

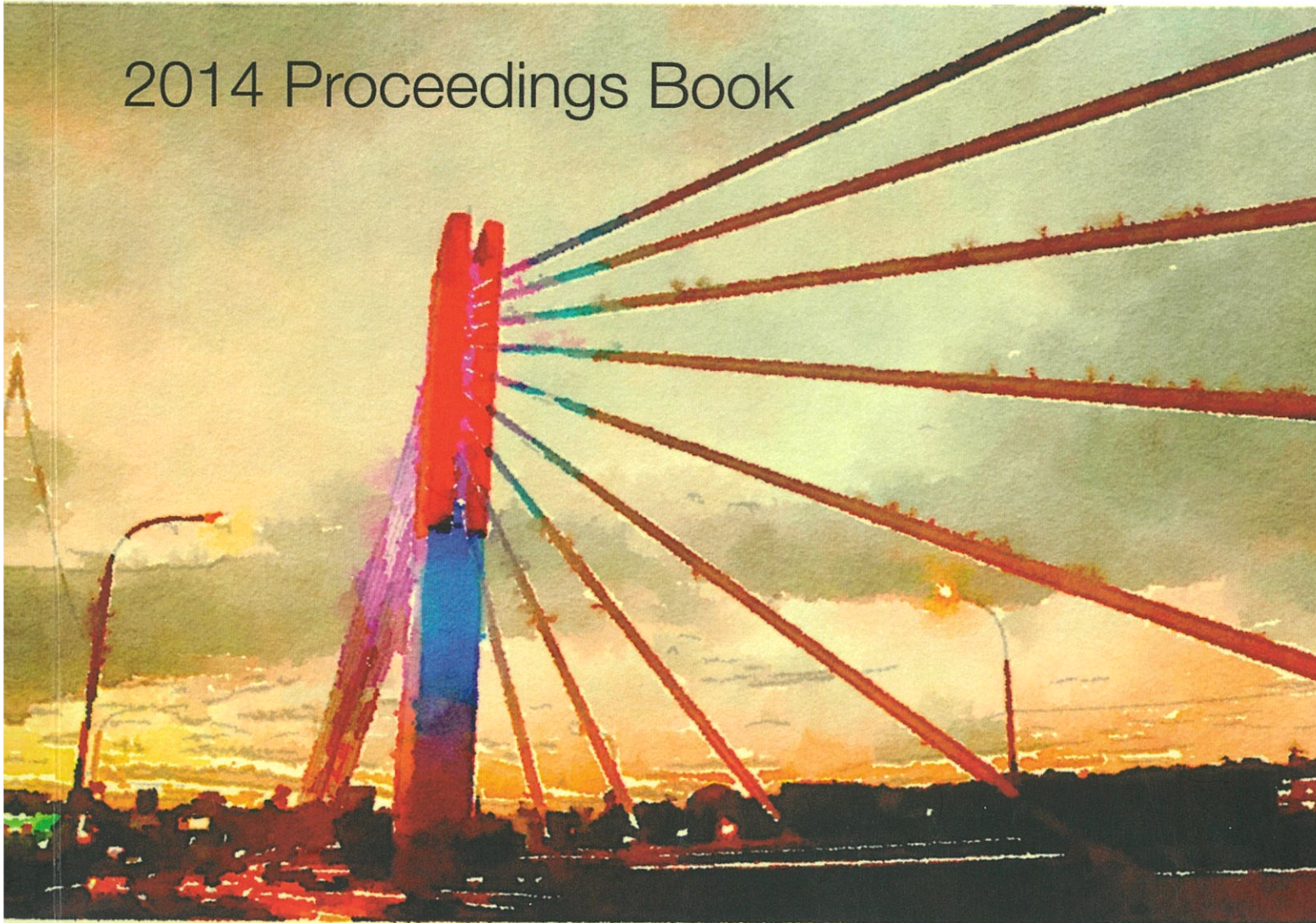


ICAICTA

International Conference on Advanced Informatics:
Concepts, Theory and Applications

20-21 August 2014, Institut Teknologi Bandung, Indonesia

2014 Proceedings Book



ISBN: 978-1-4799-6984-5

icaicta.stei.itb.ac.id



Sekolah Teknik Elektro & Informatika
Institut Teknologi Bandung



Proceedings

**International Conference on
Advanced Informatics: Concepts, Theory and
Applications (ICAICTA) 2014**

Institut Teknologi Bandung, Indonesia

20-21 August 2014

International Conference on Advanced Informatics: Concepts, Theory and Applications (ICAICTA) 2014

Copyright ©2014 by the Institute of Electrical and Electronics Engineers, Inc, All rights reserved.

Copyright and Reprint Permission

Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

Other copying, reprint or reproduction requests should be address to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, P.O. Box 1331 Piscataway, NJ 08855-1331.

IEEE Catalog Number CFP1450Y-PRT
ISBN 978-1-4799-6984-5

Additional copies of this publication are available from

Curran Associates, Inc
57 Morehouse Lane
Red Hook, NY 12571 USA
+1 845 758 0400
+1 845 758 2633 (FAX)
email: curran@proceedings.com

General Chair's Message

Welcome to the ICAICTA 2014.

It is a pleasure to host the ICAICTA 2014, the 2014 International Conference on Advanced Informatics: Concepts, Technology and Applications at Institut Teknologi Bandung (ITB) campus, Bandung, Indonesia. This conference is jointly organized by Informatics Research Group, School of Electrical Engineering and Informatics, Institut Teknologi Bandung and Toyohashi University of Technology. ICAICTA 2014 is also technically co-sponsored by IEEE Indonesia section.

The ICAICTA conference aims to bring together Indonesian, Japanese and international academicians, scientists and industrialists for knowledge sharing, exchange of ideas, collaborations and presentation of their research outcomes in informatics field. This year conference welcomes contributions for 4 tracks: Graphics, Image Processing and Intelligent Systems; High Performance Computing and Distributed Systems; Computational Science and Engineering; and Information Systems, Audit and Governance.

There were 165 submissions with authors from 11 countries around the world. All submissions were peer-reviewed (blind) by three reviewers drawn from external reviewers and the committees, and 78 papers are accepted for presentations.

Finally, as the General Chair of the Conference, I would like to express my deep appreciation to all members of the Steering Committee, Technical Programme Committee, Organizing Committee and Reviewers who have devoted their time and energy for the success of the event. A special thanks also for Prof. Seichi Nakagawa, Prof. Shigeki Nakauchi and all of our colleagues from Toyohashi University of Technology for their invaluable support and assistance.

For all participants, I wish you an enjoyable conference in this beautiful city of Bandung.

Achmad Imam Kistijantoro

General Chair of the ICAICTA 2014

Commitee

General Chair

Achmad Imam Kistijantoro (ITB, Indonesia)

Shigeki Nakauchi (Toyohashi University of Technology, Japan)

Steering Committee

Chair : Iping Supriana (ITB, Indonesia)

Seiichi Nakagawa (Toyohashi University of Technology, Japan)

Members : Ford Lumban Gaol (IEEE Indonesia)

Dwi Hendratmo (ITB, Indonesia)

Technical Program Committee

Chair : Rinaldi Munir (ITB, Indonesia)

Seiichi Nakagawa (Toyohashi University of Technology, Japan)

Co-chair : Shigeru Masuyama (Toyohashi University of Technology, Japan)

Ayu Purwarianti (ITB, Indonesia)

Members : Jun Miura (Toyohashi University of Technology, Japan), Masaki Aono (Toyohashi University of Technology, Japan), Hitoshi Isahara (Toyohashi University of Technology, Japan), Koichi Katsurada (Toyohashi University of Technology, Japan), Takaaki Takashima (Toyohashi University of Technology, Japan), Maarten de Rijke (University of Amsterdam, Netherland), Welly Naptali (Japan), A Min Tjoa (Technische Universitat Wien, Austria), Amin Anjomshooa (Technische Universitat Wien, Austria), Sakriani Sakti (NAIST, Japan), Norihide Kitaoka (Nagoya University, Japan), David Taniar (Monash University, Australia), Wei-Chu Teng (National Taiwan University of Science and Technology, Taiwan), Nasir Uddin (Victorian State IEEE CS chair, Australia), Ary Setijadi (Indonesia IEEE CS chair, Indonesia), Hans Dulimarta (Grand Valley State University, USA), Reza Ferrydiansyah (Microsoft Research, USA), Graham Morgan (Newcastle University, UK), Alberto Nakano (Univ of San Paulo, Brazil), Avan Suinesiaputra (University of Auckland, New Zealand), Kamal Zuhairi Zamli (Universiti Malaysia Pahang, Malaysia), Surya Afnarius (Andalas University, Indonesia), Oerip S. Santoso (Universitas Parahyangan, Indonesia), Setiadi Yazid (University of Indonesia, Indonesia), Dade Nurjanah (Telkom University, Indonesia), Ari M. Barmawi (Telkom University, Indonesia), Azhari (UGM, Indonesia), Dessi Puji Lestari (ITB, Indonesia), Rila Mandala (ITB, Indonesia), Benhard Sitohang (ITB, Indonesia), Kridanto Surendro (ITB, Indonesia), Siti Rochimah (ITS, Indonesia), Zainal Hasibuan (UI, Indonesia), Joko Lianto (ITS, Indonesia), Jazi Eko Istiyanto (UGM, Indonesia), Sri Nurdianti (IPB,

Indonesia), Benny Mutiara (Universitas Gunadarma, Indonesia), Fathul Wahid (UII, Indonesia), Anto Satrio Nugroho (BPPT, Indonesia)

Organizing Committee

Nur Ulfa Maulidevi (ITB, Indonesia)

Masayu Leylia Khodra (ITB, Indonesia)

Harlili (ITB, Indonesia)

Dicky Prima Satya (ITB, Indonesia)

Dody Dharma (ITB, Indonesia)

Toshihiro Fijito (Toyohashi University of Technology, Japan)

Shigeru Kuriyama (Toyohashi University of Technology, Japan)

Reviewers

Achmad Benny Mutiara	Gunadarma University
Achmad Imam Kistijantoro	Institut Teknologi Bandung
Akio Kobayashi	Toyohashi University of Technology
Alberto Nakano	UTFPR
Andriyan Suksmono	Institut Teknologi Bandung
Anto Nugroho	Swiss German University
Ari Barmawi	Universitas Telkom
Armein Langi	Institut Teknologi Bandung
Arry Akhmad Arman	Institut Teknologi Bandung
Arya Adriansyah	Technische Universiteit Eindhoven
Atsushi Tatsuma	Toyohashi University of Technology
Avan Suinesiaputra	University of Auckland, New Zealand
Ayu Purwarianti	Institut Teknologi Bandung
Azhari Azhari	Universitas Gadjah Mada
Baskara Nugraha	Institut Teknologi Bandung
Bayu Hendrajaya	Institut Teknologi Bandung
Dade Nurjanah	Universitas Telkom
Desi Lestari	Institut Teknologi Bandung
Dita Sardjono	ProMPTT Technologies, UK
Dwi Hendratmo	Institut Teknologi Bandung
Fazat Nur Azizah	Institut Teknologi Bandung
Graham Morgan	Newcastle University, UK
Hans Dulimarta	Grand Valley State University, US
Harry Budi Santoso	University of Indonesia
Hiroshi Higashi	Toyohashi University of Technology
Hitoshi Isahara	Toyohashi University of Technology
Husni Sastramihardja	Institut Teknologi Bandung
Inggriani Liem	Institut Teknologi Bandung
Iping Suwardi	Institut Teknologi Bandung
Jaka Sembiring	Institut Teknologi Bandung
Jun Miura	Toyohashi University of Technology
Kamal Zamli	Universiti Malaysia Pahang, Malaysia
Kazuho Watanabe	Toyohashi University of Technology
Kazumasa Yamamoto	Toyohashi University of Technology
Koichi Katsurada	Toyohashi University of Technology
Kridanto Surendro	Institut Teknologi Bandung

Masaki Aono	Toyohashi University of Technology
Masayu Leylia Khodra	Institut Teknologi Bandung
Michiteru Kitazaki	Toyohashi University of Technology
Naohiro Fukumura	Toyohashi University of Technology
Nasir Uddin	Victorian State IEEE CS Chair
Norihide Kitaoka	Nagoya University
Nur Ulfa Maulidevi	Institut Teknologi Bandung
Oerip Santoso	Institut Teknologi Bandung
Putri Saptawati	Institut Teknologi Bandung
Ren Ohmura	Toyohashi University of Technology
Reza Ferrydiansyah	Microsoft Research, USA
Rila Mandala	Institut Teknologi Bandung
Rinaldi Munir	Institut Teknologi Bandung
Saiful Akbar	Institut Teknologi Bandung
Sakriani Sakti	NAIST, Japan
Seiichi Nakagawa	Toyohashi University of Technology
Setiadi Yazid	University of Indonesia
Shigeki Nakauchi	Toyohashi University of Technology
Shigeru Kuriyama	Toyohashi University of Technology
Shigeru Masuyama	Toyohashi University of Technology
Siti Rochimah	Institut Teknologi Sepuluh November
Soleh Udin Al Ayubi	University of Pittsburgh
Suhardi	Institut Teknologi Bandung
Suharjito	Bina Nusantara University
Sukrisno Mardiyanto	Institut Teknologi Bandung
Takaaki Takashima	Toyohashi University of Technology
Tomoyoshi Akiba	Toyohashi University of Technology
Toshihiro Fujito	Toyohashi University of Technology
Welly Naptali	ATR, Japan
Widyawardana Adiprawita	Institut Teknologi Bandung
Wisnu Jatmiko	University of Indonesia
Wikan Danar	Institut Teknologi Bandung
Yasusi Kanazawa	Toyohashi University of Technology
Yasuyuki Sugaya	Toyohashi University of Technology
Yoanes Bandung	Institut Teknologi Bandung
Yudistira Asnar	Institut Teknologi Bandung

Contents

Development of Protection Profile and Security Target for Indonesia Electronic ID Card's (KTP-el) Card Reader Based on Common Criteria V3.1:2012 / SNI ISO/IEC 15408:2014	1
<i>Muhamad Erza Aminanto, Sarwono Sutikno</i>	
Comparison of Bidirectional Associative Memory, Counterpropagation and Evolutionary Neural Network for Java Characters Recognition	7
<i>Gregorius Satia Budhi, Rudy Adipranata</i>	
Development of Customizable Analytical Derivation Tool for Algebraic Function	11
<i>Hendra Hadhil Choiri, Nur Ulfa Maulidevi</i>	
Implementation of a Monophonic Note Tracking Algorithm on Android	17
<i>Hans Dulimarta, Ph.D.</i>	
Heart Disease Diagnosis using Extreme Learning Based Neural Networks	23
<i>Muhammad Fathurachman, Noviyanti Safitri, Umi Kalsum, Chandra Prasetyo Utomo</i>	
Automatic Multilabel Categorization using Learning to Rank Framework for Complaint Text on Bandung Government	28
<i>Ahmad Fauzan, Masayu Leylia Khodra</i>	
English to Japanese Spoken Language Translation System for Classroom Lectures	34
<i>Veri Ferdiansyah, Seiichi Nakagawa</i>	
ANN, ARIMA and MA Timeseries Model for Forecasting in Cement Manufacturing Industry	39
<i>Edy Fradinata, Sakesun Suthummanon, Nikorn Sirivongpaisal, Wannarat Suntiamorntut</i>	
Interaction Theory [New Paradigm] For Solving The Assignment Problem	46
<i>Anang Zaini Gani</i>	
Statistically Optimum Virtual Trip Line for Real-Time Traffic Monitoring System	52
<i>Fergyanto E. Gunawan</i>	
Enterprise Architecture for Cloud-based ERP System Development	58
<i>Ardian Indra Gunawan, Kridanto Surendro</i>	
Effect of 3 Key Factors on Average End to End Delay in MANET	64
<i>Saqib Hakak, Suhaimi. Abd. Latif, F. Anwar, M. K. Alam</i>	
Band Selection by Distance of Spatial Patterns for Brain Machine Interfacing	69
<i>Hiroshi Higashi, Toshihisa Tanaka</i>	
Generation of Striped Color Images by Using Inverse Line Convergence Index Filter	75
<i>Toru Hiraoka, Hirohumi Nonaka, Kiichi Urahama</i>	

Sign Language Word Recognition using Via-point Information and Correlation of the Bimanual Movements	81
<i>Shinpei Igari, Naohiro Fukumura</i>	
Multi-user Spectrum Analyzer using Java-based Client-Server Application	87
<i>Ni Made Satvika Iswari, Achmad Imam Kistijantoro</i>	
Inet Framework Modifications In Omnet++ Simulator For Mpls Traffic Engineering	93
<i>Andrew Sagitta Jauhari, Achmad Imam Kistijantoro</i>	
Vitality Based Feature Selection For Intrusion Detection	100
<i>Jupriyadi, Achmad Imam Kistijantoro</i>	
Implementation of a Human-like NPC (Non-Player Character) in a First Person Shooter Game	104
<i>Mahardiansyah Kartika, Nur Ulfa Maulidevi</i>	
Novel Two-Stage Model for Grapheme-to-Phoneme Conversion using New Grapheme Generation Rules	110
<i>Seng Kheang, Kouichi Katsurada, Yurie Iribe, Tsuneo Nitta</i>	
Risk Management Framework With COBIT 5 And Risk Management Framework for Cloud Computing Integration	116
<i>Akbar Khrisna, Harlili</i>	
The Perfomance of e-Learning Website on Open Source Virtualization	122
<i>Kristianto, Edy</i>	
Expert Systems for Self-Diagnosing of Eye Diseases Using Naïve Bayes	126
<i>Rahmad Kurniawan, Novi Yanti, Mohd Zakree Ahmad Nazri, Zulvandri</i>	
Integration of Metadata Generator to Model View Adapter (MVA) Architecture Pattern	130
<i>Anselmus Krisma Adi Kurniawan, Bayu Hendradjaya</i>	
Indonesian Twitter Text Authority Classification For Government in Bandung	136
<i>Janice Laksana, Ayu Purwarianti</i>	
Stock Trend Prediction Using Simple Moving Average Supported by News Classification	142
<i>Stefan Lauren, Harlili S.</i>	
Guided Summarization for Indonesian News Articles	147
<i>Danang Tri Massandy, Masayu Leylia Khodra</i>	
The Readiness Self-Assessment Model for Green IT Implementation in Organizations	153
<i>Nadinastiti Muladi, Kridanto Surendro</i>	
Quality-Based Framework for Requirement Analysis in Data Warehouse	159
<i>Munawar, Naomie Salim, Roliana Ibrahim</i>	

Combination of Audio Features and SVM Classifier for Automatic Musical Genre Classification	166
<i>Achmad Benny Mutiara, Rina Refianti, Nadia Rahmah Al Mukarromah</i>	
Optimization of Excitation-Emission bands for Estimating Viable Bacteria on Meat Surfaces with Fluorescence Spectroscopy	172
<i>Hiroto Nagai, Gamal ElMasry, Shigeki Nakauchi</i>	
Person Identification by Face Recognition on Portable Device for Teaching-aid System: Preliminary Report	178
<i>Albadr Lutan Nasution, Bima Sena Bayu D., Jun Miura</i>	
Pivot translation using source-side dictionary and target-side parallel corpus towards MT from resource-limited languages	184
<i>Takahiro Nomura, Tomoyoshi Akiba</i>	
Evaluating Industrial Cluster by using Spatial Auto Correlation of Patent Applications	188
<i>Hirofumi Nonaka, Seiya Kawano, Toru Hiraoka, Takahisa Ota, Shigeru Masuyama</i>	
Improved Generalizations of The Karatsuba Algorithm in GF(2ⁿ)	192
<i>Muhamad Nursalman, Arif Sasongko, Yusuf Kurniawan, Kuspriyanto</i>	
Estimation of Inheritance Relationship between Contents on Social Media	197
<i>Hitoyoshi Ohta, Akio Kobayashi, Shigeru Masuyama</i>	
Restructuring Regular Business ERP System to be Transformed into Academic ERP System	203
<i>Olivia, Kridanto Surendro</i>	
Anomaly-Based Intrusion Detection and Prevention System on Website Usage using Rule-Growth Sequential Pattern Analysis	209
<i>Yohanes Wahyu Trio Pramono, Suhardi</i>	
Numerical Analysis for Wave Propagation in Circular Waveguide Using Cylindrical Coordinate System-based FDTD Method	215
<i>Rahmi Rahmatillah, Chairunnisa and Achmad Munir</i>	
Ranking Prediction for Time-series Data using Learning to Rank(Case Study: Top Mobile Games Prediction)	220
<i>Alfian Ramadhan, Masayu Leylia Khodra</i>	
Adaptive DE based on chaotic sequences and random adjustment for image contrast enhancement	226
<i>L. M. Rasdi Rere, M. Ivan Fanany, A. Murni</i>	
Ontology based Classification for Multi-label Image Annotation	232
<i>Ismat Ara Reshma, Md Zia Ullahy, and Masaki Aono</i>	
Towards a Methodological Framework for Designing a Knowledge Market	238

D. (Didi) Rustam, Th.P. (Theo) van der Weide

Early Detection of Type II Diabetes Mellitus with Random Forest and Classification and Regression Tree (CART) 244

Mira Kania Sabariah, Aini Hanifa, Siti Sa'adah

Transformation of UML 2.0 Sequence Diagram into Coloured Petri Nets 249

Aditya Bagoes Saputra, Thomas Anung Basuki², Jimmy Tirtawangsa¹

Knowledge Management Framework for Indigenous Knowledge 255

Leilia Naomi Sarosa, Ir. Kridanto Surendro, M.Sc, Ph.d.

Comparison of syllable-based and phoneme-based DNN-HMM in Japanese Speech Recognition 261

Hiroshi Seki, Kazumasa Yamamoto, Seiichi Nakagawa

A Joint Time Synchronization Concept for Wireless Communication System 267

Hendra Setiawan, Masayuki Kurosaki, Hiroshi Ochi

Ontology-based Knowledge Representation of Failure Mode and Effect Analysis on Electric/Electronic Architecture Modeling Conforming to the ISO 26262 272

Arthur Silitonga, Martin Hillenbrand

Prediction of Interest for Dynamic Profile of Twitter User 278

Elisafina Siswanto, Masayu Leylia Khodra, Luh Joni Erawati Dewi

Solving The Time Fractional Diffusion Equations By The Halfsweep Sor Iterative Method 284

A. Sunarto, J. Sulaiman, A. Saudi

E-Readiness Framework For Cloud Computing Adoption In Higher Education 290

Soni Fajar Surya G, Kridanto Surendro

Strain Hardening Prediction of Materials Using Genetic Algorithm and Artificial Neural Network 295

Mike Susmikanti, Jos Budi Sulistyo

T-E CLC: A Conceptual Model towards Creative Learning Community 299

Dawam D. J. Suwawi, Warih Maharani, Husni S. Sastramihardja

A Comparison for Handling Imbalanced Datasets 305

Arif Syaripudin, Masayu Leylia Khodra

SAML Single Sign-On Protocol Development Using Combination of Speech and Speaker Recognition 311

Patrick Telnoni, Rinaldi Munir, Yusep Rosmansyah

Finding Effective Query Strings from Results of Primary Search 317

Ryota Teshima, Masayuki Okabe, Kyoji Umemura

Query Subtopic Mining for Search Result Diversification	321
<i>Md Zia Ullah, Masaki Aono</i>	
A Framework of Human Emotion Recognition Using Extreme Learning Machine	327
<i>Prasetia Utama, Widodo, Hamidillah Ajie</i>	
Fuzzy Traffic Congestion Model based on Speed and Density of Vehicle	332
<i>Dwi H. Widyantoro, M.D. Enjat Munajat</i>	
Distinguishing Attack and Second Preimage Attack on Mini-AES CBC-MAC	337
<i>Cahyo Ramdhani Wulamarisman, Susila Windarta</i>	
A New Multi-label Classifier for Identifying Membrane Protein Functional Types Based on Sequence Information	343
<i>Xuan Xiao, Hong-Liang Zou</i>	
Melody Generation System based on a Theory of Melody Sequence	347
<i>Sakurako Yazawa, Masatoshi Hamanaka, Takehito Utsuro</i>	
Kinect 3D Camera Based Eye-Tracking to Detect the Amount of Indoor Advertisement Viewer	353
<i>Calvin Kwan, James Purnama, Kho I Eng</i>	
A Comparison of Fingerprint Enhancement Algorithms for Poor Quality Fingerprint Images	359
<i>Kevin Arighi Yusharyahya, Anto Satriyo Nugroho, James Purnama, Maulahikmah Galinium</i>	

Comparison of Bidirectional Associative Memory, Counterpropagation and Evolutionary Neural Network for Java Characters Recognition

Gregorius Satia Budhi
Informatics Department
Petra Christian University
Surabaya, Indonesia
greg@petra.ac.id

Rudy Adipranata
Informatics Department
Petra Christian University
Surabaya, Indonesia
rudya@petra.ac.id

Abstract— Javanese language is the language used by the people on the island of Java and it has its own form of letters called Java characters. Recognition of Java characters is quite difficult because it consist of basic characters, numbers, complementary characters, and so on. In this research we developed a system to recognize Java characters and compared three methods of neural network namely bidirectional associative memory, counterpropagation and evolutionary neural network. Input for the system is a digital image containing several Java characters. Digital image processing and segmentation are performed on the input image to get each Java character. For each Java character, feature extraction is done using ICZ-ZCZ method. Output from feature extraction will become input for neural network. From experimental result, evolutionary neural network can perform better recognition accuracy than the other two methods.

Keywords—Java characters recognition, bidirectional associative memory, counterpropagation, evolutionary neural network

I. INTRODUCTION

Javanese language is the language used by the people on the island of Java. Javanese language has its own form of letters referred to the character of Java. Java characters recognition has its own difficulty level because of basis characters, vowels, complementary, and so on. Because it is difficult to recognize, then lately not many people can do the writing or reading of Java characters. For many people, Java characters eventually regarded as a decoration only and do not mean anything. This will further erode gradually the existence of Java characters and will ultimately also affect the Javanese culture in general.

Some researchers have conducted research on this Java character recognition. Nurmila [1] used backpropagation neural network and the accuracy result was about 61%. Other researcher, Priyatma used fuzzy logic for recognition [2] and the recognition results are satisfactory.

In this research, we developed a system that can automatically recognize Java characters in the form of digital image, and turn them into a document written with the *hanacaraka* font. The first process is digital image

segmentation and feature extraction. The features will be used as input for neural network. In this research we compare three methods of neural networks, namely bidirectional associative memory, counterpropagation network, and evolutionary neural network.

II. JAVA CHARACTERS

Java characters are differ from the commonly used Latin characters. Java characters have different shape and structure with the Latin characters. *Carakan* characters is the core of Java characters consisting of 20 syllables called Dentawyanjana, can be seen in Figure 1 [3].



Fig. 1. Basic (*carakan*) characters

For numbers in Java characters can be seen in Figure 2 [3].

1	2	3	4	5	6	7	8	9	0

Fig. 2. Symbol of numbers

Sandhangan character is commonly used as complementary character, vowel or consonant that are commonly used in everyday language. *Sandhangan* can be seen in Figure 3 [3].

Sandhangan name	Java character	Description
<i>Wulu</i>		Vowel i





<i>Suku</i>		Vowel u
<i>Taling</i>		Vowel é
<i>Pepet</i>		Vowel ê
<i>Taling tarung</i>		Vowel o

Fig. 3. Sandhangan characters

III. IMAGE SEGMENTATION

Segmentation is one of the important processes used to transform the input image to the output image taken based on the attributes of the image. Segmentation divides the image into regions based on its intensity so can distinguish objects and background. Segmentation should be discontinued if each object has been isolated or clearly visible [4]. The segmentation methods that used in this research are thresholding and skeletonizing.

Thresholding is one way to separate the objects in the image from the background by selecting a threshold value T that can separate these two modes. With the election of the value of T , all points (x, y) where $f(x, y) > T$, can be called an object point and besides it is called a background point or vice versa [4].

Skeletonizing or thinning is the process to get rid of the extra pixels and produces images that are more modest. The purpose of skeletonizing is made simpler image so that the image can be analyzed further in the way of its shape and suitability. Problem encountered in conducting thinning is how to determine the pixels are redundant. If we cannot determine it, the thinning process is more likely to an erosion process where erosion can cause a region is deleted. Skeleton should remain intact and have some basic properties such as [5]:

- Must consist of several thin regions, with a width of 1 pixel.
- Pixels that form the skeleton should be near the middle are of the cross section of the region.
- Skeletal pixel must be connected to each other to form several regions that are equal to the number of region in original image.

IV. BIDIRECTIONAL ASSOCIATIVE MEMORY

Bidirectional associative memory (BAM) proposed by Bart Kosko in 1998 [6]. This method associates the patterns of a set, for example set A to set B, the group or other set of patterns, and vice versa. BAM architecture can be seen in Figure 4.

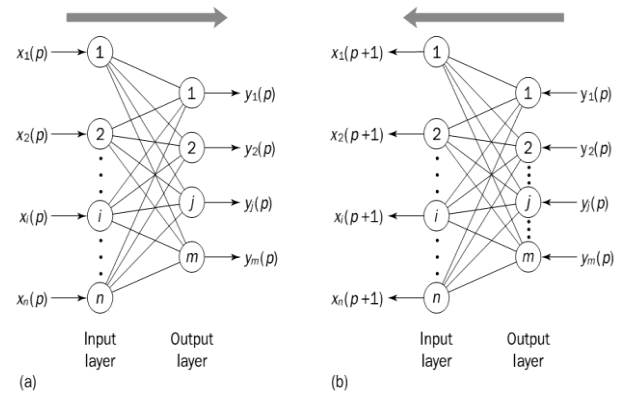


Fig. 4. Architecture of BAM: (a) forward direction ($X \rightarrow Y$); (b) backward direction ($Y \rightarrow X$)

V. COUNTERPROPAGATION NETWORK

Counterpropagation network (CPN) is defined by Robert Hecht-Nielsen in 1987 [7]. This method is widely used because it is simple and easy on the training process. Additionally CPN has good stats in the representation of the input layer for a wide range of environment. CPN combines unsupervised training method on Kohonen Layer and supervised on Grossberg layer [7]. Network topology of CPN can be seen in Figure 5.

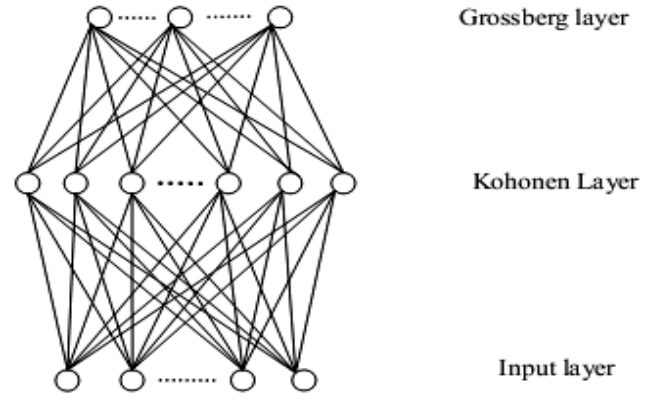


Fig. 5. Counterpropagation network topology

VI. EVOLUTIONARY NEURAL NETWORK

Evolutionary neural network (ENN) is a combination of a neural network with evolutionary algorithm. Although the neural network can be used to solve various kinds of problems, it still has some limitations. A common limitation is usually associated with network training. Backpropagation learning algorithms are often used as flexible and easy to implement had serious drawbacks, which cannot guarantee that the optimal solution is given. Another difficulty is related to selecting the optimal network topology for the neural network. Network architecture that is appropriate for certain cases more often chosen from heuristic methods, and neural network topology design is still an art than a technique. This shortcoming can be addressed using evolutionary algorithm.

Evolutionary algorithm refers to a probabilistic adaptation algorithm inspired from natural evolution. This method follows

the statistical search strategies in a population of individuals, each representing a possible solution to the problem. Evolutionary algorithm divides into three main forms, namely: evolution strategies, genetic algorithms, and evolutionary programming [8].

In this research, the evolutionary algorithm used is the genetic algorithm. Genetic algorithm is an effective optimization technique that could help both the optimization of weight and selecting the network topology. In order to use genetic algorithm, first a problem must be represented as a chromosome. For example, when we want to look for a set of optimal weight of a multilayer feed forward neural network, the first step in solving this problem is the system should make the process of encoding of the network into a chromosome as in Figure 6 [6].

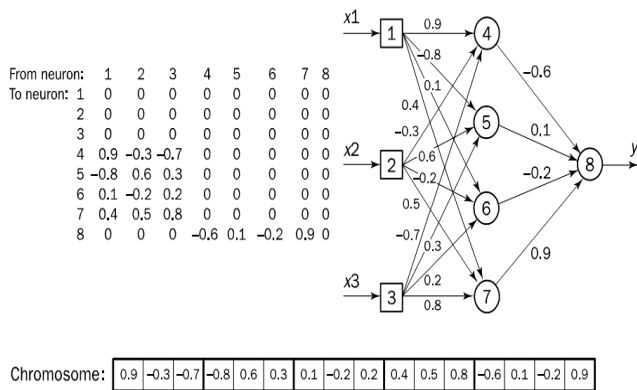


Fig. 6. Encoding a network into a chromosome

The second step is to define the fitness function to evaluate the performance of the chromosome. This function must be calculated given the performance of the neural network. We can implement a simple function from squared errors. To evaluate the fitness of the chromosomes, each chromosome weight is given to each link in the network. Training of examples collections are then presented to the network, and the number of squared errors is calculated. Small squared errors indicate that the chromosome is more fit than the other. In other words, genetic algorithm seeks to find a set amount of weight that has the smallest squared errors.

The third step is to choose the genetic operators, namely crossover and mutation. Crossover operator requires two parent chromosomes and creates a child with genetic material from both of its parent. Each gene of the child chromosome is represented by the corresponding genes of randomly selected parent. Mutation operator randomly selects a gene and replaces it with a random result between -1 to 1. By doing so, the system is ready to apply genetic algorithms. However, users still need to define the number of population, the number of networks with different weights, the probability of crossover and mutation as well as the number of generation [6].

VII. IMPLEMENTATION AND RESULT

System workflow starting from input of a Java characters digital image. Then we do the grayscale processing and filtering to remove noise that exists. After that the

segmentation process is carried out to get the parts of hanacaraka character using thresholding and skeletonizing. Later feature extraction process is done by using ICZ-ZCZ [9] and the feature will be used as inputs to the neural network.

ICZ (Image Centroid and Zone) – ZCZ (Zone Centroid and Zone) is zoning type feature extraction that utilizing centroid of the image or centroid of the zone. Each digital image input (each Java character image) is divided into 20 zones (4 * 5 zones), and for each zone, the ICZ and ZCZ methods will be performed so there are 40 ICZ-ZCZ output values that become neural network input node.

The overall system workflow can be seen in Figure 7.

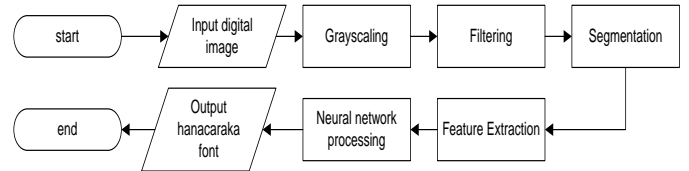


Fig. 7. System workflow

Application interface can be seen in Figure 8.

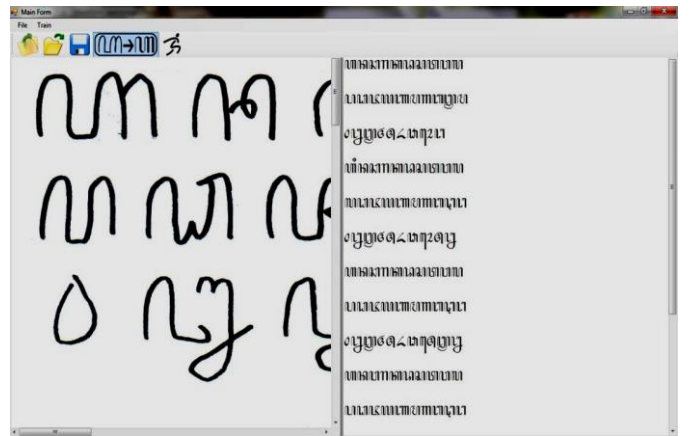


Fig. 8. Application interface

Experimental results of bidirectional associative memory (BAM) can be seen in Table 1.

TABLE I. EXPERIMENTAL RESULT OF BAM

No	Number of sample	Input node	Output node	Accuracy (%)
1	2	6	4	100.00%
2	2	15	10	0.00%
3	3	4	5	100.00%
4	4	6	3	100.00%
5	6	6	3	66.67%
6	6	6	3	33.33%
7	6	6	4	100.00%
8	8	6	4	75.00%
9	8	6	5	62.50%
10	8	6	5	75.00%

11	8	8	5	37.50%
12	4	3	1	0.00%
13	3	30	10	33.33%
14	4	30	15	0.00%
15	4	30	30	0.00%

From the experimental results above it can be concluded that the BAM is inaccurate to use for Java characters recognition. For input node, we need at least 40 nodes, while BAM only works well when the input nodes are the same or less than 6 nodes only. And for the output nodes, we need at least 20 nodes because Java characters consists of at least 20 basic characters, not included numbers and *sandhangan*, while BAM works well for 3 or 4 nodes only.

Another experiments use counterpropagation network (CPN) and evolutionary neural network (ENN) 1 layer and 2 layers, and from experimental result, the average of recognition accuracy of CPN is only about 70% for training data and 4% for testing data, while the average of recognition accuracy of ENN is about 94% for training data and about 62% for testing data. Parameters used for ENN are: the number of neuron for each layer: 60, crossover probability: 100%, mutation probability: 50%, maximum population: 50, maximum epoch: 10 million and error limit: 0.1. The experimental result of CPN and ENN can be seen in table II.

TABLE II. EXPERIMENTAL RESULT OF CPN AND ENN

Character type	Data type	Accuracy (%)		
		CPN	ENN (1 layer)	ENN (2 layers)
All characters (basic / <i>carakan</i> , number & <i>sandhangan</i>)	Training	70.22	94.90	93.53
	Testing	4.76	58.23	62.38
Basic / <i>carakan</i>	Training	60.28	97.67	96.33
	Testing	3.17	58.12	59.31
Numbers	Training	73.14	99.33	98.67
	Testing	5.02	60.84	64.85
<i>Sandhangan</i>	Training	77.20	93.33	88.89
	Testing	6.26	66.92	68.12

CONCLUSION

From the experimental that has been done, it can be concluded that bidirectional associative memory and counterpropagation neural network could not be used for recognition of Java characters because the average of accuracy is very low, while evolutionary neural network still could be

used for Java characters recognition because from the experimental result, it show that the average of accuracy is quite high. For future research, the accuracy may be improved by using another method for feature extraction that can distinguish similar Java character.

ACKNOWLEDGMENT

We thank the Research Center, Petra Christian University, Surabaya, Indonesia, which has funded this research through the Internal Research Grant (05/Pen-LPPM/UKP/2012), fiscal year 2012. We also thank Edwin Prasetyo Nandra, Danny Setiawan Putra, Eric Yogi Tjandra, Evan Sanjaya, Jeffry Hartanto, Ricky Fajar Adi Edna P., and Christopher H. Imantaka for their help in doing the system coding

REFERENCES

- [1] Nurmila, N., Sugiharto, A., dan Sarwoko, E. A., "Back Propagation Neural Network Algorithm For Java Character Pattern Recognition," *Jurnal Masyarakat Informatika* vol 1, no 1, pp 1-10, 2010.
- [2] Priyatma, J. E. dan Wahyuningrum, S. E., "Java Character Recognition Using Fuzzy Logic," *SIGMA* vol 8, No 1, pp 75-84, 2005.
- [3] Java Characters, Aksara Jawa, http://id.wikipedia.org/wiki/Aksara_Jawa, last access January 2013.
- [4] Gonzalez, R.C., and Woods, R.E., "Digital Image Processing 3rd Edition," New Jersey: Prentice-Hall, Inc., 2008.
- [5] Parker, J.R., "Algorithm for Image Processing and Computer Vision," New York: John Wiley and Sons, Inc., 2010.
- [6] Negnevitsky, M., "Artificial Intelligence: A Guide to Intelligence Systems (2nd ed.)," New York: Addison Wesley, 2005.
- [7] Boyu, W., Feng W., and Lianjie S., "A Modified Counter-Propagation Network for Process Mean Shift Identification," *IEEE International Conference on Systems, Man and Cybernetics*. pp. 3618 – 3623, 2008.
- [8] Dewri, R., "Evolutionary Neural Networks: Design Methodologies," <http://ai-depot.com/articles/evolutionary-neural-networks-design-methodologies/>, last access January 2013.
- [9] Rajashekararadhya, S.V., Ranjan, Vanaja, "Efficient zone based feature extraction algorithm for handwritten numeral recognition of four popular South Indian scripts," *Journal of Theoretical and Applied Information Technology* 4(12), pp. 1171-1181, 2005.