiboonwong Det Kedkham Supattra Srivanichakorn
ASEAN Institute for Health Development - Mahidol University
E-Mail: kedcham@hotmail.com

Keywords: 1-year survival, cholangiocarcinoma, Cox, Thailand, prognosis

Abstract
Roi-et province, the north-eastern Thailand has encountered with the problem of cholangiocarcinoma for many years by focusing on the risk prevention, early diagnosis and treatment but the factors which may influence the prognosis of disease during treatment in Thailand were hardly studied. A retrospective cohort study was designed to demonstrate the characteristic and survival outcome among 221 imaging-diagnosed cholangiocarcinoma patients. Cox-proportional hazard regression was applied to study hazard ratio among particular factors. The 1-year median survival time was 10 months, 1-year survival rate was 45%.There was no association between survival time and age >60 years, sex, occupation, type of health insurance, bilirubin level > 5 mg/dl, CA 19-9 level and getting surgery or palliative operation. Only the factor of CEA level > 5 µg/l was statistically significantly effect to 1-year survival time. CEA level can be used to make a decision for treatment. However 5-year follow-up would be considered.

Keywords: Submission procedure, manuscript format, font size, font style, blank line

1. Introduction
From WHO’s annual compilation of health-related data in year 2012 (World Health Statistics 2012) demonstrate that 7.8 million people worldwide died from cancer in the year of 2008(1). The mortality from cancer is 13% of all cause of death in the world(2). About 70% of all cancer deaths in 2008 occurred in low- and middle-income countries. Lung, stomach, liver, colon and breast cancer cause the most cancer deaths each year. Cholangiocarcinoma (CCA) accounts for about 10–25% of the primary liver cancers in most parts of the world with age-standardized incidence rates (ASRs) between 0.3 and less than 1.5 per 100 000 in Western countries(3-5). An increasing trend of CCA incidence has been reported in many parts of these countries(6). The incidence of CCA in Eastern Asia is also low, such as in Korea and Japan (ASRs less than 1.5) (7). The CCA incidence in Thailand is, however, exceedingly high with ASRs of 33.4 per 100 000 in men and 12.3 per 100 000 in women(8).

Thailand is the middle income countries that also face the problem of cancer. The data from Hospital-Based Cancer Registry of National Cancer Institute in Thailand in year 2010 shows that hepato-biliary cancer is in the top five of cancer prevalence (9). Hepato-biliary cancer can be classified into 3 types of cancer by histological study namely hepatocellular carcinoma (HCC), cholangiocarcinoma (CCA) and mixed type. The results from histological study in 7 cancer centers and 3 universities in year 2001 – 2003, more than 75% of hepato-biliary cancer in Northeast region was from cholangiocarcinoma. In other regions the percentage proportion of cholangiocarcinoma was about 25 – 40%(10).

Most CCA patients have unresectable disease at presentation and die within 12 months from the effects of cancer cachexia and a subsequent rapid decline in performance status. Overall survival rate, including resected patients, is poor, with less than 5% of patients surviving to 5 years, a rate which has not changed significantly over the past 30 years(11). Although CCA is a relatively rare tumor around the world, interest in this disease is rising as incidence and mortality rates for intrahepatic tumors increase markedly worldwide(12). The statistics from the National Cancer Institute's SEER program in USA
illustrate the percentage of 5 years survival rate among intrahepatic/extrahepatic CCA patient is 15%/30% for stage I, 6%/24% for stage II and III and 2%/2% for stage IV. However, many other factors may affect a person's outlook, such as the location of the cancer, whether or not it is resectable (removable by surgery), and a person's general health(13). One study from Thailand by Uttaravichien.T published in year 1999 considering the 1, 3 and 5 years survival rate according to stage of intrahepatic CCA shows that the 1, 3 and 5 years survival rate after surgery among stage III is 100%, 33%, 3 persons respectively. Stage IV-A patient's is 80%, 30% and 0% respectively. Stage IV-B's is 26%, 12% and 0% respectively(14).

There were several factors studied previously that might affect the prognosis of CCA beside of staging. The demographic data of patient, some study shows no significant differences in the survival time according to age and sex from the study of Uttaravichien. T, 1999(14), but the study in Republic of Korea show that the patient older than 60 years old have median survival time significantly less than the younger patients whereas there were no significant difference between gender (11). Actually, there were many processes to care the CCA patients. The socioeconomic factors also associated with the prognosis of the disease not only from the treatment accessibility but also the knowledge of self-care and the risk of getting liver fluke infestation from raw freshwater fish eating behavior. The health insurance in Thailand under “30 scheme” has been launched since 2002 which allowed patients with cancer access the health care much more than before. It might improve the prognosis of the disease among CCA patient, however since the survival study in Thailand in 1999(14); so far there have been no research about the survival outcome of CCA in Thailand. The treatment technique applied the survival analysis; curative resection is still known to be the only effective therapeutic measure (15).

Some clinical-pathologic factors have been reported to be related to a dismal prognosis after resection, such as lymph node metastasis, a certain gross type, and positive resection margin(16-19). Some reports have suggested that lymph node metastasis is the most important prognostic factor for survival(16). However, there is no established consensus on the prognosis significance of lymph node dissection or even the extent of lymph node dissection (20). Clinical and laboratory presentation also can be used to predict the prognosis such as jaundice and bilirubin level can represent the degree of invasion and the location of tumor, the level tumor marker CA 19-9 higher than 200 U/ml give the median survival time shorter than the resected patients who had the level < 200 U/ml statistically significantly(11). Using chemotherapy and radiotherapy are not clear if chemotherapy used in this situation helps people live longer (21, 22). Meanwhile, the research from Japan demonstrates conversely that repeated surgery, combined with new effective regimens of chemotherapy could benefit the survival of Intrahepatic CCA patients(23).

Thailand has encountered with the problem of CCA for many years by focusing on the risk prevention (24, 25), early diagnosis and treatment but the factors which may influence the prognosis of disease during treatment in Thailand were hardly studied. Roi-et province is the province in northeastern region of Thailand, were selected to be the studied site, due to Roi-et province also has the high prevalence of CCA and Roi-et hospital were upgraded to be the Regional Cancer Center in North-eastern region formally in May 2012. Survival time of each stage of CCA does not only represent the severity of the disease but also reflect the quality of treatment guideline whereas there were few survival studies in the past several years in Thailand despite Thailand is the endemic area of CCA(26, 27). Therefore, this research focuses on studying the survival outcome of CCA patients to describe the recent disease prognosis and also identifies risk factors associating with the prognosis of CCA.

2. Method

A retrospective cohort study was designed to illustrate the characteristic of CCA patients and to demonstrate the survival analysis among CCA patients having different findings and receiving treatment procedures. The studied population included all charts of patients who were diagnosed as CCA according to ICD10 code of C221 in Roi-et hospital during January – December 2010. All charts were identified from
the unit by the nurses or statistician working in the hospital. Those charts were copied with concealing the name, hospital number, address, birth date of patients.

The data of all confirmed CCA patients were recruited from several sources and reviewed by trained health officers, nurses and medical doctors. The profile and demographic data of CCA patients were collected from Hos-XP program using ICD10 code C221 by using the date of applying CT scan to calculate patient profile at diagnosis date. Patients’ symptom and laboratory results were reviewed from OPD and IPD chart. Only a laboratory-test done within 30 days before or after the date of applying CT scan or MRI. The intervention given to the patients were reviewed from Hos-XP program, OPD and IPD chart by considering intention to treat, only the procedure done in Roi-et hospital were considered to be the intervention which patient received regardless an alternative treatment patients seek outside the hospital. Patient-death status was collected from annual population survey data-base of Roi-ed hospital together with the National Health Security Office’s record. To identify the dead people, the date of birth, sex and sub-district were matched. However, the death information retrieved in this study was in between 1st January 2010 – 31st October 2011. Therefore, to calculate 1-year survival among these patients, only the patients diagnose as CCA during 1st January 2010 – 31st October 2010 were considered.

The collected data was checked for completion, coded and entered into computerized database using Excel version 2003. Data analysis was performed by using STATA program, version 11. Descriptive analysis was conducted to describe the characteristic of CCA patient in Roi-et hospital during January – December 2010. The 25th, 50th and 75th percentile of 1-year survival time and cumulative survival at 12th month of patient with intrahepatic CCA, perihilar CCA, distal bile duct CCA and mixed type of CCA were calculated by the Kaplan-Meier method. Moreover, all independent factors of each type of CCA were figured out well.

The log-rank test was used to compare the survival curve of variables in each group at significant level at p-value < 0.05. The certain variables were selected by hierarchical variable selection method for applying Cox-proportional hazard regression that can be explained hazard ratio between the patients who exposed the given factors and the patients who have not exposed the factor at significant level at p-value < 0.05 by using the statistics program STATA version 11.

3. Results

There were total 427 patients diagnosed as CCA according to ICD 10 from Roi-et hospital’s data base in year 2010. From those, only 271 patient records have imaging result (269 CT scan, 1 MRI and 1 MRCP) in either OPD or IPD chart showing suspected or confirmed CCA.

Roi-et hospital has started the operation of hepatic resection by one surgeon working in Roi-et hospital since the beginning of 2010 so some patients were referred to receive a treatment from another tertiary-care hospital. During 1-year follow up, there were 139 cases receiving any kinds of treatment from only Roi-et hospital (not referred), 4 patients got hepatic resection, 5 patients got cholecystectomy 5 patients got explore laparoscopy, 1 patient got core needle liver biopsy and 27 patients got palliative surgery (ERCP, PTBD, by pass and wearing stent). There was only 1 patient getting chemotherapy as adjuvant therapy.

Among all 271 imaging of those CCA patients treated at Roi-et hospital, there were 221 CCA patient diagnosed during 1st January 2010 – 31st October 2010. The median age of those 221 CCA patients was 62 (range 40 – 90) years old. The case distribution by other demographic data, clinical presentation and treatment procedure were shown in table1. Following the matched data-base of National Health Security Office’s record in during 1st January 2010 – 31st October
In 2011, there were 121 CCA patients already died without any injuries. The fatality rate among 221 CCA patients during 1 year follow-up was 54.8%. The Kaplan-Meier survival estimation showed that the median of overall survival time was 10 months and 25% of the cases died within first 3 months after date of diagnosis (Fig. 1) and no one died after receiving a surgery within 1 month.

According to Log-rank test (Table 1), the factor of having abdominal pain, CEA > 5 µg/l and ALP level were significantly associated with disease prognosis. The factor of age > 60 years, having abdominal pain, CEA > 5 µg/l, ALP level, and the kind of intervention were selected to test whether they meet the proportional hazard assumption (Fig. 2). Eventually, all selected variables except the variable of age and getting intervention met the assumption. Considering the Hazard ratio by multiple cox-proportional hazard regression among those factors, only the factor of CEA > 5 µg/l was significantly associated with the death outcome in 1-year follow up with the hazard ratio of 5.26. (Table 2)

![Kaplan-Meier survival curve](image)

**Fig. 1.** Kaplan-Meier survival curve among 271 CCA patients who were followed up for 12 months after getting imaging diagnosis in Roi-et Hospital in year 2010 (N=271)

**Table 1**

<table>
<thead>
<tr>
<th>Factors</th>
<th>Number of CCA case (%)</th>
<th>Number of death (%)</th>
<th>Median survival (months)</th>
<th>p-value (Log-rank test)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>146 (66)</td>
<td>84 (58)</td>
<td>8</td>
<td>0.27</td>
</tr>
<tr>
<td>Female</td>
<td>75 (34)</td>
<td>37 (49)</td>
<td>&gt;12</td>
<td></td>
</tr>
<tr>
<td><strong>Age (year)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;60</td>
<td>77 (35)</td>
<td>37 (48)</td>
<td>≥12</td>
<td>0.09</td>
</tr>
<tr>
<td>≥60</td>
<td>144 (65)</td>
<td>84 (58)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No job</td>
<td>61 (28)</td>
<td>32 (52)</td>
<td>8</td>
<td>0.85</td>
</tr>
<tr>
<td>Government officer</td>
<td>9 (4)</td>
<td>5 (56)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Farmer</td>
<td>134 (61)</td>
<td>77 (57)</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Monk</td>
<td>5 (2)</td>
<td>2 (40)</td>
<td>≥12</td>
<td></td>
</tr>
<tr>
<td>General employee</td>
<td>12 (5)</td>
<td>5 (42)</td>
<td>≥12</td>
<td></td>
</tr>
<tr>
<td><strong>Health insurance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No insurance</td>
<td>3 (1)</td>
<td>1 (33)</td>
<td>≥12</td>
<td>0.62</td>
</tr>
<tr>
<td>Civil servant medical benefit scheme</td>
<td>17 (8)</td>
<td>10 (59)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Universal coverage</td>
<td>182 (82)</td>
<td>101 (55)</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Social security service</td>
<td>4 (2)</td>
<td>3 (75)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>15 (7)</td>
<td>8 (40)</td>
<td>≥12</td>
<td></td>
</tr>
</tbody>
</table>
TABLE I (CONTINUE)

Number, and percent proportion of CCA patients diagnosed in year 2010 in Roi-et Hospital stratified by demographic, clinical presentation and treatment procedure and the significant level (p-value) from the Log-rank test each factors. (N=221)

<table>
<thead>
<tr>
<th>Factors</th>
<th>Number of CCA case (%)</th>
<th>Number of death (% SFR)</th>
<th>Median survival (month)</th>
<th>p-value (Log-rank test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• No job</td>
<td>61 (28)</td>
<td>32 (52)</td>
<td>8</td>
<td>0.85</td>
</tr>
<tr>
<td>• Government officer</td>
<td>9 (4)</td>
<td>5 (56)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>• Farmer</td>
<td>134 (61)</td>
<td>77 (57)</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>• Monk</td>
<td>5 (2)</td>
<td>2 (40)</td>
<td>≥12</td>
<td></td>
</tr>
<tr>
<td>• General employee</td>
<td>12 (5)</td>
<td>5 (42)</td>
<td>≥12</td>
<td></td>
</tr>
<tr>
<td>Health insurance</td>
<td></td>
<td></td>
<td></td>
<td>0.62</td>
</tr>
<tr>
<td>• No insurance</td>
<td>3 (1)</td>
<td>1 (33)</td>
<td>≥12</td>
<td></td>
</tr>
<tr>
<td>• Civil servant medical benefit scheme</td>
<td>17 (8)</td>
<td>10 (59)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>• Universal coverage</td>
<td>182 (82)</td>
<td>101 (55)</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>• Social security service</td>
<td>4 (2)</td>
<td>3 (75)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>• Others</td>
<td>15 (7)</td>
<td>6 (40)</td>
<td>≥12</td>
<td></td>
</tr>
<tr>
<td>Clinical</td>
<td></td>
<td></td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>• No abdominal pain</td>
<td>41 (19)</td>
<td>29 (71)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>• Abdominal pain</td>
<td>180 (81)</td>
<td>92 (51)</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Tumor marker</td>
<td></td>
<td></td>
<td></td>
<td>0.22*</td>
</tr>
<tr>
<td>• CA 19-9 (U/ml)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o ≤200</td>
<td>61 (28)</td>
<td>29 (48)</td>
<td>≥12</td>
<td></td>
</tr>
<tr>
<td>o &gt;200</td>
<td>47 (21)</td>
<td>28 (60)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>• CEA (µg/l)</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>o &lt; 5</td>
<td>42 (19)</td>
<td>13 (31)</td>
<td>≥12</td>
<td></td>
</tr>
<tr>
<td>o ≥ 5</td>
<td>61 (28)</td>
<td>41 (67)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Three level of TB (mg/dL)</td>
<td></td>
<td></td>
<td></td>
<td>0.18*</td>
</tr>
<tr>
<td>o &lt; 5</td>
<td>93 (9)</td>
<td>44 (47)</td>
<td>≥12</td>
<td></td>
</tr>
<tr>
<td>o ≥ 5 – 10</td>
<td>19 (19)</td>
<td>11 (58)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>o ≥ 10</td>
<td>42 (30)</td>
<td>26 (62)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>level of ALP (IU/L)</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.01*</td>
</tr>
<tr>
<td>o &lt; 150</td>
<td>42 (19)</td>
<td>16 (38)</td>
<td>≥12</td>
<td></td>
</tr>
<tr>
<td>o ≥ 150 – 400</td>
<td>64 (29)</td>
<td>34 (53)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>o ≥ 400</td>
<td>50 (23)</td>
<td>33 (66)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Referral to other hospital</td>
<td></td>
<td></td>
<td></td>
<td>0.72</td>
</tr>
<tr>
<td>• Referred</td>
<td>81 (11)</td>
<td>45 (56)</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>• Not referred</td>
<td>140 (9)</td>
<td>76 (54)</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Intervention among not referred group (N=140)</td>
<td></td>
<td></td>
<td></td>
<td>0.40</td>
</tr>
<tr>
<td>• Surgery</td>
<td>15 (11)</td>
<td>7 (47)</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>o Hepatic resection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Cholecystectomy</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Explore laparotomy</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Non surgery (palliative care)</td>
<td>20 (14)</td>
<td>9 (45)</td>
<td>≥12</td>
<td></td>
</tr>
<tr>
<td>o Applying ERCP, PTBD, by pass or stent</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• No intervention (supportive care)</td>
<td>105 (75)</td>
<td>60 (57)</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>
Fig 2. Comparison of hazard among CCA patients with age equal or less than 60 years and CCA patients with age > 60 years by Smoothed Hazard Estimates techniques that showed the association did not meet the proportional hazard assumption.

Table 2. Hazard ratio of having the factor of CEA level, abdominal pain, and alkaline phosphatase level among patient diagnosed as CCA in Roi-et Hospital during 1st January – 31st October 2010 by Multiple Cox-proportional Hazards Regression

<table>
<thead>
<tr>
<th>Factors</th>
<th>Hazard ratio</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEA &gt; 5 µg/l</td>
<td>5.26</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Abdominal pain</td>
<td>0.47</td>
<td>0.17</td>
</tr>
<tr>
<td>Alkaline phosphatase(IU/L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>5 – 10</td>
<td>2.23</td>
<td>0.14</td>
</tr>
<tr>
<td>10</td>
<td>1.60</td>
<td>0.40</td>
</tr>
</tbody>
</table>

4. Discussion

This study was conducted to figure out the overall 1-year survival outcome among any types and stages of CCA patient in Roi-et hospital. It cannot answer a survival time of particular type and stage of the disease because of using secondary data in the hospital, there were no record to be identified those information. However, age-standardized incidence rate study by ICD10 review from cancer registries in Thailand showed that over 99% of all CCA in Thailand was intrahepatic CCA.(28) Therefore, the result from this study is likely to represent a situation of intrahepatic CCA rather than extrahepatic CCA. The fatality rate in 1 year follow up was 55%. In other words, the 1-year overall survival rate was 45% which was higher than the study in Cluj Napoca, 2005 - 2009(29) but lower than the study in Malaysia about 22%. However, most CCA patients in Malaysia’s study, 1997 - 2007 (83%) were extrahepatic CCA. The median survival time was 9 months that was relatively greater than the median survival time in 10-year study in Malaysia (30). The number of death after surgery within 30 days was considered as the mortality from a complication the operation(31), nevertheless no CCA patient in this cohort who died within 30 days after getting operation.

The factors which may influence statistically significant to the survival outcome from Log-rank test were having abdominal pain, CEA > 5, and ALP level whereas the factor of sex, age >60year, occupation type, type of health insurance, bilirubin level > 5, CA19-9 level, getting surgical or palliative intervention were not statistically associated to survival outcome. Actually, another factor which may affect the death outcome of CCA was nutritional status that can be measured by Body Mass Index (BMI). Due to incomplete record, the information of height and weight at diagnosis date could not be retrieved. According to the Log-rank test, CCA patient having different type of health insurance and occupation had the same chance to get dead within 1 year. Those can reflect the equality to access to care in government hospital. Using the level of CA19-9 and bilirubin cannot forecast the prognosis of CCA in 1 year in this study which was not consistent to the meta-analysis study in China.(32)

Many studies discussed about the advantage of surgical and palliative care to CCA patient, but this study showed there were no differences between having or not having the interventions among patient getting a treatment in Roi-et Hospital. When getting surgery and palliative intervention were grouped to compare to the supportive care, the difference was still not significant statistically (P-value = 0.18). It means that the benefit of intervention physician give to CCA patient in Roi-et Hospital was not clear and also implies that case assessment to provide any intervention should be discussed. Therefore, these results support that to improve the prognosis of CCA patient, the early diagnosis and early
screening are very important for both intrahepatic and extrahepatic CCA. However, the result may be changed if those patients are followed continuously for few years after diagnosis. Furthermore, because interventions were accounted by intention-to-treated technique, some changes or additional interventions after diagnosis date may be missed. The factor of age could not be included in Cox-proportional hazard regression due to the hazard curve of age < 60 years and > 60 years were not parallel overtime, however the curve showed that at the first 6 months after diagnosis the hazard of the patient with age > 60 years were more than the patient’s with age < 60 years. Then, the hazard of both age groups became parallel with similar rate after 6th month of diagnosis.

According to Cox-proportional hazard regression, CEA level > 5 µg/l was the only one factor that was statistically significantly associate to the survival outcome which can be explained by positive correlation between tumor stage and CEA level (33). Thus, CEA level can help the surgeon to make a decision for giving treatment. Having abdominal pain and ALP level may be the proxy of disease severity at diagnosis date(22), but the result showed that they were not associated to the death outcome.

Because of the retrospective cohort study, some data may be missed from records. Although the data missing was randomly, the missed data will decrease the power of test. Cancer staging and microscopic classification could not be retrieved because they will normally be confirmed after surgery which there was only 19 patients operated. The cancer staging was the important confounder of survival study to evaluate an effect of intervention since a surgeon would not perform surgery among advance stage CCA patient. If most patients came to hospital with late stage of CCA, physician will decide to give a palliative or supportive care rather than surgery. Consequently, survival outcome among patients getting surgery tend to be better than palliative care. However, the result in this study shows that there was no different survival outcome between interventions. The sensitivity and specificity of using CT scan to tell cancer staging was not high, 10% sensitivity to detect extrahepatic invasion and 65% sensitivity to detect ductal dilatation (34), so the pathological finding of cancer should be collected properly to study survival time of applying an intervention each stage of cancer. Only 32 patients had recorded their weight and height at the date of diagnosis, so BMI of most patients cannot be calculated. The date patient got interventions was not accounted in the study, so the different date on when physician applied the intervention might affect the survival time. Some patients received both hepatic resection and PTBD, but the study categorized them in the hepatic resection group. Therefore the effect from each individual particular intervention should be studied more, prospective data collection with well design was recommended. Due to intention to treat was used in the study, so some alternative treatment that patient might get from another place was not considered in the study which can affect the survival time as well.

5. Conclusion

The retrospective cohort study to describe and analyze the 1-year overall survival outcome among 221 CT imaging-diagnosed CCA patients in Roi-et Hospital shown that the median survival time was 10 months and survival rate of 1st year following diagnosis was 45%. The high fatality rate in 1st year following diagnosis implied that diagnosis was late, so early screening and diagnosis should be emphasized. There was no association between survival time and age > 60 years, sex, occupation, type of health insurance, bilirubin level > 5 mg/dl, CA 19-9 level and getting surgery or palliative operation. Only the factor of CEA level > 5 µg/l was statistically significantly effect to 1-year survival time. Therefore, the physician would consider the level of CEA to make a decision for treatment. However, some variables which was not able to be collected may relate to the outcome such as BMI, tumor classification (ICC or ECC) and tumor staging, therefore the specific survival outcome by those factors cannot be figured out. To complete the some effect from those factors, a prospective study with proper data collecting system should be strengthen.

6. Acknowledgment

We thank Roi-et provincial health office and Cancer center in Roi-et hospital for their very kindly
support and facilitating and also Bureau of Epidemiology, Ministry of Public Health for funding support.

References


[27] Sripa B, Pairojkul C. Cholangiocarcinoma: lessons from Thailand. Current opinion in gastroenterology. [Research Support, N.I.H.,
Extramural Research Support, Non-U.S. Gov't Review]. 2008 May;24(3):349-56.


Analysis of Spectral based Vocal Parameters for Classifying Suicidal States in Clinical Depressed Patients

Thaweesak Yingthawornsuk
Department of Media Technology,
King Mongkut’s University of Technology Thonburi
Tel. 02-470-7606, E-Mail: thaweesak.yin@kmutt.ac.th

Abstract
Identifying persons suffering a suicidal risk from those who are less clinically depressed is critical for diagnosing the syndrome underlying a patient’s abnormal behaviour. This study describes a way to address such issue. The vocal parameters extracted from male speech samples among depressed, suicidal and control subjects were analysed and distinguished based on the typically acoustical parameters comprised of Mel-Cepstral Coefficients (MFCC) and Energy parameters extracted along a continuous frequency range of 0-5 KHz. The experimental results have been revealed that MFCC and energies in sound spectrum are potentially effective as the vocally discriminative input for multivariate classifier in separating the categorized populations with considerably accurate scores as a result of pairwise performance evaluations.

Keywords: Spectral Energy, MFCC, Suicidal Assessment, Depression, Speech

1. Introduction
Suicide is compulsory in person with severe depression resulted from when the symptom of such emotional disorder critically elevates in state of mind. It is still not clarified to understanding of suicidal phenomenon. Further investigation needs to be carried out for gaining more relevant information. Finding in this study will be additionally one of supplements to the suicide prevention program. However, suicide prevention is presently limited to solely clinical level which consumes time and bases heavily on the psychiatrist’s experience. The ways to prevent suicide are monitoring the symptom of depression in person by care taker, and judgment on the degree of severe from symptom by physician. The particular technique to evaluate a person who is at risk of suicide is sorely needed in clinical practice. Many research groups have been focusing on suicidal prediction and attempting to figure out how to identify groups of categorized patients. The integration of various methodologies have been conducted in past studies to reach the concrete conclusion and suggestion that the most popular technique emerging in area of speech processing has been taken as data processing and information extraction in account of suicidal assessment. Suicidal patients at near-term risk exhibit significant perceptual changes in vocal qualities that can help distinguish them from control persons [2]. In formerly published papers [1-2], [4], [5], the analytical techniques have been developed to determine if subjects were categorized into one of three following patient groups: Control, Non-suicidal Depressed or High-risk Suicidal. The vocal cues have been properly used as indicators in diagnosing the underlying symptom in patient by experienced clinicians [2], [6], but these skills are not in widespread clinical use. The considerable evidence suggests that the emotional arousal produces changes in the speech production scheme by affecting the respiratory, phonatory, and articulatory processes that in turn are encoded in speech signal itself [7-8]. Changes in heart rate, blood pressure, respiratory patterns, muscle tension, and motor activity transiently alter respiratory, phonatory, and articulatory functions in speech production in an acutely state-related fashion, directly tied to emotions. Consequently, emotional disturbances can be expected to cause measurable changes in speech parameters.

The main objectives of this study are to exhibit that the spectral pattern of frequency response corresponding to spoken sound of depressed patient is affected and spectrally shifted in energy from that in case of normal speaker, and to reveal an existence of relative link between acoustical properties in spoken sound of patient
and emotional illness that patient experiences. This paper is organized as follows: Second section explains descriptions on speech sample database, patient populations, feature extraction, and statistical analyses. Next consecutive sections provide results from experiment, discussion, conclusion and further direction of study in future, respectively.

2. Database

All speech recordings were intentionally collected from three different categorized groups of depressed, high-risk suicidal and control subjects. Database consists of thirty males evenly grouped into such categories. Each subject in each group has two different types of speech samples recorded. One is collected from main interviewing session with psychiatrist and another from the post session that patient reads a predetermined part of book. The passage used in post session is composed of the standardized texts generally used in speech science since it contains all of normal sounds in spoken English and it is phonetically balanced [3].

In processing state, the raw speech sample of individual subject was randomly extracted from our database and used in representing that subject. All speech samples are off-line analyzed and processed throughout the entire procedure in this study. First each speech signal was digitized via a 16-bit analog-to-digital (A/D) converter at a 10-kHz sampling rate with an anti-aliasing filter (i.e., 5-kHz low-pass). The background noise and voice artifact not belonged to patient are removed via manually monitoring with a GOLDWAVE Audio Editor.

3. Feature Extraction

In research procedure, we first developed a speech database that consists of samples taken from patient state above. We then developed an analysis system that can automatically extract the vocal features of interest from all individual subjects in database. Once the vocal features are completely extracted from the speech of all subjects, the dataset is then separated into two sets for training and testing purposes. During training phase, the vocal features extracted from each subject in the training set were employed to develop a probabilistic model of class distributions. During testing phase, the performance of this model was evaluated based on the vocal features extracted from the test subjects.

Feature extraction methods employed in this work are basically based on the linear source-filter model of speech production as illustrated in Fig. 2. In this linear source-filter model, speech is theoretically generated by convolving an excitation source with a linear-time invariant filter that represents the Vocal tract (VT). The VT serves as an acoustic filter. Its shape is changed continuously by the movement of its articulators. Depending on the position of its articulators, it emphasizes the certain frequencies called formant frequencies. Therefore as the glottal flow waveform passes through the VT, the energy around the formant frequencies is amplified. This phenomenon yields to the generation of different speech sounds.

![Fig.1 Research procedure](image1)

![Fig.2 Model of speech production](image2)
Based on this model the vocal properties of near-term suicidal patients were investigated the Source and Filter domains of speech production mechanism separately. The variations reflected on the source domain properties were investigated by two excitation-based speech features; Vocal Jitter and Glottal Spectral Slope and those reflected on the filter domain properties were investigated by Mel-Cepstral Filter Bank Coefficients. This proposed work has been strictly focused on the Glottal Flow Slope and MFCC for one-on-one parameter domain analysis in term of evenly less bias multi-integrated parameter input to multivariate classifier.

4. Comparative Statistical Analyses

For each extracted feature, the presence of statistically significant differences between near-term suicidal and other patient groups was evaluated by a set of comparative statistical analyses, which are the Wilcoxon’s sum of rank test to measure group distribution, F-test for group variance comparison and T-test for mean comparison.

5. Classification

First we determine the probabilistic modeling of the feature distribution. PDF of the training feature set representing each diagnostic class is modeled by Unimodal Gaussian Model and Gaussian Mixture Model (GMM) as well. It depends on how the empirically extracted feature distributes, including a posteriori probability maximized. Secondly the performance evaluation is then followed up. The classification accuracy of the probabilistic model is evaluated on a test feature set. In order to evaluate the performance of the classification model, we employ the holdout procedure. This procedure was developed for small databases and the implementation is as follows:

- Remove the samples associated with one patient from the composite dataset (test set)
- Construct the PDF for each class based on the remaining samples (training set)
- Assign the test patient into the class for which it has the largest a posteriori probability
- Put all the removed samples back into the composite dataset
- Repeat the same process until all subjects are used in classifier design and evaluation

This procedure enables us to train and test on each subject but not use the same subject for both training and testing at a time.

6. Result and Discussion

Two-sample statistical tests yielded significant differences between class distributions and means in case of the Glottal source feature. Depressed and suicidal patients exhibit higher spectral slope than non-depressed controls (depicted in Fig. 3) with Wilcoxon’s sum of ranks test (p<0.05), F-test (no significance) and T-test (p<0.05). In classifying depressed patients from control subjects using Glottal Slope alone in classification its accurate score came out to be effectively high at 90% compared to other two pairwise results shown in Table 1. Based on the first four low-orders MFCC the Gaussian mixture model with 6 components have been tested and found to be the best provider for classification accuracy among subject groups tabulated in Table 2. Identifying suicidal speaker from both depressed and control ones seems to have a fairly effective percentage of 80% in accuracy which is considered slightly productive in term of a single-parameter classifier, but possibly increasing when employed as a partial factor in feature combination with other extracts. Integrating Glottal Slope and MFCC covering both source and filter domains yielded the highest classification performance with 90% in accuracy.

![Fig.3 Statistic Test on Glottal source feature distribution](image-url)
### Table 1. Glottal Slope classification results

<table>
<thead>
<tr>
<th>Glottal Spectral Slope</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>NPV</th>
<th>PPV</th>
<th>% Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control/Depressed</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>90</td>
</tr>
<tr>
<td>Depressed/Suicidal</td>
<td>0.90</td>
<td>0.90</td>
<td>0.89</td>
<td>0.85</td>
<td>75</td>
</tr>
<tr>
<td>Control/Suicidal</td>
<td>0.60</td>
<td>0.70</td>
<td>0.92</td>
<td>0.68</td>
<td>60</td>
</tr>
</tbody>
</table>

### Table 2. MFCC classification results

<table>
<thead>
<tr>
<th>First 4 mel-cepstral filter bank coefficients</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>% Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control/Depressed</td>
<td>0.70</td>
<td>0.60</td>
<td>0.77</td>
<td>0.72</td>
<td>75</td>
</tr>
<tr>
<td>Depressed/Suicidal</td>
<td>0.80</td>
<td>0.80</td>
<td>0.89</td>
<td>0.80</td>
<td>80</td>
</tr>
<tr>
<td>Control/Suicidal</td>
<td>0.90</td>
<td>0.70</td>
<td>0.75</td>
<td>0.87</td>
<td>80</td>
</tr>
</tbody>
</table>

### Table 3. Integrated multi-parameter classification results

<table>
<thead>
<tr>
<th>Integrated multi-parameter classifier</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>% Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control/Depressed</td>
<td>0.90</td>
<td>0.90</td>
<td>0.81</td>
<td>0.88</td>
<td>85</td>
</tr>
<tr>
<td>Depressed/Suicidal</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>90</td>
</tr>
<tr>
<td>Control/Suicidal</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>90</td>
</tr>
</tbody>
</table>

### 7. Conclusion

In source domain, glottal spectral slope was effective in discriminating depressed patients from control subjects. In filter domain analysis the first four lower-order MFCCs were effective in discriminating suicidal patients from both non-depressed controls and depressed patients.

Integrating source and filter domain extracts as a set of feature inputs to the integrated multi-parameter classifier increased 10% of correct classification score compared to a case of single-parameter classifier.

Future direction will deal with larger database, standardized recording procedure and long-term responsive to patients on their own control behavior.

### 8. Acknowledgment

This technical report has been financially granted by National Research Council of Thailand.

### References

Charge Equalizing System for Two-unit Serially Connected Battery String Using Forward Converter Topology

Charnyut Karnjanapiboon¹ and Saichol Chudjuarjeen²
¹Department of Electrical Engineering, Faculty of Engineering, Rajamangala University of Technology Lanna Nan
²Department of Electrical Engineering, Faculty of Engineering, Rajamangala University of Technology Krungthep
Tel. 054-710-259 Ext. 1140, E-Mail: chanyut@rmutl.ac.th

Keywords: Charge equalizing system, forward converter topology, electric vehicle, unbalanced energy

Abstract
Today, electric vehicles are now popular and widely used in Thailand. The examples of these vehicles are electric bicycles and electric motorcycles. The main power source that supplies energy to electric motors is a serially connected battery string. While using the serially connected battery string, an energy unbalance problem will occur even though batteries of the same model and manufacturer from the same production line are operated. This energy unbalance problem decreases the service life of the pack of the serially connected battery string. To maintain the power supply to run services at full capability, a charge equalization system is required in order to equalize the unbalanced energy of each battery unit in the string to get the same energy value. The aim of this article is to design and test a charge equalization system that can reduce the cost of replacing new battery units as a result of the energy unbalance. In the previous research, a power electronic circuit was used along with a capacitor leading to a high current stress in the designed circuit. To reduce this stress, a forward converter topology for the charge equalization system was proposed. The research methodology consisted of a review of related research, design of a system, simulation and evaluation. The simulation of the forward converter topology system worked out to be a model using two SPA (SL-6-5) 6V-5AH/20HR batteries each of which was at a different energy level. With this configuration, the proposed circuit was able to equalize the energy of the batteries in the serially connected battery string.

Keywords: Charge equalizing system, forward converter topology, electric vehicle, unbalanced energy

1. Introduction
Today, electric vehicles are now popular and widely used in Thailand. The main advantage of an electric vehicle is to reduce pollution gases that affect human environment. Comparing to fuel based vehicles, the electric vehicles can start to move instantly because they do not require an engine start procedure. The main important part of an electric vehicle is an electric motor. The responsibility of the electric motor is to convert electrical energy into a mechanical force. The mechanical force of the motor is torque that can be transmitted to electric vehicle driving wheels in order to move a body of the electric vehicle. To excite the electric motor to produce the torque, a power source is required. There are many power sources in the world; for the electric vehicle, a battery is used as an electric power source. There are many types of batteries. A lead acid battery is widely used in electric appliances because of its reasonable cost versus output power. In general, there are many voltage ranges of the lead acid battery such as 2 V, 6 V and 12 V. If the electricity requires high voltage to operate, a serially connected configuration must be arranged. For a 24 V system, it can use 12 units of a 2 V battery, 4 units of a 6 V battery or 2 units of a 12 V battery in a serially connected pattern. This article focuses on the 12 V serially connected battery system which consists of 2 units of a 6 V battery. The problem of the battery in the serially connected pattern is an energy unbalance problem that will occur even though batteries of the same model and manufacturer from the same production line are operated. The
battery still has a difference in an electrochemical reaction process. This difference will be greater increase along with a usage time of the battery. This is a main cause that decreases a service life of a series connected battery string. Some batteries are over charged and others are under charged. This energy unbalance problem of overcharging and undercharging decreases the service life of the pack of the serially connected battery string. To maintain the power supply to run services at full capability, a charge equalization system is required in order to equalize the unbalanced energy of each battery unit in the string to get the same energy value. There are several research articles involving the charge equalizing system.

The research articles [1-4] were proposed a converter circuit comprising an inductor, a capacitor and a switch which was a buck-boost converter, SEPIC converter and single inductor single switch converter. While using a single common switch, the current of the switch was very high. Moreover, some capacitors were also facing with voltage stress when applying with a large number of battery units in a serially connected battery string.

The aim of this article is to design and test a charge equalization system that can reduce the cost of replacing new battery units as a result of the energy unbalance. To reduce this stress, a forward converter topology for the charge equalization system was proposed. The proposed circuit of the charge equalizing system was shown in Fig. 1. The proposed circuit consisted of two main active switches (MOSFET), one passive switch (diode) and one 1:1 ratio transformer.

2. Principle Operation of Proposed System

From a diagram of the proposed system shown in Fig. 1, the battery current and the diode current of an essential operating modes are presented in Fig. 2, Fig. 3 and Fig. 4 respectively. Notice that, in a charging process of a serially connected battery, the stage of charge (SOC) is proportional to the battery voltage so the responsibility of the CES is to ensure that the voltages of each battery are equal. This task is done by equalizing the excess energy from one battery to another. There are three possible conditions for the battery voltage:

- A voltage of battery number one $V_{B1}$ is greater than a voltage of battery number two $V_{B2}$.
- A voltage of battery number one $V_{B1}$ is smaller than a voltage of battery number two $V_{B2}$.
- A voltage of battery number one $V_{B1}$ is equal to a voltage of battery number two $V_{B2}$.

In the first battery voltage condition $V_{B1}>V_{B2}$, there are three intervals. In the first interval $t_0-t_1$, a current of the battery number one $B_1$ goes negative while a current of the battery number two $B_2$ goes positive. This means the energy from the battery $B_1$ is transferred to the battery $B_2$ via an inductive element of a transformer. The inductive element of the transformer are primary winding and secondary winding. At the end of this interval, some small energy is stored in the transformer. In the second interval $t_1-t_2$, the stored energy in the transformer flows back to the battery $B1$ via the diode $D$. In the third interval $t_2-t_3$, there are no activities of the current. The waveforms of the battery current and the diode current while $V_{B1}>V_{B2}$ are shown in Fig. 2.

![Fig. 2 Waveforms of Battery Current and Diode Current while $V_{B1}>V_{B2}$](image)

In the second battery voltage condition $V_{B1}<V_{B2}$, there are also three intervals. In the first
interval $t_0-t_1$, a current of the battery number two $B_2$ goes negative while a current of the battery number one $B_1$ goes positive. This means the energy from the battery $B_2$ is transferred to the battery $B_1$ via an inductive element of a transformer. At the end of this interval, some small energy is stored in the transformer. In the second interval $t_1-t_2$, the stored energy in the transformer flows back to the battery $B_1$ via the diode $D$. In the third interval $t_2-t_3$, there are no activities of the current. The waveforms of the battery current and the diode current while $V_{B1}<V_{B2}$ are shown in Fig. 3.

![Fig. 3 Waveforms of Battery Current and Diode Current while $V_{B1}<V_{B2}$.

In the third battery voltage condition $V_{B1}=V_{B2}$, there are three intervals. In the first interval $t_0-t_1$, a current of the battery number one $B_1$ and a current of the battery number two $B_2$ go negative. This means the energy from the battery number one $B_1$ and the energy of the battery number two $B_2$ is stored in an inductive element of a transformer. In the second interval $t_1-t_2$, the stored energy in the transformer flows back to the battery $B_1$ via the diode $D$. In the third interval $t_2-t_3$, there are no activities of the current. The waveforms of the battery current and the diode current while $V_{B1}=V_{B2}$ are shown in Fig. 4.

![Fig. 4 Waveforms of Battery Current and Diode Current while $V_{B1}=V_{B2}$.

3. Simulation results

To set up the computer CAD simulations, the pre-defined variables of the proposed charge equalization technique are shown in Table I.

<table>
<thead>
<tr>
<th>Input variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Battery</td>
<td>2 Units</td>
</tr>
<tr>
<td>Battery Voltage</td>
<td>6 V</td>
</tr>
<tr>
<td>MOSFET ($M_1$ and $M_2$)</td>
<td>IRFZ44</td>
</tr>
<tr>
<td>Switching frequency</td>
<td>20 kHz</td>
</tr>
<tr>
<td>Inductor Value $L_1$ and $L_2$</td>
<td>50 µH</td>
</tr>
</tbody>
</table>

The computer CAD simulation schematic is shown in Fig. 5. There are three battery voltage conditions for simulation.

First condition $V_{B1}>V_{B2}$: A voltage of battery number one is set at 6.5 V. A voltage of battery number one is set at 6.0 V. The simulation results of $I_{B1}$, $I_{B2}$ and $I_D$ are shown in Fig. 6.

Second condition $V_{B1}<V_{B2}$: A voltage of battery number one is set at 6.0 V. A voltage of battery number one is set at 6.5 V. The simulation results of $I_{B1}$, $I_{B2}$ and $I_D$ are shown in Fig. 7.

Third condition $V_{B1}=V_{B2}$: A voltage of battery number one is set at 6.5 V. A voltage of battery number one is set at 6.5 V. The simulation results of $I_{B1}$, $I_{B2}$ and $I_D$ are shown in Fig. 8.

![Fig. 5 Computer CAD Simulation Schematic.](image)
From the simulation results shown in Fig. 6, Fig. 7 and Fig. 8, it is shown that the energy from both batteries B1 and B2 are interchangeable via coupling transformer T using forward converter topology. An ellipse symbol shows a free-wheeling diode that allows magnetizing energy from the transformer T to flow back into the battery B1. The current amplitude of the battery depends on how much its voltage differences are. The more battery voltage differences, the more battery current amplitude occurs. The high frequency noise that oscillates between the time intervals t0-t1 and t1-t2 is a resonant signal between transformer inductance and a capacitance across the MOSFET switch.

4. Conclusion

This proposed charge equalizing system for two units serially connected lead-acid battery string using forward converter topology is a selective choice for balancing an unbalance energy problem to extend the battery service life. The main advantage of this proposed circuit does not require an auxiliary power supply to support a high side gate driving signal leading to simple circuit configuration. However, this article proposes only a computer CAD simulation. It is better to verify this simulation results by setting up an experimental prototype charge equalization system.

5. Acknowledgments

We would like to thank Rajamangala University of Technology Lanna Nan for supporting the fund.

References

The Simulation Technique of Variable-Frequency Asymmetrical Voltage-Cancellation Control of Series Resonant Inverters in Induction Cooking by PSPICE Programs

Jirapong Jittakorn 1, Saichol Chudjuarjeen 2, Tanit Boonsai 1, and Samart Yachiangkam 3

1 Faculty of Technical education, Rajamangala University of Technology Thanyaburi, Pathumthani
2 Department of Electrical and Telecommunication Engineering, Faculty of Engineering, Rajamangala University of Technology Krungthep
3 Department of electrical engineering, Rajamangala University of Technology Lanna, Faculty of Engineering, Chiang Mai, Thailand
E-Mail: jirapong2@hotmail.com

Abstract
This paper presents the simulation technique of a variable-frequency asymmetrical voltage-cancellation control (VFAVC) of series resonant inverters in domestic induction cooking which the simulated circuit is used by the computer programs as PSPICE programs. The series resonant inverter (SRI) archives the zero voltage switching (ZVS) condition. The simulated technique can adjust the switching frequency and dead time. The simulated results using the PSPICE program verify the proposed control scheme.

Keywords: Series Resonant Inverter, Variable-Frequency Asymmetrical Voltage-Cancellation Control, PSPICE Simulation

1. Introduction
Currently, the high-frequency resonant inverters is used to operation control in home appliance as the induction cooking that is one of the many application of induction heating. The operations of induction cooking are based on magnetic fields by using the power semiconductor devices and a high-frequency switching, normally operated between 20kHz and 100kHz, due to its cleanness, safety, quick warming, maintainability, controllability, high efficiency, high reliability, and low cost [1-3]. Thus, induction cooking have been focused on the research and developments by using high-frequency resonant inverters in order to get highly efficient reliable, and using various control methods to vary the output power of inverter such as the asymmetrical duty cycle (ADC) control, the output power can be regulated by varying the duty cycle and switching frequency [4, 5], the pulse density modulation (PDM) technique regulates the output power by varying the period of switches [6-10], the square wave (SW) modulation controls the output power by varying the switching frequency while the inverter operates under ZVS condition [11, 12], the phase-shift (PS) control varies the output power by shifting the phase of the switch conduction sequences [13, 14], the discontinuous current mode (DCM) varies the output power by varying the switching frequency and the duty cycle which depends on the switching frequency [15], the asymmetrical voltage-cancellation (AVC) control is proposed in [11-14]. In [14], that proposed by varying the duty cycle with a fixed-frequency control techniques. However, a ZVS area will be decreased to lead NON-ZVS operation condition in fix frequency for the low quality factor loads when the duty cycle is adjusted for power control of load, and the efficiency of inverter is reduced. Then, the switching frequency of switch devices must higher than the resonant frequency to maintain a ZVS area [20, 21] and to achieve a better efficiency.

The aim of this work use VFAVC-control for the SRI with the series resonant load as the induction cooking appliance, which is simulated by the PSPICE programs. It can be adjusted by the switching frequency and the dead time of a gate signal. This paper is organized as follows. Section II describes the characteristic of series resonant load. The VFAVC is exploited in section III. The SRI simulation by the PSPICE programs and the simulated results are shown in section IV. Finally, the research work is concluded in section V.

2. Characteristic of Series Resonant Inverter
2.1 The Series Resonant Load
The series resonant load consists of the equivalent resistance $R_{eq}$ and the equivalent inductance $L_{eq}$ connected with the resonant capacitor $C_r$, it shows in Fig. 1.

The impedance of series resonant ($Z_{eq}$) is given by

$$Z_{eq} = R_{eq} + j \left( \frac{\omega L_{eq} - \frac{1}{\omega C_r}}{\omega C_r} \right) = R_{eq} \left( 1 + jQ \left( \frac{\omega}{\omega_c} - \frac{1}{\omega_c} \right) \right). \tag{1}$$

The amplitude of $Z_{eq}$ is

$$|Z_{eq}| = R_{eq} \sqrt{1 + Q^2 \left( \frac{\omega}{\omega_c} - \frac{1}{\omega_c} \right)^2}. \tag{2}$$

The load quality factor ($Q$) is obtained by

$$Q = \frac{\omega L_{eq}}{R_{eq}} - \frac{1}{\omega_c R_{eq} C_r} = \frac{Z_r}{R_{eq}}. \tag{3}$$

The resonant impedance ($Z_r$) is equal to $\sqrt{L_{eq} / C_r}$.

### 2.2 The Full Bridge Inverter

The full bridge inverter with the series resonant load circuit in Fig. 2 is analyzed by the steady-state circuit. It is based on the following assumptions. The inverter consists of the four power electronic switches with antiparallel diode.

- All circuit components are ideal.
- The dc input voltage of the inverter ($V_{DC}$) is constant.
- The effects of stray capacitance and the snubber capacitor are neglected.

### 2.3 The VFAVC

The average output power $P_o$ of the SRI [17] can be calculated by (4). Fig. 3 shows the switching pattern of VFAVC-control, which consists of the gate signal S1 to S4, the output voltage $v_o$, and the output current $i_o$.

$$P_o = \sum_{i=1}^{n} I^2_{ch,mar} R_{eq} \approx \frac{\dot{V}_{oi}^2}{2 R_{eq} \left( 1 + Q^2 \left( \frac{\omega}{\omega_c} - \frac{1}{\omega_c} \right)^2 \right)} \tag{4}$$

### 3. The Simulation of Series Resonant Inverter

This section describes the technique simulation of the SRI with the series resonant load of induction cooking appliance, which is simulated by PSPICE programs. Fig. 4 shows the signal gate drive of the power switch as IGBT for example of the gate signal S2.
The gate signal V-pulse of the power switch S1 can find in (4).

\[ PW_{(S1)} = \left( \frac{1}{FS} \right) - TD \]  

(4)

The gate signal V-pulse of the power switch S2 and S3 can find (5) – (6).

\[ PW_{(S2)} = PW_{(S3)} = \left( \frac{1}{FS} \right) - TD \]  

(5)

\[ TD_{(S2)} = TD_{(S3)} = \left( \frac{1}{FS} \right) + TD \]  

(6)

The gate signal V-pulse of the power switch S4 can find in (7) that AL1 is the adjusted angle of AVC-control as \( \alpha \).

\[ PW_{(S4)} = \left( \frac{1}{FS} \right) - TD - AL1 \]  

(7)

Where \( FS \) is the switching frequency, \( TD \) is dead time of a gate signal, and \( PW \) is pulse width of gate signal. Fig. 5 shows the simulated circuit of SRI with series resonant load by PSPICE programs, which is the parameter in Table 1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{DC} )</td>
<td>200V</td>
</tr>
<tr>
<td>( f_c )</td>
<td>26.543 kHz</td>
</tr>
<tr>
<td>( L_{eq} )</td>
<td>214 ( \mu )H</td>
</tr>
<tr>
<td>( R_{eq} )</td>
<td>21.22 ( \Omega )</td>
</tr>
<tr>
<td>( C_r )</td>
<td>168 nF</td>
</tr>
<tr>
<td>IGBT, ( S_1 ) - ( S_4 )</td>
<td>IRGBC40S</td>
</tr>
</tbody>
</table>
4. Conclusions

In this paper, a variable-frequency asymmetrical voltage-cancellation control (VFAVC) strategy with the full-bridge series resonant inverter for induction cooking appliance, which is simulated by the PSPICE programs. The simulated results at $\alpha = 90^\circ$ achieve ZVS condition and can adjust the switching frequency with the dead time of a gate signal. The average output power $P_o$ can be adjusted by $\alpha$ angle for 25% to 100% of the maximum output power and can be adjusted the switching frequency.

References


An AC to AC Resonant Converter for Induction Heating

Phanom Tawdee¹ and Saichol Chudjuarjeen²

¹ Department of Electrical and Computer Engineering Faculty of Science and Engineering Kasetsart University, Chalermprakiat Sakon Nakhon Province Campus, Sakon Nakhon, Thailand.
² Department of Electrical Engineering, Faculty of Engineering, Rajamangala University of Technology Kruengthep
Tel. 02-287-9629, E-Mail: c_somchai2@hotmail.com

Keywords: bidirectional switch, ac to ac converter, series resonant, induction heating

Abstract
This paper proposes the ac to ac resonant converter with frequency control techniques for Induction heating. The high frequency power conversion circuit can operate from single-phase 200 to the low power at 50 Hz. A dual mode control scheme based on high frequency pulse width modulation, in synchronization with the line frequency positive and negative half cycles, and frequency modulation control is proposed to regulate the output voltage for wide output power regulation. The experimental results are tested to verify and validity of the proposed power conversion circuit and to evaluate its voltage regulation.

Keywords: Half-bridge resonant inverter, series resonant, induction melting.

1. Introduction
Induction heating is a well-known technique to produce very high temperature. For applications like steel melting, brazing, and surface hardening, an appropriate frequency must be used depending on the work-piece geometry and skin-depth requirements [1, 4]. Recent development of power semiconductor devices, new circuit techniques, and control schemes in high-frequency circuits using advanced power devices such as MOSFETs and insulated gate bipolar transistors (IGBTs) have progressed the induction heating applications continuously [1]–[9]. Various resonant inverters using power devices such as MOSFETs and IGBTs offer reduced switching loss by soft-switching technique and attractive possibilities in developing high-frequency operation, high efficiency, small size, and light weight.

This paper proposes a high frequency PWM ac to ac converter for induction heating application. The line frequency changer is changed by the bidirectional power semiconductor switching devices. The operation principle of the soft switching high frequency is described by using switching equivalent circuits. Furthermore, its circuit performance characteristics on the basis of experimental results are illustrated herein.

2. Induction Heating
2.1 Circuit description
The main power circuit features of a half bridge inverter for induction melting as shown in Fig. 1. It consists of full bridge rectifier diode, a bus filter (L, C), the IGBT and a diode connected in antiparallel. The circuit produces high frequency switching by turning on the IGBT while the diode is in turn-on state, it is possible to turn on the switch IGBT with the voltage remaining at zero (Zero voltage switching, ZVS). The resonant circuit is comprised of resonant inductor Lcoil (including coil inductance and resistance), and a resonant capacitor C_r.

![Figure 1. Half-bridge resonant inverter for induction heating.](image-url)
Figure 2. Principle of bidirectional switches.

Fig. 2 show the principle of bidirectional switches which comprise four diodes and one switch. Fig3 shows the switching pattern of the proposed ac to ac converter and Fig. 3 shows the duty cycle method.

Figure 3 Switching control scheme

From Fig. 4, we can find the duty cycle by equation (1)

\[ D = \frac{T_{ON}}{T_s} = \frac{V_c}{V_i} \quad 0 \leq D \leq 1 \] (1)

Where the input voltage can define in (2)

\[ v_i(\omega t) = \sqrt{2}V_i \cos(\omega t) \] (2)

Fig. 4. Duty cycle control

2 Experimental results

To verify the validity of the bidirectional converter with asymmetrical duty cycle control, a computer simulation and a hardware experiment are performed using parameter in Table I. The output current and voltage waveforms of the system are shown in Fig. 5 and 6. Next, the duty cycle is adjusted to 50% for the maximum power.

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input voltage</td>
<td>( V_i )</td>
<td>150V</td>
</tr>
<tr>
<td>Switching Frequency</td>
<td>( f )</td>
<td>20 kHz</td>
</tr>
<tr>
<td>Resonant capacitor</td>
<td>( C_r )</td>
<td>3 ( \mu )F</td>
</tr>
<tr>
<td>Resonant inductor</td>
<td>( L_r )</td>
<td>160 ( \mu )H</td>
</tr>
<tr>
<td>Output capacitor</td>
<td>( C_{sb} )</td>
<td>1 ( \mu )F</td>
</tr>
<tr>
<td>Choke Inductor</td>
<td>( L_{sb} )</td>
<td>190 ( \mu )H</td>
</tr>
<tr>
<td>Switches</td>
<td>S1 and S2</td>
<td>IRG4PH50UD</td>
</tr>
</tbody>
</table>

Figure 5 \( v_o \) and \( i_{coil} \) waveforms at 20 kHz. (\( i_{coil} \) (below): 40 A/div, \( v_o \) (above): 200 V/div and Time: 2 \( \mu s \)/div.)

Figure 6 \( v_o \) and \( i_{coil} \) waveforms at 108.7 kHz. (\( i_{coil} \) (below): 40 A/div, \( v_o \) (above): 200 V/div and Time: 2 \( \mu s \)/div.)
Fig. 7 shows the work piece at 750°C temperature which can see it red.

3. Conclusion

In this paper, the single-phase ac–ac converter with frequency controls is proposed and digitally implemented for induction heating application. The experimental results show the results to verify and validity of the proposed circuit. The proposed circuit is simple and low cost with minimum switches employed.

References


An Induction Cooking using Current Source Inverter

Vichien Hathairatsiri Wiroj Pechpunsri and Saichol Chudjuarjeen
Department of electrical and Telecommunication engineering,
Rajamangala University of Technology Krungthep, Bangkok, Thailand
E-mail: c_somchai2@hotmail.com

Keywords: class D current source inverter, induction cooking, parallel resonant

Abstract
A class D current source inverter for induction cooking power supplies is proposes in this paper. Switches devices operate in zero-current soft switching mode. Both IGBT are driven with respect to ground. The input inductor use about 1.3 mH for shaping the line current nearly sinusoid. The inverter has been operated at 35.7 kHz. The output power transferred to the load is 900 watts. It can heat the water about 0.6 liters from room temperature to approximately 100°C within 2.30 minutes with unity power factors on the input side.

Keywords: class D current source inverter, induction cooking, parallel resonant

1. Introduction
Induction heating is a well-known technique to produce very high temperature such as in melting steel, brazing, surface and hardening. Each application uses different appropriate frequency [1]. The induction cooking is one of many applications for induction heating. It is designed to replace common stove plates. The advantages of induction cooking are the plate stays cool when the vessel is heated and less energy is used for cooking. This technique requires high frequency current supply that enables to induce high frequency eddy current to occur at the bottom of vessel and these give rise to the heating effect.

The topologies of current source inverter which used in induction heating applications are full-bridge and half-bridge inverter. For the low power the half-bridge inverter has more appropriate than full-bridge inverter due to the half-bridge inverter has 2 switches. However the half-bridge current source inverter has much loss at the two high frequency inductors.

Generally, the control of current source inverter needed for control at the resonant frequency. Due to the load is parallel resonant circuit. For the non ferromagnetic load which has a high quality factor. The inductance of induction load has a little variation, so the phase lock-loop is not need.

This paper describes a class D current source inverter for induction cooking appliance. The control operates at a fixed switching frequency that is higher than its resonant frequency, it can maintain ZCS operation in the wide range load. The operation principles of control strategy are investigated and validity is verified by experimental results.

2. Current Source Inverter
The parallel resonant inverter or current source inverter needs a switch that can block a bipolar voltage. It can make appropriate switching action by connecting a switch and diode in series. The output voltage of the inverter is sinusoidal, in the case of low Damping Factor and operating frequency is near resonant frequency. The inverter is selected to operate at a little higher inverter frequency than a resonant frequency, in order to achieve zero-current soft-switching which reduces loss at IGBT's switches and protects spike voltage. The voltage across switch has both positive and negative values. The positive voltage is blocked by IGBT and negative voltage is blocked by diodes.
3. Parallel Resonant ZCS-PWM Inverter

Fig. 3 shows the parallel class D current source inverter for induction heating application. The inverter consists of two switches \((S_1, S_2)\) with blocking diodes \((D_1, D_2)\), a resonant capacitor \((C_p)\), a DC inductor \((L_{DC})\) and an induction coil that comprises of a series combination of resistance \((R_{eq})\) and coil inductance \((L_{coil})\).

As shown in Fig. 4, four modes of operation exist within one switching cycle. The corresponding circuit topology for each mode of operation is illustrated in Fig. 5. The analysis is as follows. 1) Mode 1 \((t_0-t_1)\): While switch \(S_1\) and diode \(D_1\) are on, at \(t = t_0\), switches \(S_1\) and \(S_2\) receive positive gating signals. The negative voltage appears at the diode \(D_2\). 2) Mode 2 \((t_1-t_2)\): At \(t = t_1\), While switch \(S_1\) and diodes \(D_1\) still conducts, switch \(S_2\) and the antiparallel diode \(D_22\) are off, the positive output voltage switch appears at \(S_2\) and diode \(D_2\). And ZCS operation is achieved. During this mode 3) Mode 3 \((t_2-t_3)\): At \(t = t_2\), the switch \(S_1\) is turned off. Similar to that in Mode 1, and the diode \(D_{11}\) starts conducting positive. The negative voltage appears at the diode \(D_1\). 4) Mode 4 \((t_3-t_4)\): At \(t = t_3\), when the diodes \(D_{11}\) and \(D_1\) are off, the switch \(S_2\) and diode \(D_2\) conduct and the ZCS condition is achieved. During this mode, the output voltage \(v_o\) becomes negative. Therefore, the one-cycle operation of the full-bridge inverter is completed. The next operating cycle continues to repeat from modes 1 to 4.
4. Experimental Results
To verify the validity of the proposed topology and control scheme, a hardware experiment is performed using parameter in Table I.

![Graph](image-url)

**Figure 7** $v_o$ and $I_1$ waveforms at 108.7 kHz ($I_1$: 20 A/div, $v_o$: 100 V/div and Time: 2 µs / div.)

![Graph](image-url)

**Figure 8** $v_o$ and $i_{coil}$ waveforms at 108.7 kHz ($i_{coil}$: 40 A/div, $v_o$: 200 V/div and Time: 2 µs / div.)

From Experimental result it can be seen that the inverter operates at ZVS conditions every situation which is the lowest switching frequency.

![Table](image-url)

**TABLE I**

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>$v_{AC}$</td>
<td>91 Vrms</td>
</tr>
<tr>
<td>Switching Frequency</td>
<td>$f$</td>
<td>35.21 kHz</td>
</tr>
<tr>
<td>Parallel resonant capacitor</td>
<td>$C_p$</td>
<td>0.44 µF</td>
</tr>
<tr>
<td>Induction coil inductor</td>
<td>$L_{coil}$</td>
<td>40 µH</td>
</tr>
<tr>
<td>Equivalent resistor (with workpiece)</td>
<td>$R_{eq}$</td>
<td>4.8Ω</td>
</tr>
<tr>
<td>Switches</td>
<td>$S_{i}$, $S_{2}$, $S_{3}$, $S_{4}$</td>
<td>IRFP460</td>
</tr>
</tbody>
</table>

The average output power $P$ can be obtained as

$$P = \frac{v_{o, rms}^2}{R_p} \text{ or } P = \frac{i_{coil, rms}^2}{R_{eq}}$$

$$R_p = \frac{R_{eq}^2 + X_{coil}^2}{R_{eq}}$$

FIGURE 5 Operation modes of the Inverter

FIGURE 6 Changing series circuit to parallel circuit Equivalent.

Mode 1 ($t_1 - t_0$)

Mode 2 ($t_1 - t_2$)

Mode 3 ($t_2 - t_3$)

Mode 4 ($t_3 - t_4$)

![Diagram](image-url)
5. Conclusion

A class D current source inverter can use for induction cooking application with constant switching frequency. The resonant frequency increased when parameters ($L_{Coil}$, $R_{eq}$) change. And the point of constant switching frequency still maintains ZCS operation. So the phase-locked loop is not need in this application. The small dc inductor can use in this topology. Experimental studies are performed to verify the proposed control method. The main advantages of this inverter are characterized as follows: Applicable to non-magnetic load such as aluminum as well as magnetic load and the reduction in size and weight.

6. Acknowledgment

The authors would like to thank The Research and Development Institute of Rajamangala University of Technology Krungthep for the financial supporting this project.

7. References


