Mahidol University
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THAILAND SECTION

MITiCON

The 2nd Management Innovation Technology International Conference

"Technology and Innovation Management for Societal and Global Challenges"

November 16-18, 2015

Bangkok, Thailand

Proceedings

Editor: Sotarat Thammaboosadee

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The 2nd Management Innovation Technology International Conference (MITiCON2015)

16-18 November 2015, Bangkok, Thailand

Conference Proceedings

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Dr. Sotarat Thammaboosadee
MITiCON2015 Secretary

Welcome Message from the General Chair and Secretary

On behalf of the Organizing Committee, it is our greatest honor to welcome you to the 2nd Management and Innovation Technology International Conference (MITiCON2015), hosted at the Grand Mercure Fortune Bangkok Hotel, Thailand, 16–18th November 2015. MITiCON2015 is supported and sponsored by the Information Technology Management Program, Faculty of Engineering, Mahidol University, co-sponsored by the Graduated Studies of Commerce, Burapha University and supported by several industrial firms. The MITiCON2015 features a world-class conference that brings together researchers and practitioners in the field of management, innovation technology and information technology for the society and global challenges according to the conference theme: "Technology and Innovation Management for Societal and Global Challenges". MITiCON2015 provides an opportunity for academic and industry professionals to present and discuss the latest issues and research progress in the area of technology and innovation management such as IT and innovation management, knowledge management, technology assessment, strategic management, data management, IT corporate management, IT governance, Enterprise Architecture, business management, financial management, economics, policies management, educational management, and their social impacts. Additionally, other related engineering and science topics are also welcome.

This year we received 125 high-quality papers from more than 10 countries. Many papers demonstrated notable systems with empirical analyses. Many of them proposed interesting and outstanding researches in the related fields of innovation management. Each paper was reviewed by two reviewers. Based on these rigorous reviews, MITiCON2015 consequently accepted 73 papers in 7 research tracks for inclusion in the conference program. Therefore MITiCON2015 represents an acceptance rate around to 58%. All accepted

papers will be included in the Proceeding of Management and Innovation Technology International Conference.

The highlights of the conference include:

• Three Keynote speeches by researchers and executive from academic and industry:

- Dr. Smitti Darakorn Na Ayutthaya (Mahidol University), who gives a talk in "Innovation in the Digital Economy for National Policy of Thailand".

- Asst. Prof. Dr. Banpot Wiroonratch (Graduated Studies of Commerce, Burapha University), he provides an academic tutorial in Ph.D. research conduction.

- Ben Gerber (DBS Bank, Singapore), who gives a talk in "Understanding Privacy"

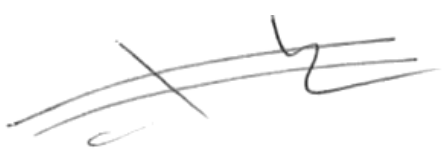
• 10 parallel sessions of international paper oral presentations throughout a two-day period

• 2 parallel sessions of local paper oral presentations on the last day of the conference; and

A series of social functions have been planned, which include a welcome reception, lunches, conference banquet at Grand Mercure Fortune Bangkok Hotel.

Apart from attending the technical program, you are encouraged to experience the magic of the Nightlife City, Bangkok, especially to the Ratchada area which the conference venue is located.

Last but not least, we would like to express our sincere gratitude to everyone involved in making the conference a success. Many thanks go to advisory board members, the organizing committees, the keynote speakers, the program committee and reviewers, the session chairs, the conference participants, and of course, to all the contributing authors who will be sharing the innovation and novelty of their high quality research. We wish our best wishes for an awesome staying in Thailand!



Asst. Prof. Dr. Supaporn Kiattisin
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MITiCON2015 Secretary

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Keynote Speech

Innovation in the Digital Economy for National Policy of Thailand

Dr. Smitti Darakorn Na Ayutthaya

On behalf of the Royal Thailand Government has pledged to promote the digital economy for transformation. The Ministry of Information and Communication Technology is joining hands with the Federation of Thai Industries in translating the Government's policy on the digital economy into action. Thai economy in 2015 would grow by about 4 percent. The digital economy in the industrial sector, SME operators would be urged to adopt e-business as a new channel for their business operations. "Digital economy" refers to an economy that is based on digital technologies, which are rapidly transforming both business practices and societies. The Thai government is giving a boost to the digital economy in order to enhance the competitiveness of the Thai industrial sector and prepare Thailand for the ASEAN Economic Community. In response to this policy, entrepreneurs and operators of the digital business will be created and developed, so that they will become a driving force for the country's productivity.

Keynote Speech

The Conduct of Dissertation:

The questions must be answered is

how the discovered models can be really used

Asst. Prof. Dr. Banpot Wiroonratch

Mostly research methodology for social sciences are carried out in three steps. 1. What is the original idea? 2. What is the problem found? 3. What the new idea is. Whenever you can answer these questions you can complete you research. Addition, the used sample size and statistic should be suitable as well.

Keynote Speech

Understanding Privacy

Ben Gerber

Data is driving opportunity and increasing quality of life across the world. To realize these opportunities, organizations must demonstrate they are trustworthy and value privacy as a social good by handling data responsibly.

What is privacy? Where do privacy expectations originate from? What does your organization need to do to respect privacy, and meet or exceed the expectations of customers, constituents and regulators? This session will provide the audience with an understanding of international privacy concepts, legal and regulatory requirements and best practices.

Conference Agenda

The 2nd Management and Innovation Technology International Conference (MITiCON2015)

16 - 18 November 2015, Bangkok, Thailand

Grand Mercure Bangkok Fortune Hotel

November 16, 2015		
4:30 pm to 6:30 pm	**Registration and Reception Lobby, Fl.1**	
November 17, 2015		
8:30 am to 10:00 am	**Registration and Reception Room: Grand Mercure 4, Fl.3**	
9:30 am to 10:00 am	**Opening Ceremonies Room:Grand Mercure 4, Fl.3**	
10:00 am to 10:45 am	**Keynote Speech-I Presenter:Dr. Smitti Darakorn Na Ayutthaya Topic:Digital Economy Room:Grand Mercure 4, Fl.3**	
10:45 am to 11:00 am	*Coffee Break*	
11:00 am to 11:30 am	**Keynote Speech-II Presenter:Asst. Prof. Dr. Banpot Wiroonratch Topic:The Conduct of Dissertation (presented in Thai) Room:Grand Mercure 4, Fl.3**	
11:30 am to 1:00 pm	**Lunch Location: One Rachada, Fl. G**	
1:00 pm to 5:30 pm	**PRESENTATION**	
1:00 pm to 2:15 pm	**Track-IM1 Information Technology and Innovation Management Session Chair: *Asst. Prof. Dr. Adisorn Leelasantitham* Room: Grand Mercure 3, Fl.3**	**Track-EM&PS Educational Management & Policies Management and Social Aspects Session Chair: *Dr. Sarunya Lertputtarak* Room: Grand Mercure 4, Fl.3**
1:00 pm to 1:15 pm	**IM-044** IT Management for SCM and Logistics in Agricultural Product Industry *Thongchai Surinwarangkoon*	**PS-026** Personal Factors Affecting Visionary Leadership for Supply Chain Management in the Manufacture Industrial of Thailand: An Empirical Study *Kasem Bunnoiko, Walailak Atthirawong*
1:15 pm to 1:30 pm	**IM-066** Requirement Prioritization for Software Release Planning Based on Customer Value with Analytic Hierachy Process *Alissara Chindapornsopit, Taweesak Samanchuen*	**PS-025** "Facebook" a Dreamlike Stage: Big Data Features, Performance, and Neoliberal Economic Approaches *Sustarum Thammaboosadee, Rubkwan Thammaboosadee, Sotarat Thammaboosadee*
1:30 pm to 1:45 pm	**IM-056** A Truck Tires Usage Worthiness Prediction Model *Nakarin Prateeppattanatumrong, Sotarat Thammaboosadee*	**EM-054** Constructing a Risk Behavior Guideline for Adolescent Students using Decision Tree *Surin Aunsan, Sotarat Thammaboosadee*
1:45 pm to 2:00 pm	**IM-075** The Hierarchical Technology Valuation Model for Big Data Technology Applied in Recruitment *Thiti Noydee, Sotarat Thammaboosadee*	**EM-057** Analyzing the Characteristics of Maths and English Tablet-based Games for Primary School Children *Hsu Nang, Antony Harfield, Ratchada Viriyapong*
2:00 pm to 2:15 pm	**IM-086** Of Online Community: Clustering Group of Compatible Mentor and Mentee *Pratya Nuankaew, Punnarumol Temdee*	**EM-027** A Study of Relationships of Attitudes and Behaviors towards to Usage of Google Translate of IT Students *Onwara Thanongsaksakul, Sotarat Thammaboosadee, Rubkwan Thammaboosadee*
2:15 pm to 2:30 pm	*Coffee Break*	
2:30 pm to 4:00 pm	**Track-IM2 Information Technology and Innovation Management Session Chair: *Emeritus Prof. Lance Fung* Room: Grand Mercure 3, Fl.3**	**Track-EM Educational Management Session Chair: *Dr. Jean Paolo G. Lacap* Room: Grand Mercure 4, Fl.3**

2:30 pm to 2:45 pm	**IM-062** Analysis of Global Mobile Device in Thailand *Panyaphat Aekitsawatwikul, Adisorn Leelasantitham, Supaporn Kiattisin, Smitti Darakorn Na Ayuthaya*	**EM-049** Application of BIM into Civil Engineering Management Class *Thoedtida Thipparat, Narong Chaisongkroh, Nonthachart Kulprapa, Thongpoon Thaseepetch*
2:45 pm to 3:00 pm	**IM-055** CRM Strategies discovered by Clustering Technique and Business Intelligence; case study in Chemical Industry *Thanakal Yotsomsak, Sotarat Thammaboosadee*	**EM-050** Application of QFD to Design a Course in Building Information Modeling (BIM) *Thoedtida Thipparat, Narong Chaisongkroh, Nonthachart Kulprapa, Sunantha Srisopha*
3:00 pm to 3:15 pm	**IM-005** Information Format-Shopping Orientation Fit in Mobile Commerce App: A Contradiction between Functional and Psychological Consequences *Chiang-Yu, Cheng, Yu-Tsu Lin, Chih-Wei, Cheng*	**EM-016** The Preparation of Vietnamese Students at Burapha University for Asean Economic Community (AEC) Skilled Labour Market *Chinh Bui Xuan, Saranya Lertbuddharak, Sirinya Chokchaiworarat*
3:15 pm to 3:30 pm	**IM-009** A Web-and-Android-Based Crime Data Retrieval System: A Case Study: Investigation Sub-Division Chiangrai Police Station *Thammavich Wongsamerchue, Wimol San-Um*	**EM-002** A Framework for Empowering Teachers to Author Interactive Content for Tablet Classroom Activities *Siwawes Wongcharoen, Jaratsri Rungrattanaubol, Antony Harfield*
3:30 pm to 3:45 pm	**IM-053** Semantic Ontology for Fine Arts Knowledge Management *Wassana Ouppala, Sotarat Thammaboosadee*	**EM-087** Classification of Basic Computer Skills for Skill Based Online Learning *Sataworn Chaichumpa, Santichai Wicha, Punnarumol Temdee*
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4:00 pm to 5:30 pm	**Track-EG** **Engineering, Science, and Technology Management** **Session Chair: *Prof. Dr. B. K. Pal*** **Room: Grand Mercure 3, Fl.3**	**Track-IT1** **Computer Engineering, Computer Science, Information Technology,and Software Engineering** **Session Chair: *Dr. Taweesak Samanchuen*** **Room: Grand Mercure 4, Fl.3**
4:00 pm to 4:15 pm	**EG-068** Occupational Health Hazards Vis-à-vis Industrial Safetyand Environmental Degradation – Case Studies *Dr. B. K. Pal, Sunil Kumar Bisoyi, Deepak Majhi, Susil Kumar Bisoyi*	**IT-061** Efficient Compact Join Algorithm for Acyclic Conjunctive SPARQL *Jaesung Lee, Dongguk Kim, Kyungsun Kim, Hanmin Jung*
4:15 pm to 4:30 pm	**EG-071** Optimal routing model for multi modal transportation *Thanawat Bamrungthai, Supaporn Kiattisin, Smitti Darakorn Na Ayuthaya*	**IT-070** A Development of Efficient Routing Algorithm Applied in Transportation Networks *Tun Tun Naing, Sunantha Sodsee*
4:30 pm to 4:45 pm	**EG-063** The Development of Distributed Sensors Network for Measurement of Thermal Comfort in Academic Classroom *Wipawadee Wongsuwan, Wimol San-Um*	**IT-065** A Verification of Instantaneous Acoustic Emission Signals Based on ASTM E976-94 Standard through Short-Time Fourier Transform Method *Jirayu Samkunta, Wimol San-Um*
4:45 pm to 5:00 pm	**EG-001** A Structural Equation Model Development of Environmental Performance and Economic Performance of The Electrical and Electronics Industry in Thailand *Surin Wichchuwong, Vinai Panjakajornsak, Amnuay Saengnoree*	**IT-064** An Image Encryption Scheme and Its Android Application using Robust Chaotic Map with Absolute Value Nonlinearity *Sivapong Nilwong, Wimol San-Um*
5:00 pm to 5:15 pm	**EG-038** Application of AHP and VIKOR for Chemical Product Selection *Thoedtida Thipparat, Narong Chaisongkroh*	**IT-039** Emotion Recognition using EEG data with a Multiple Classification Framework *Anuchin Chatchinarat, Chun Che Fung, Kok Wai Wong*
5:15 pm to 5:30 pm	**EG-051** 4D Application for Energy Building Project *Thoedtida Thipparat, Narong Chaisongkroh*	**IT-032** Improving Classification Performance with Complementary Fuzzy-Based Neural Networks *Ratchakoon Pruengkarn, Chun Che Fung, Kok Wai Wong, Worapat Paireekreng*
5:30 pm to 5:45 pm	**EG-090** Design of Thermoelectric-Based Cooling System used for Portable Application *Teerapon Thongpasri, Surapong Pongyupinpanich*	
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November 18, 2015	
8:30 am to 9:00 am	**Registration and Reception** **Room: Grand Mercure 4, Fl.3**
9:15 am to 11:45 am	**MORNING PRESENTATION**

9:15 am to 10:30 am	**Track-EA&IT** **Enterprise Architecture, IT Corporate Management, and IT Governance** **Session Chair: *Prush Sa-Nga-Ngam*** **Room: Grand Mercure 3, Fl.3**	**Track-BM1** **Business, Marketing, Strategic, and Financial Management** **Session Chair: *Asst. Prof. Dr.Yordying Thanatawee*** **Room: Grand Mercure 4, Fl.3**
9:15 am to 9:30 am	**EA-030** The Factors Affecting to Acceptable Behaviors of Enterprise Resource Planning *Mathuros Panmuang, Chonnikarn Rormorn, Khuanwara Potiwara*	**BM-010** The Use of Social Media for Corporate Disclosure by Companies Listed in the GCC *Ehab K. A. Mohamed, Mohamed A. K. Basuony*
9:30 am to 9:45 am	**EA-074** Economic Analysis of the Information System Investment Using Cost and Benefit Analysis (CBA) Method *Leo Willyanto Santoso, Yulia, Imelia Widjanadi*	**BM-014** A Study of the Core Competencies Affecting the Performance of Security Investment Consultant at Security Companies in the Stock Exchange of Thailand *Phatre Friestad*
9:45 am to 10:00 am	**EA-076** IT Investment Evaluation Using Multi Objective Multi Criteria: Case Study on an Expedition Company *Yulia, Leo Willyanto Santoso, Danny Tantra*	**BM-034** Employee or Employer? Entrepreneurial Perspectives of Tourism Management Students of a Higher Education Institution in Angeles City, Philippines *Darriel B. Mendoza, Jean Paolo G. Lacap*
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10:15 am to 10:30 am	**IT-033** Management of Internet Bandwidth Using Machine Learning Technique *Hari Suparwito, Hong Xie, Chun Che Fung, Shri Rai*	**BM-045** The Role of Regulatory Focus on Promotional Mental Accounts *Pei-Ru, Li, Po-Shun, Chen, Chia-Jung Chang*
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11:00 am to 11:15 am	**IT-079** Comparison Between Shape-based And Area-based Features Extraction for Java Character Recognition *Rudy Adipranata, Gregorius Satia Budhi, Liliana, Bondan Sebastian*	**BM-040** A Causal Model of Innovation Capability, Market Orientation and Absorptive Capacity Affecting Competitive Advantage of Thailand Rubber Industry *Prapapan Mantam, Vinai Panjakajornsak*
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11:45 am to 12:00 pm	**IT-069** Applying Item Category Rating in Recommendation Systems *Thanaphon Phukseng, Nawaporn Wisitpongphan, Sunantha Sodsee*	**BM-035** Value Analysis of Cyber Security Based on Attack Types *Mehrnaz Akbari Roumani, Chun Che Fung, Shri Rai, Hong Xie*
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1:00 pm to 1:30 pm	**Keynote Speech-III** **Presenter: Ben Gerber** **Topic: Understanding Privacy** **Room:Grand Mercure 4, Fl.3**	
1:45 pm to 4:15 pm	**LOCAL PRESENTATION (Thai Tracks)**	
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2:45 pm to 3:00 pm	*Coffee Break*	
3:00 pm to 3:15 pm	**TT-081** การเปรียบเทียบคุณลักษณะและประสิทธิภาพเครื่องแม่ข่ายเสมือนแบบก้อนเมฆของศูนย์ข้อมูลกลาง Uninet ระหว่าง ยูคาลิปตัสคราวด์และไมโครซอฟท์ซิสเต็มเซ็นเตอร์ 2012 *ศรัด จันทร์ไกร, สุภาภรณ์ เกียรติสิน, อดิศร ลีลาสันติธรรม, สมิทธิ ดาราภร ณ*	**TT-089** การวิเคราะห์สมรรถนะการทำงานของโรงไฟฟ้าพลังงานร่วม: กรณีศึกษา *อัญชิตา จิตตามัย, สุเมธ เนติสัตตานนท์*
3:15 pm to 3:30 pm	**TT-004** การเปรียบเทียบประสิทธิภาพการทำงานของ Extract, Transform and Loading (ETL) โดยใช้ต้นไม้การตัดสินใจและตรรกศาสตร์คลุมเครือ *ณัฐพล นาคบัวแก้ว, สุภาภรณ์ เกียรติสิน, อดิศร ลีลาสันติธรรม, โชษาศรัดต ธรรมบุษดี สมิทธิ ดาราภร ณ อยุธยา*	**TT-018** มาตรฐานการบริการคนไร้ที่พึ่งนนทบุรี ในสถานแรกรับคนไร้ที่พึ่งนนทบุรี *ณัฐสิมี วรัตน์กลบันทร์, นพดล เดชประเสริฐ*
3:30 pm to 3:45 pm	**TT-023** การบริหารจัดการที่ส่งผลต่อการมีส่วนร่วมในการพัฒนาสถานทำงานน่าอยู่ น่าทำงานของพนักงานและข้าราชการ สำนักนโยบายและยุทธศาสตร์ สำนักงานปลัดกระทรวงสาธารณสุข *สโรชิน สหสาคร, สุชนนี เมธิโยธิน*	**TT-022** แนวทางการปฏิบัติงานในการเข้าถึงมวลชนของหน่วยทหารระดับกองร้อยในพื้นที่หน่วยเฉพาะกิจยะลา ระหว่างปี 2552 - 2557 *วาทินี สุวรรณรักษ์, สุชนนี เมธิโยธิน*
3:45 pm to 4:00 pm	**TT-091** การลดสัญญาณรบกวนข้ามช่องใน VLSI Design โดยใช้ทฤษฎีกบกระโดด *อดิศักดิ์ จีบคำพล, นุสรา ฮวดโพธิ์พันธ์, อภิชาต ดีรประเสริฐสิน*	**TT-092** การจัดวางโครงสร้าง VLSI Chip เพื่อลดเส้นทางการเชื่อมต่อโดยใช้ทฤษฎีกบกระโดด *วิไลพร แหว่กระโทก, สิทธิพงศ์ ชวนโพธิ์, พรภัสสร อ่อนเกิด, อภิชาต ดีรประเสริฐสิน*
4:00 pm to 4:15 pm	**TT-094** Designing the Governance and Measurement Model for Thailand Mobile Connect Service by Utilising the TM Forum eTOM and ISO 38500 Framework *Mahasak Pijittum , Supaporn Kiattisin, Smitti Darakorn Na Ayuthaya*	**TT-093** การออกแบบจัดวางผังโรงงานเพื่อลดขั้นตอนการเดินทางโดยใช้เทคนิคซัฟเฟิลฟรอกลิปปิง *อนัญญา ศรีวงษ์, สิรินทิพย์ วันจันทึก, ประกาย นาคี, อภิชาต ดีรประเสริฐสิน*

Comparison between Shape-Based And Area-Based Features Extraction For Java Character Recognition

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***Abstract*— Java language is one of the local languages are widely used in Indonesia. Java language is widely used by resident of the island of Java. Java language has special character called Java character. In this research we compare features extraction which will be used to perform the recognition of Java character. The accuracy of recognition is greatly affected by accuracy of features extraction. Because if there are a lot of similar features between one character with other characters, may cause the system to recognize as the same characters. In this research we compare between shape-based features and area-based features. Shape-based features consist of curves, lines and loop composing a Java character. The number of curves, lines and loop will vary between characters with other characters. For area-based features extraction, each character divide into 9x9 equal regions. In each region, the number of pixels will be calculated. From experimental results, area-based features extraction gives better result than shape-based features extraction. This experiment is done by using probabilistic neural network (PNN) as a method of recognition. By using shape-based features extraction, the system only has recognition accuracy below 20%, but using area-based features extraction, the recognition accuracy can achieve more than 60%.**

***Keywords*— Shape-based feature extraction, area-based feature extraction, probabilistic neural network.**

I. INTRODUCTION

Indonesia is a nation composed of many ethnic groups. Each ethnic has its own culture. One ethnic is Javanese who mostly lived on the island of Java. Javanese has a culture which covers language, writing, dancing, food, etc. In writing, Javanese has its own form of letters referred to the character of Java. Learning of Java characters has its own difficulty level because Java character consist of so many symbols, categorized as basis characters, vowels, complementary, and so on. Because it is difficult to learn, then lately not many people can do the writing or reading of Java characters. In this research we will try to preserve the Javanese character by developing a system to recognize Java character automatically.

One of the most important parts of the Java character recognition is feature extraction. The accuracy of recognition is greatly affected by accuracy of features extraction. Because if there are a lot of similar features between one character with other characters, may cause the system to recognize as the same characters. In this research we compare between shape-based features and area-based features. Shape-based features consist of curves, lines and loop composing a Java character. The number of curves, lines and loop will vary between characters with other characters [1]. To detect shape-based features, flood fill algorithm, Hough transform [2,3,4] will be used. For area based features extraction, each character divide into nine equal regions. In each region, the number of pixels will be calculated [5].

Before doing features extraction, several image preprocessing have been applied. The first one is skeletonization and followed by image segmentation. Skeletonizing is one of image processing that is used to reduce the pixels of an image while maintaining information, characteristic and important pixels of the object. The purpose of skeletonizing is to make simpler image so that the image can be analyzed further in terms of shape and suitability for comparison with other images. This is implemented by changing the initial image in binary into skeletal representation of the image [2]. The next preprocessing is image segmentation. Image segmentation is done to get a piece of each Java character.

II. JAVA CHARACTER

Java characters have 20 basis characters, 20 characters who serve to close vowel (called *pasangan*), 8 main characters (called *murda*) used to write the beginning of sentences and words that show proper names, titles, cities, institutions, and other names, some complimentary (called *sandhangan*) as vowels, special characters, punctuation, etc.

Basis character can be seen in Fig. 1 [6].

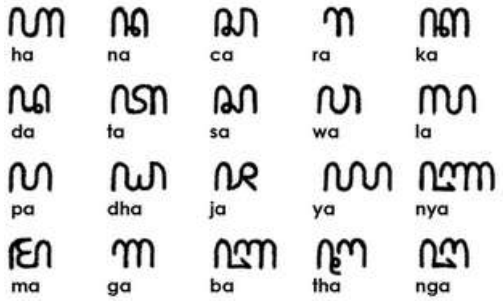

Fig. 1. Basis Java Character.

Main characters that used to write the beginning of sentences or names of person can be seen in Fig. 2 [7].

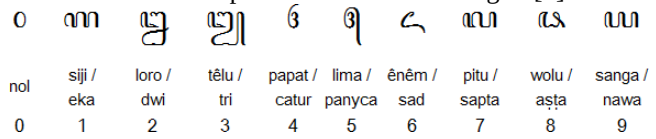

Fig. 2. Main Java Characters.

Some complementary especially for vowels can be seen in Fig. 3 [8].

Java character	Description	*Sandhangan* name
	Vowel i	*Wulu*
	Vowel u	*Suku*
	Vowel é	*Taling*
	Vowel ê	*Pepet*
	Vowel o	*Taling tarung*

Fig. 3. *Sandhangan* Character for Vowels.

III. Skeletonizing

Skeletonizing is one of image processing that is useful for reducing pixel of an image (binary image), but may still retain the information, and the characteristics of the object that is on the image. There are several methods that can be used to implement skeletonizing, one of which is a method proposed by Zang-Suen [5]. The basic idea is to determine whether a pixel could be eroded just by looking at the eight neighbors of the pixel. The eight neighbors and the pixel can be seen in the Fig. 4.

8	1	2
7	X	3
6	5	4

Fig. 4. Pixel and Its Eight Neighbors.

To determine whether a pixel can be removed or not, there are two requirements. The first requirement is as follows [1]:

- If pixel has more than one and less than 7 neighbors, then it can be removed.
- If pixel has the only one connectivity, then it can be removed.
- If at least one of the neighbors who are in the direction of 1, 3, or 5 is a background pixel, the pixel can be removed.
- If one of the neighbors who are in the direction of 3, 5, or 7 is a background pixel, the pixel can be removed.

The second requirement differs from first requirement in the last two steps:

- If at least one of the neighbors who are in the direction of 7, 1, or 3 is a background pixel, the pixel can be removed.
- If one of the neighbors who are in the direction of 1, 5, or 7 is a background pixel, the pixel can be removed.

The first step on the above steps can be written as a logical expression in (1).

$$v(X) \wedge (\sim edge(X) \vee (v(d3) \wedge v(d5) \wedge (v(d1) \vee v(d7)))) \quad (1)$$

While the second step on the above steps can be written as a logical expression in (2).

$$v(X) \wedge (\sim edge(X) \vee (v(d7) \wedge v(d1) \wedge (v(d5) \vee v(d3)))) \quad (2)$$

X indicates the pixel being examined. V function generates the pixel value (1 = true for foreground pixels and 0 = false for pixel background). Edge function is true if X at the end of the object (referring to the number of neighbors of more than one and less than seven and the number of connectivity = 1). d1, d3, d5, and d7 referring to the neighbors pixels in a certain direction to the pixel X as seen in Fig. 4.

IV. Feature Extraction

Feature extraction is the process of finding a mapping from original features into new features that is expected to give better result for class differences [9]. Feature extraction is an important topic in the classification, because the good features will be able to increase the rate of accuracy, while features that are not well tended will decrease the rate of accuracy.

In this research we will use and compare shape-based and area-based feature extraction. For shape-based, consist of curves, lines and loops that composed one Java character. While for area-based, image of Java character divided into small areas and the number of pixel in each area will be calculated.

A. Flood Fill Algorithm

Flood fill algorithm is used to detect a loop or closed curve. It has three main parameters, namely the start node, the target color and color replacement. Flood fill algorithm searches all nodes in the array which are connected to the start node through the path of the target color and then replace it with a replacement color. The following steps below are flood fill based algorithm by using recursion [5]:

1. Return if the node doesn't have same color as the target
2. Set the nodes color into a replacement color.
3. Run flood fill one step from the node to the west.
   Run flood fill one step from the node to the east.
   Run flood fill one step from the node to the north.
   Run flood fill one step from the node to the south.
4. Return.

B. Hough Transform

Hough Transform is used to detect shape in the image, e.g. line or curve. Hough Transform was first proposed by P.V.C Hough [3], and then Duda and Hart have implemented it to detect the lines in the image [4].

Hough Transform maps the points in the image into the parameter space (Hough Transform space) based on a function that defines the shape that wants to be detected. Then the algorithm takes a vote on an array element called the accumulator array. The straight lines that will be detected by Hough Transform should satisfy (3) and (4).

$$y = a\,x + b \tag{3}$$

$$b = -x_1\,a + y_1 \tag{4}$$

By changing (3) to (4), each edge point *(x, y)* on an image will result in single line equation parameters *(a, b)*. The points on the same line will have the value of the parameter that cross at a point *(a, b)* in the parameter space as shown in Fig. 5.

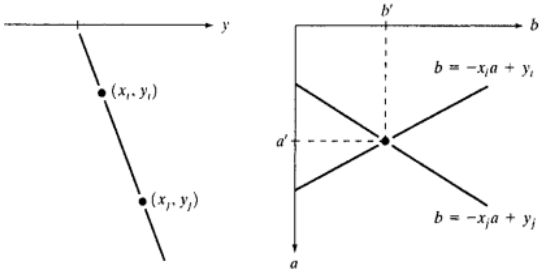

Fig. 5. (a) xy Area (b) Parameter space.

First, the value of the accumulator is initialized to 0. The edge of the object in the image, for each point *(x, y)*, the value of *b* is calculated according to Equation 4. The result is to be rounded to the nearest acceptable value in accumulator. Accumulator value will increase for each appropriate value *a* and value *b* according to (5).

$$A(a, b) = A(a, b) + 1 \tag{5}$$

Each edge point has appropriate line parameter mapped in the accumulator. The higher the value in the accumulator, the greater the likelihood of a line is detected in the image. A polar equation for a line with a parameter ρ and orientation θ has been proposed by Duda and Hart [4] as seen in (6).

$$\rho = x\,\cos\theta + y\,\sin\theta \tag{6}$$

Each point in the image is mapped into the accumulator for each value ρ and θ which satisfy (7).

$$A(\rho, \theta) = A(\rho, \theta) + 1 \tag{7}$$

The illustration of this mapping can be seen in Fig. 6.

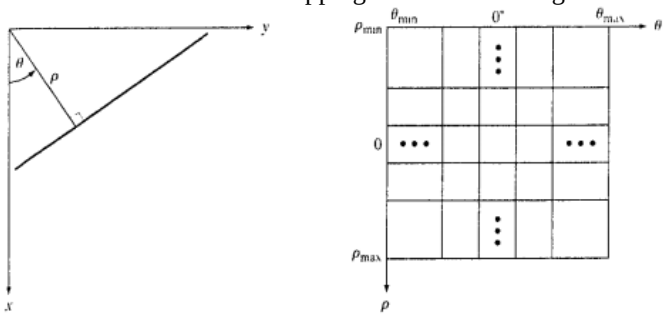

Fig. 6. (a) Representasi normal suatu garis. (b) Parameter space (ρ, θ).

The range of values for the angle θ is ± 90 as measured by the x-axis. While the range of values of ρ is $\pm\sqrt{2}\,D$, where D is the distance between the vertex on the image [2].

Hough Transform can be used also to detect a parabolic curve. This was proposed by M.Z. Mat Jafri and F. Deravi [10]. There are four parameters involved, namely the point (x_0, y_0), orientation (θ), and the coefficient which contains information about the parabolic curvature in standard parabolic curve detection. But this algorithm can detect parabolic curve in any orientation using only three parameters [10]. The parameters are the point (x_0, y_0) and orientation θ. In this algorithm, by using 3D accumulator, all parabolic curves in various positions can be detected. The approach uses a point on the curve as a parameter which also shows the position of maximum curvature of the parabolic curve. For the gradient approach, Sobel operator is used. A coordinate transformation matrix is used to derive a new parabolic equations involving parabolic curve orientation to detect the parabolic curve in any orientation. Fig. 7 shows the graphic of parabolic curve with a specific orientation angle.

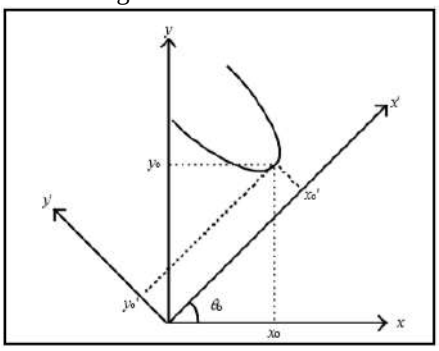

Fig. 7. Parabolic Curve.

(x', y') coordinates is the (x, y) coordinates rotation by θ degrees with the center coordinate system as the axis of rotation. The vertex of parabola is (x_0', y_0') at the (x', y') coordinates or (x_0, y_0) in the (x, y) coordinates. Equation (8) is equation of the parabola in the (x', y') coordinates [10].

$$(y' - y_0') = p\,(x' - x_0')^2 \tag{8}$$

Equation (9) is standard two dimensional geometry matrix for counter-clockwise rotation with θ angle transformation.

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} \tag{9}$$

By substituting the value of x, y, x0 and y0 in (9) to (8), the parabolic (8) can be written as (10).

$$\begin{aligned} &(-x\sin\theta + y\cos\theta) - (-x_o\sin\theta + y_o\cos\theta) \\ &= p\,[(x\cos\theta + y\sin\theta) - (x_o\cos\theta + y_o\sin\theta)]^2 \end{aligned} \tag{10}$$

The value of differentiation of this equation is

$$\begin{aligned} &-\sin\theta + \frac{dy}{dx}\cos\theta \\ &= 2p\,[(x\cos\theta + y\sin\theta) - (x_o\cos\theta + y_o\sin\theta)]\,.\left[\cos\theta + \frac{dy}{dx}\sin\theta\right] \end{aligned} \tag{11}$$

By substituting (11) into (10), a new relation to the parabola vertex and the orientation (x_0, y_0, θ) is shown in (12) [6].

$$\begin{aligned} y_o = &\left[\frac{k_1(x\cos\theta + y\sin\theta) + (x\sin\theta - y\cos\theta)}{k_1(\sin\theta - \cos\theta)}\right] \\ &-\frac{(k_1\cos\theta + \sin\theta)}{(k_1\sin\theta - \cos\theta)}\,x_o \end{aligned} \tag{12}$$

where k_1 is

$$k_1 = \frac{-\sin\theta + \frac{dy}{dx}\cos\theta}{2(\cos\theta + \frac{dy}{dx}\sin\theta)} x_o \quad (13)$$

Using the above relationship, parabola detection in various orientations can be done using only three dimensional accumulator arrays.

V. System Design

The system design is done by using a flowchart, which can be seen in Fig. 8.

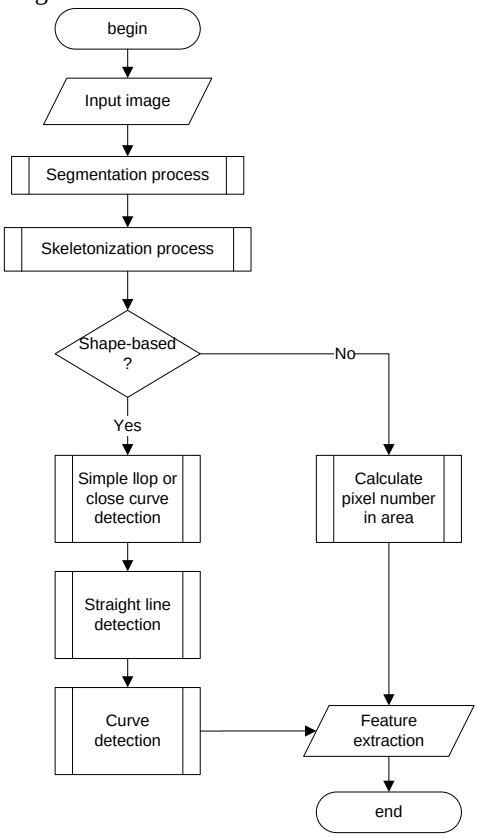

Fig. 8. System Design.

Before doing feature extraction, image segmentation first performed to obtain an image of each Java character. Then, after the obtained images that contain only one Java character, skeletonizing is done in order to get the Java character with a thickness of one pixel. From the results of skeletonizing, then feature extraction will be done either based on shape-based or area-based.

For shape-based feature extraction, the process will detect loop, lines, and curves that form Java character. For each of Java character, is divided into two segment, upper segment and lower segment. For each segment, the number of detected loop, line and curve is calculated. Those numbers are features that will be used as input to the Java character recognition. For each of Java character there will be seven features from shape-based feature extraction: number of total loop, number of loop in upper segment, number of loop in lower segment, number of line in upper segment, number of line in lower segment, number of curve in upper segment and number of curve in lower segment.

In the area-based feature extraction, the first step is to resize the image of each Java character to become 81 x 81 pixels. Then the image that has been resized, divided into 9x9 regions. So in total there are 81 regions with the size of each area is 81 pixels. The number of black pixels in each area is calculated, and the results of these calculations are features that will be used later in the process of Java character recognition. There are total 81 features from area-based feature extraction.

For recognition process, probabilistic neural network (PNN) algorithm is used. This method is used because PNN has a high accuracy in the classification of data, also has high speed when performing the process [11].

VI. Experimental Results

Ten images of Java character are used in experiment. In each images, all Java characters divided into two, for training and for classification. All of them are processed with shape-based feature extraction and area-based feature extraction. The results of recognition rate are compared between them.

Example of shape-based feature extraction result can be seen in Fig. 9.

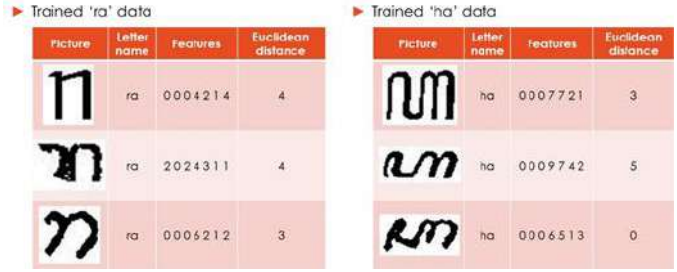

Fig. 9. Example of Shape-based Feature Extraction

Experiment result of shape-based feature extraction for Java character recognition using PNN method can be seen in Table 1.

TABLE I RECOGNITION RESULT OF PNN USING SHAPE-BASED FEATURE EXTRACTION

No.	Image	Number of Java Character for Training	Number of Java Character for Classification	Accuracy (%)
1	Image 1	60	136	15.44
2	Image 2	46	110	16.36
3	Image 3	57	79	20.25
4	Image 4	61	222	23.42
5	Image 5	51	126	22.22
6	Image 6	28	27	29.63
7	Image 7	59	153	15.69
8	Image 8	43	87	16.09
9	Image 9	56	142	14.79
10	Image 10	15	10	30.00
Average				**18.77**

From experimental result in Table 1, it can be seen that accuracy rate is only 18.77, below 20%. For experiment using

area-based feature extraction, can achieve accuracy rate 61.08%. The result can be seen in Table 2.

TABLE II RECOGNITION RESULT OF PNN USING AREA-BASED FEATURE EXTRACTION

No.	Image	Number of Java Character for Training	Number of Java Character for Classification	Accuracy (%)
1	Image 1	60	136	63.24
2	Image 2	46	110	49.09
3	Image 3	57	79	54.43
4	Image 4	61	222	56.76
5	Image 5	51	126	64.29
6	Image 6	28	27	55.56
7	Image 7	59	153	66.01
8	Image 8	43	87	75.86
9	Image 9	56	142	62.68
10	Image 10	15	10	60.00
Average				**61.08**

From the results of this experiment, although it can be concluded that the area-based feature extraction is better, but the results of the recognition is still not satisfactory, because it only reached slightly above 60%. Further research can be done using another recognition method to obtain better recognition results.

VII. CONCLUSIONS

From the experimental results, it can be concluded that the use of area-based feature extraction give better results than the use of shape-based feature extraction. By using PNN as a Java character recognition method, the use of area-based feature extraction can result in accuracy rate of over 60%, while the use of shape-based feature extraction can only result accuracy rate less than 20% accuracy rate. This is because many of Java characters that have number of shape features that are similar to each other.

ACKNOWLEDGMENT

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Nawaporn Wisitpongphan	King Mongkut's University of Technology North Bangkok	Thailand
Nitt Visesphan	Burapha University	Thailand
Nonthachart Kulprapa	Rajamangala University of Technology Tawan-Ok	Thailand
Nonthachart Kulprapa	Rajamangala University of Technology Tawan-Ok	Thailand
Onwara Thanongsaksakul	Mahidol University	Thailand
Panyaphat Aekitsawatwikul	Mahidol University	Thailand
Patcharanan Klankaew	King Mongut's Institute of Technology Ladkrabang	Thailand
Pei-Ru, Li	National Taiwan Normal University	Taiwan
Phatre Friestad	Burapha University	Thailand
Po-Shun, Chen	Chaoyang University of Technology	Taiwan
Prapapan Mantam	King Mongut's Institute of Technology Ladkrabang	Thailand
Pratya Nuankaew	Mae Fah Luang University	Thailand
Punnarumol Temdee	Mae Fah Luang University	Thailand
Ratchada Viriyapong	Naresuan University	Thailand
Ratchakoon Pruengkarn	Murdoch University	Australia
Roland Petrasch	Thammasat University	Thailand
Roman Hentschke	AMDIS Media and IT Services UG	Germany
Rubkwan Thammaboosadee	Bangkok University	Thailand
Rudy Adipranata	Petra Christian University	Indonesia
Sangjun Rattanee	King Mongkut's University of Technology Thonburi	Thailand
Santichai Wicha	Mae Fah Luang University	Thailand

Name	Organization	Country
Sarunya Lertputtarak	Burapha University	Thailand
Sataworn Chaichumpa	Mae Fah Luang University	Thailand
Shri Rai	Murdoch University	Australia
Silvia Rostianingsih	Petra Christian University	Indonesia
Sirinya Chokchaiworarat	Burapha University	Thailand
Sivapong Nilwong	Thai-Nichi Institute of Technology	Thailand
Siwawes Wongcharoen	Naresuan University	Thailand
Smitti Darakorn Na Ayuthaya	Mahidol University	Thailand
Sotarat Thammaboosadee	Mahidol University	Thailand
Sunantha Sodsee	King Mongkut's University of Technology North Bangkok	Thailand
Sunantha Srisopha	Rajamangala University of Technology Tawan-Ok	Thailand
Sunil Kumar Bisoyi	National Institute of Technology, Rourkela	India
Supaporn Kiattisin	Mahidol University	Thailand
Surapong Pongyupinpanich	Ramkhamhaeng University	Thailand
Surat Supitchayangkul	Burapha University	Thailand
Surin Aunsan	Mahidol University	Thailand
Surin Wichchuwong	King Mongut's Institute of Technology Ladkrabang	Thailand
Susil Kumar Bisoyi	R. G. Kar Medical College Kolkata	India
Sustarum Thammaboosadee	Thammasat University	Thailand
Taweesak Samanchuen	Mahidol University	Thailand
Teerapon Thongpasri	Ramkhamhaeng University	Thailand
Teewin Narunart	King Mongut's Institute of Technology Ladkrabang	Thailand
Thammavich Wongsamerchue	Thai-Nichi Institute of Technology	Thailand
Thanakal Yotsomsak	Mahidol University	Thailand
Thanaphon Phukseng	King Mongkut's University of Technology North Bangkok	Thailand
Thanawat Bamrungthai	Mahidol University	Thailand
Thiti Noydee	Mahidol University	Thailand
Thoedtida Thipparat	Rajamangala University of Technology Tawan-Ok	Thailand
Thongchai Surinwarangkoon	Suan Sunandha Rajabhat University	Thailand
Thongpoon Thaseepetch	Rajamangala University of Technology Tawan-Ok	Thailand
Tun Tun Naing	King Mongkut's University of Technology North Bangkok	Thailand

Name	Organization	Country
Vinai Panjakajornsak	King Mongut's Institute of Technology Ladkrabang	Thailand
Walailak Atthirawong	King Mongut's Institute of Technology Ladkrabang	Thailand
Wassana Ouppala	Mahidol University	Thailand
Werapon Chiracharit	King Mongkut's University of Technology Thonburi	Thailand
Wilailuk Khamloy	Burapha University	Thailand
Wimol San-Um	Thai-Nichi Institute of Technology	Thailand
Wipawadee Wongsuwan	Thai-Nichi Institute of Technology	Thailand
Worapat Paireekreng	Dhurakij Pundit University	Thailand
Yulia	Petra Christian University	Indonesia
Yulia	Petra Christian University	Indonesia
Yu-Tsu Lin	Chaoyang University of Technology	Taiwan
จรัสพงศ์ กาญจนลักษณ์	มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าพระนครเหนือ	Thailand
จิรพรรณ เลี่ยงโรคาพาธ	มหาวิทยาลัยมหิดล	Thailand
ณัฏฐพล นาคบัวแก้ว	มหาวิทยาลัยมหิดล	Thailand
ณัฐสินี วรัตน์กุลนันท์	มหาวิทยาลัยบูรพา	Thailand
ดำรงพล ชนะวรรณ	มหาวิทยาลัยมหิดล	Thailand
ตุลย์ ไตรยสรรค์	มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี	Thailand
เทอดพงษ์ แดงสี	มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าพระนครเหนือ	Thailand
ธีทัต ตรีศิริโชติ	มหาวิทยาลัยบูรพา	Thailand
นพดล เดชประเสริฐ	มหาวิทยาลัยบูรพา	Thailand
นุจรี ภาคาสัตย์	มหาวิทยาลัยบูรพา	Thailand
นุสรา ฮวดโพธิ์พันธ์	มหาวิทยาลัยเทคโนโลยีราชมงคลอีสาน	Thailand
ประกาย นาดี	มหาวิทยาลัยเทคโนโลยีราชมงคลอีสาน	Thailand
พงษ์พิสิฐ วุฒิดิษฐโชติ	มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าพระนครเหนือ	Thailand
พรพรรณ รักนาค	มหาวิทยาลัยบูรพา	Thailand
พรภัสสร อ่อนเกิด	มหาวิทยาลัยเทคโนโลยีราชมงคลอีสาน	Thailand
ภูวรินทร์ นิลรังษี	มหาวิทยาลัยบูรพา	Thailand
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รวี อาณานุการ	มหาวิทยาลัยบูรพา	Thailand
เรียม เขียนทอง	มหาวิทยาลัยบูรพา	Thailand
วาทินี สุวรรณรักษ์	มหาวิทยาลัยบูรพา	Thailand
วิไลพร แหว่กระโทก	มหาวิทยาลัยเทคโนโลยีราชมงคลอีสาน	Thailand
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ศรุต จันทรไกร	มหาวิทยาลัยมหิดล	Thailand
ศักดิ์ชาย จันทร์เรือง	มหาวิทยาลัยบูรพา	Thailand
โษฑศ์รัตต ธรรมบุษดี	มหาวิทยาลัยมหิดล	Thailand
สมิทธิ ดารากร ณ อยุธยา	มหาวิทยาลัยมหิดล	Thailand
สโรชิน สหสาคร	มหาวิทยาลัยบูรพา	Thailand
สิทธิพงศ์ ชวนโพธิ์	มหาวิทยาลัยเทคโนโลยีราชมงคลอีสาน	Thailand
สิรินทิพย์ วันจันทึก	มหาวิทยาลัยเทคโนโลยีราชมงคลอีสาน	Thailand
สุชนนี เมธิโยธิน	มหาวิทยาลัยบูรพา	Thailand
สุชนนี เมธิโยธิน	มหาวิทยาลัยบูรพา	Thailand
สุชนนี เมธิโยธิน	มหาวิทยาลัยบูรพา	Thailand
สุภาภรณ์ เกียรติสิน	มหาวิทยาลัยมหิดล	Thailand
สุเมธ คำงำเมือง	มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี	Thailand
สุเมธ เนติลัดดานนท์	มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี	Thailand
อดิศร ลีลาสันติธรรม	มหาวิทยาลัยมหิดล	Thailand
อติศักดิ์ จีบค้างพลู	มหาวิทยาลัยเทคโนโลยีราชมงคลอีสาน	Thailand
อนัญญา ศรีวงษ์	มหาวิทยาลัยเทคโนโลยีราชมงคลอีสาน	Thailand
อภิชาต ติรประเสริฐสิน	มหาวิทยาลัยเทคโนโลยีราชมงคลอีสาน	Thailand
อัญชิตา จิตตามัย	มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี	Thailand

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