ICCEREC

THE 2017 INTERNATIONAL CONFERENCE ON CONTROL, ELECTRONICS, RENEWABLE ENERGY, AND COMUNICATIONS

PROCEEDINGS

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September 26-28, 2017
Tentrem Hotel, Yogyakarta-Indonesia

Telkom University

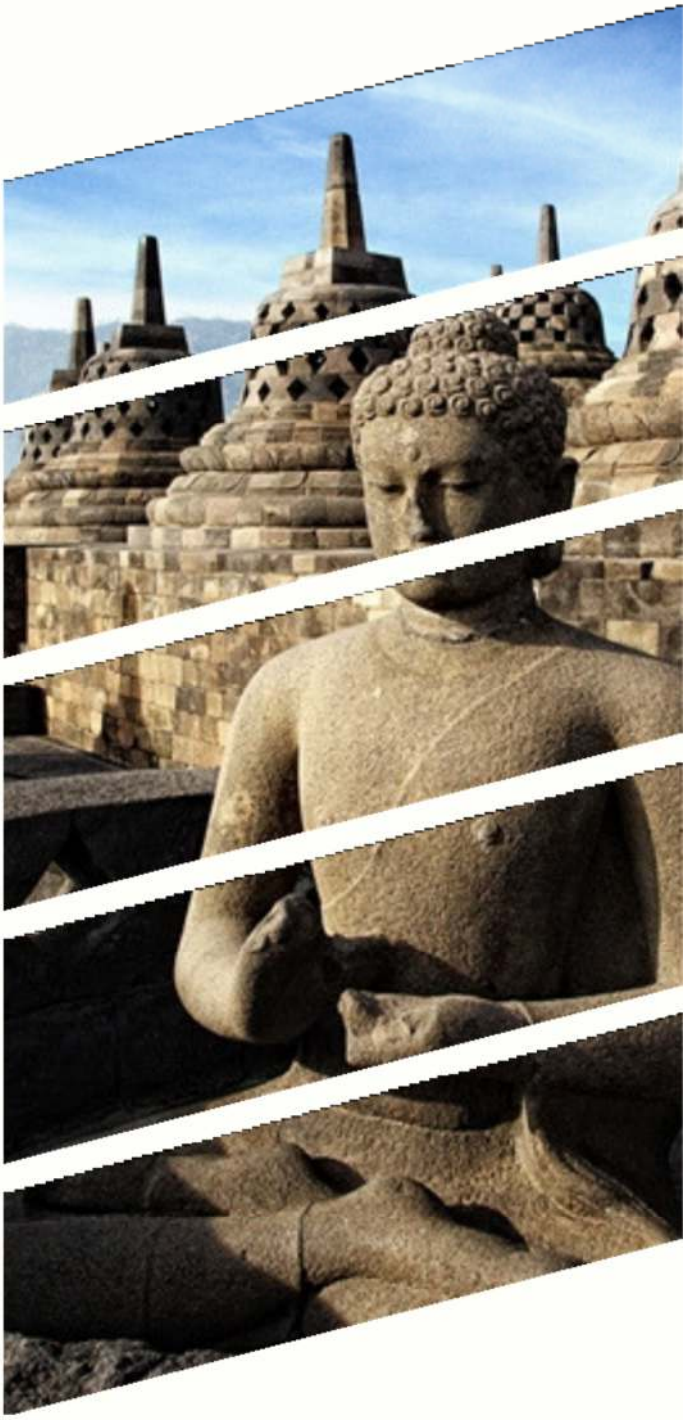
IEEE ComSoc IEEE Communications Society Indonesia Chapter

IEEE Signal Processing Society Indonesia Chapter

ABOUT
ICCEREC 2017

ICCEREC 2017 is organized by the international organizing committee of ICCEREC and is technical co-sponsored by the IEEE Communications Society Indonesia Chapter and IEEE Signal Processing Society Indonesia Chapter, so that ICCEREC has a strong foundation of bringing together industry and academia.

This conference provides an international forum for researchers, academicians, professionals, and students from various engineering fields and with cross-disciplinary interests in control, electronics, renewable energy, computer engineering and communications to interact and disseminate information on the latest developments. The conference will include technical sessions, tutorials, and technology and business panels. You are invited to submit papers in all areas mentioned above. Accepted papers will be published in the ICCEREC 2017 Conference Proceedings and presented papers will be submitted to IEEE Xplore after each paper is thoroughly reviewed and (if any) satisfactorily modified according to the reviewer comments.



WELCOME MESSAGE

GENERAL CHAIR OF ICCEREC 2017

SIGIT YUWONO, PhD

Welcome to ICCEREC 2017, Yogyakarta – Indonesia.
It is our great pleasure to welcome you to the International Conference on Control, Electronics, Renewable Energy, and Communications 2017 (ICCEREC 2017), which is already the 3rd running; while the 1st and the 2nd were held in Bandung in 2015 and 2016, respectively.

This conference provides an international forum for researchers, academicians, professionals, and students from various engineering fields and with cross-disciplinary interests in control, electronics, renewable energy, computer engineering and communications to interact and disseminate information on the latest developments.

Papers submitted to ICCEREC this year came from authors in North America, Europe, Africa, and Asia countries.
ICCEREC 2017 is organized by international technical program committee, organizing committee, and international steering committee, and is technical co-sponsored by the IEEE Communications Society Indonesia Chapter and the IEEE Signal Processing Society Indonesia Chapter.
In this occasion, I would like to express my sincere appreciation to all above contributors for their great help and valuable supports to ICCEREC 2017. Many thanks to them for their efforts to bring all attendees an excellent technical program and an opportunity to spend a pleasant time at the conference.
The committee expect that the conference will bring many benefits to the scientific and technological development and to new or established international collaborations. The committee is doing its best effort for the inclusion of the conference proceedings to the IEEE Xplore Data Base. So that, the presentations of this conference will be accessible to a wider range of readers and will have continual impact to this research field.
Yogyakarta is one of the oldest cities in Indonesia, so it is very historical and is considered as the foremost cultural center of Java; therefore, tourist attractions are easily found in Yogyakarta. I hope all attendees an enjoyable and memorable stay in Yogyakarta.

Yogyakarta, 26 September 2017

Chair of ICCEREC 2017,

Sigit Yuwono, PhD.
Telkom University

WELCOME MESSAGE

TPC CHAIR OF ICCEREC 2017

Dr. RINA PUDJI ASTUTI

Welcome to ICCEREC 2017,
It is a great honor for all of us to host of The third International Conference on Control, Electronics, Renewable Energy and Communications (ICCEREC) 2017 in Yogyakarta, Indonesia. Welcome to Yogyakarta and we hope that you enjoy the center of Javanese arts, graceful palace, the foods, and richness culture.

This conference represents a great achievement in topics of interest, which the best contributors coming from excellent laboratories and schools throughout the world, precipitate to come and contribute their finest works. Where the high qualified papers in Control, Electronics, Renewable Energy and Communicatios will be presented.

The conference received 141 papers with 350 authors from 20 countries. After carefully peer reviews by 138 reviewers, we have 68 accepted papers from 16 countries. And finally we have 50 registered papers from 10 countries. ICCEREC 2017 has maintain high quality technical program. We also would like to thank to SPS Indonesia Chapter and Telkom University as the organizer of 3rd ICCEREC 2017, and ComSoc Indonesia Chapter that involved as Technical Co-Sponsor of the conference. We hope that fruitful discussions and exchange of ideas between researchers during conference will yield new technological innovations for contributing to a better life for humans in the coming decades.

Best Regards,
TPC Chair of ICCEREC 2017

Dr. Rina Pudji Astuti

PROGRAM AT A GLANCE

Day One, 26 September 2017

- 08.00 - 08.30 Registration
- 08.30 - 09.30 Opening Ceremony
- 09.30 - 10.15 Keynote Session I
- 10.15 - 10.30 Coffee Break
- 10.30 - 11.15 Keynote Session II
- 11.15 - 12.00 Keynote Session III
- 11.00 - 13.00 Lunch
- 13.00 - 14.30 Technical Session 1 & 2
- 14.30 - 14.45 Coffee Break
- 14-45 - 16.30 Technical Session 3 & 4
- 19.30 - 21.00 Gala Dinner

Day Two, 27 September 2017

- 08.00 - 09.30 Tutorial 1 & Technical Session 5
- 09.30 - 09.45 Coffee Break
- 09.45 - 11:30 Tutorial 2 & Technical Session 6
- 11.30 - 13.00 Lunch
- 13.00 - 14.30 Technical Session 7 & 8

Day Three, 28 September 2017

- One Day Tour

KEYNOTE SESSION

Keynote Speech 1 :
26 September, 2017
09.30 - 10.15

Assoc Prof. Dr. Jiwa Abdullah

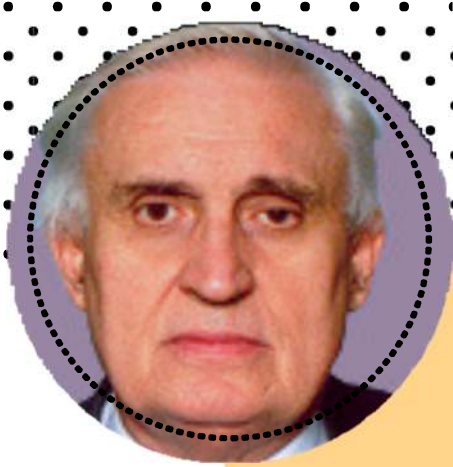
FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING, UNIVERSITI TUN HUSSEIN ONN, MALAYSIA

"WSN/IOT INTEGRATION TOWARDS SEAMLESS CYBER- PHYSICAL SYSTEMS"

Abstract:

Before the 90s, monitoring system being deployed in isolation. Each application stands by its own. Vendors try to capture their proprietary product in the hope of making so much financial gain as possible. Nevertheless, in past two decades, a lot of research activities have been dedicated to the fields of mobile ad hoc network (MANET) and wireless sensor networks (WSN). Products are more universally deployed, from multiple vendors and are talking to each other. More integration are being done and deployed. Multiple platforms seems inevitable but with proper standardization, seamless operations are in place. More recently, the cyber- physical system (CPS) has emerged as a promising direction to enrich the interactions between physical and virtual worlds. In the presentation, we first review some research activities in MANET, WSN, IoT, including networking issues and coverage and deployment issues. Then, we review some CPS platforms and systems that have been developed recently, including health care, navigation, rescue, intelligent transportation, social networking, and gaming applications. Through these reviews, we hope to demonstrate how CPS applications exploit the physical information collected by WSNs to bridge real and cyber spaces and identify important research challenges related to CPS designs.

KEYNOTE SESSION



Keynote Speech 2 :
26 September 2017
10.30 - 11.15

Full Prof. Dr. Zoran Bojkovic

LSM IEEE UNIVERSITY OF BELGRADE,
REPUBLIC OFSERBIA

"CURRENT TECHNOLOGICAL ADVANCES TO SMART GRIDS"

Abstract:

A smart grid (SG) delivers electricity from suppliers to consumers using at the same time two-way digital technology that reduces cost and increases reliability and transparency. Here, communication networks play a critical role as the intelligence of this complex system is built based on information exchange across the power grid. An intelligent monitoring system that keeps track of all electricity flowing as well as the use of superconductive transmission lines for less power loss are included, too. Of course, the integration of alternative sources of electricity, such as solar and wind is welcome. These features help to promote energy independence and are a key tool in dealing with emergency resilience issues.It should be noted that the design of the communication network associated with the SG involves a detailed analysis of requirements, including choice of the most suitable technologies for each case study and the architecture for the resultant heterogeneous system. In this presentation, potential implications that current technological advances can make to SG are outlined firstly, such as big data, cloud computing and the Internet of Things (IoT). Data analysis generated from various smart devices in the SG environment, is one of the most challenging tasks as it varies with respect to parameters such as size, volume, velocity and variety. Another big challenge in building SG often arises from the fast growing amount of data and limited communication resources. To address this issues, the concept of distributing communications architecture that implements SG communications in an efficient and cost- effective manner is provided. In that way, communication distance is shortened, so that the data will be delivered more efficiently and reliably. With the rapid development of electric vehicles (EVs), the energy management issues in SGs integrated with Evs are attracting huge interest. This is a reason to tackle the corresponding issue. On the other hand, machine-to.machine communication is a significant part in SG networks.This improved automation results in a many heterogeneous applications. Thus, the final part is assigned to this goals. Finally,a number of open questions have been posed which will be of practical interest for further development of SGs and energy system as a whole. The end draws the conclusion of the presentation.

KEYNOTE SESSION

Keynote Speech 3 :
26 September 2017
11.15 - 12.00

Dr. Eng. Takayuki Nozaki
YAMAGUCHI UNIVERSITY

"INTRODUCTION AND RECENT RESULTS OF FOUNTAIN CODES"

Abstract:

The reliable communication systems can be realized by error/erasure correcting codes. Fountain codes are erasure correcting codes realizing the reliable communications system for the user diagram protocol (UDP), which is used in multicasting and broadcasting.
The first topic of this talk is fundamentals of fountain code. This introduces two well-known fountain codes, namely, LT code and Raptor code, and these decoding algorithms. Moreover, we briefly introduce some applications of the fountain code.
The second topic is recent results of fountain codes. We introduce a recent code construction based on bit-level shift, that is, zigzag decodable fountain code, and its decoding algorithms.
Furthermore, we give some comparison a zigzag decodable fountain code with conventional fountain codes by theoretical analysis and computer simulations.

TUTORIAL SESSION

Tutorial 1 :
27 September 2017
08.00 - 09.30

Prof.Dr Zoran Bojkovic
Prof.Dr Bojan Bakmaz
UNIVERSITY OF BELGRADE , SERBIA

"IMPACT OF LATEST COMMUNICATION TECHNOLOGIES ON SMART GRID APPLICATIONS"

Abstract:

The goal of this tutorial is to present recent communication technologies for smart grid (SG) applications in the near future. The operation of distribution networks and the participation of distributed energy resources are based on efficient and reliable communication systems. A variety of communication technologies (wire and wireless) are considered for the next generation networks applications.The first one, comprises optical communications, digital subscriber line and power line communications, They guarantee high reliability, bandwidth, cyber security. The next, wireless technology includes orthogonal - frequency division multiplexing (OFDMA)-based networks (WiMAX,LTE,etc). They are finding a growing interest among electric utilities, thanks to their low cost and easier installation. It should be noted that the high number of existing communication technologies leads to an opportunity for SG applications, even the debate on which technology fits better the SG needs is open. On the other hand, SGs have to be design taking into account the requirements of expected functionalities such as network operation with cooperative distribution energy resources system protection and/or network reconfiguration. From this point of view, the following topics are included, such as: big data, distributed communication architecture, machine-to-machine communication, SG integration with mobile cloud, cyber-physical system perspective., techno-social SGs , traffic type in SG and delivery requirements. For more details and implementation, the audience can be referred to the overview papers, multiple speeches, special issues and the latest books, all presented through the references.

TUTORIAL SESSION

Tutorial 2 :
27 September 2017
09.45 - 11.30

Assoc Prof. Dr. Jiwa abdullah

FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING, UNIVERSITI TUN HUSSEIN ONN, MALAYSIA

"MANET/WSN, PERSPECTIVES, ANALYSIS, EDUCATION AND RESEARCH POTENTIALS"

Abstract :

The tutorial session involves the overview of the MANET and WSN which covers the various characteristics that govern the functionalities of these systems. We may cover topics such as: (1) Overview of MANET/WSN; (2) Proactive/Reactive Routing Protocol Analysis; (3) Clustering and Energy Consumption Analysis; (4) Performance analysis for 802.11/802.15.4; (5) WSN Simulation Platform based on Matlab for easy understanding to UG students.

PARALLEL SESSION

26 September 2017
Session 1 : 13:00-14:30

Tracks : COMP **Room : Bakau Room**

No	Time	Title	Authors
1	13.00-13.15	Channel Selection for Common Spatial Pattern Based on Energy Calculation of Motor Imagery EEG Signal	Hilman Fauzi, Ibrahim Shapiai, Noor Akhmad Setiawan, Jafreezal Jaafar and Mahfuzah Mustafa
2	13.15-13.30	Lie Detector with Pupil Dilation and Eye Blinks Using Hough Transform and Frame Difference Method with Fuzzy Logic	Respatyadi Dwiatmojo, Muhammad Nasrun and Casi Setianingsih
3	13.30-13.45	Sentiment Analysis Using Multinomial Logistic Regression	Ramadhan Prakoso, Astri Novianty and Casi Setianingsih
4	13.45-14.00	Indonesia Ancient Temple Classification Using Convolutional Neural Network	Kefin Danukusumo, Pranowo Pranowo and Martinus Maslim
5	14.00-14.15	Adaptive Multilevel Wavelet BCH Code Method in the Audio Watermarking System	Irma Safitri
6	14.15-14.30	3D GPU-Based SPH Simulation of Water Waves Impacting on A Floating Object	Andhika Priyambada and Dede Tarwidi

Session 2 : 13:00-14:30

Tracks : COMM **Room : Bangkirai Room**

No	Time	Title	Authors
1	13.00-13.15	Radiated Emission Test Analyzes Method to Investigate SAR	Erik Madyo Putro, Budi Sulistya, Reza Septiawan, Arief Rufiyanto, Sardjono Trihatmo and Maratul Hamidah
2	13.15-13.30	Low Cost Visible Light Communication Transceiver Prototype for Real Time Data and Images Transfer	Nenggala Yudhabrama, Inung Wijayanto and Sugondo Hadiyoso
3	13.30-13.45	A Smart Power Outlet for Electric Devices That Can Benefit from Real-Time Pricing	Vikram Ramavarapu, Richard Sowers and Ramavarapu Sreenivas
4	13.45-14.00	Path Associativity Centralized Explicit Congestion Control (PACEC) for SDN	Sofia Naning Hertiana, Adit Kurniawan and Hendrawan Hendrawan
5	14.00-14.15	Local Polynomial Regression Based Path Loss Estimation for Weighted Centroid Localization of Endoscopic Capsule	Umma Hany and Lutfa Akter
6	14.15-14.30	Coupling Reduction Between Two Elements of Array Antenna Using U-Shaped Defected Ground Structure	Halason Nabaho, Mochamad Yunus, Edwar Edwar and Achmad Munir

PARALLEL SESSION

26 September 2017
Session 3 : 14:45-16:45

Tracks : EL-REN **Room : Bakau Room**

No	Time	Title	Authors
1	14:45-15.00	Entropy Measurement as Features Extraction in Automatic Lung Sound Classification	Achmad Rizal, Risanuri Hidayat and Hanung Adi Nugroho
2	15.00-15.15	An Interfacing Digital Blood Pressure Meter with Arduino-GSM Module for Real-time Monitoring	Zulfikar Ramli, Sugondo Hadiyoso and Achmad Rizal
3	15.15-15.30	Rehabilitation Exercise Monitoring Device for Knee Osteoarthritis Patients	Mitra Mohd Addi and Nur Amirah Ishak
4	15.30-15.45	Feasibility Study of Ocean Wave Energy for Wave Power Plant at Sibolga-Tapanuli Tengah	Riswan Dinzi, Hendrik Hutagalung and Fahmi Fahmi
5	15.45-16.00	Fuzzy Logic Based Active Power Generation Dispatching Considering Intermittent Wind Power Plants Output	Fatmawati Azis, Ardiaty Arief and Muhammad Nappu
6	16.00-16.15	Design of Solar Water Pumping System in Urban Residential Building	Prisma Megantoro, Danang Wijaya and Eka Firmansyah
7	16.15-16.30	Design of Hybrid PV-Generator-Battery System for Two Kind of Loads at Aha Village, Morotai Island, North Maluku	Salmon Hutapea and Agus Purwadi
8	16.30-16.45	Electricity Price and Subsidy Scenario for Hybrid Power Generations on Off-Grid System	Fadolly Ardin, Amien Rahardjo and Chairul Hudaya

PARALLEL SESSION

26 September 2017
Session 4 : 14:45-16:45

Tracks : COMM **Room : Bangkirai Room**

No	Time	Title	Authors
1	14.45-15.00	Equivalent Circuit Analysis of Square-Loop-Resonator BPF with CrossShaped I/O Coupling for X-Band Frequency Application	Edwar Edwar and Achmad Munir
2	15.00-15.15	Square Ring Microstrip Patch Triple Band Antenna for GSM/ WLAN/ WiMAX System	Abdulrashid Mumin, Jiwa Abdullah, Rozlan Alias, Samsul Haimi Dahlan and Raed Abdulkareem Abdulhasan
3	15.15-15.30	Dual List Interference Cancellation in Underlay Cognitive Radio	Linda Meylani, Adit Kurniawan and Mohammad Sigit Arifianto
4	15.30-15.45	Performance Analysis of Hybrid Optical Amplifier in Long-Haul Ultra-Dense Wavelength Division Multiplexing System	Brian Pamukti Sunardi and Akhmad Hambali
5	15.45-16.00	Cohn Topology-based 1:8 Power Divider for S-Band Array Antenna Feeding Network	Achmad Munir, Endon Bharata and Edwar Edwar
6	16.00-16.15	Trilateration and Iterative Multilateration Algorithm for Localization Schemes on Wireless Sensor Network	Matsna Rahman, Ratna Mayasari and Ahmad Hanuranto

27 September 2017
Session 5 : 08:00-09:30

Tracks : COMP **Room : Bangkirai Room**

No	Time	Title	Authors
1	08.00-08.15	Spatiotemporal Saliency Detection in Traffic Surveillance	Wei Li, Dhoni Putra Setiawan and Hua-An Zhao
2	08.15-08.30	Analysis of Flight Data Recorder Compression Reliability for Airplane on Demand Blackbox Data Transmission	Dhipo Putra, Surya Michrandi Nasution and Fairuz Azmi
3	08.30-08.45	Analysis of Cockpit Voice Recorder Compression Reliability for Airplane on Demand Blackbox Data Transmission	Setianto Nugroho, Surya Michrandi Nasution and Fairuz Azmi
4	08.45-09.00	Interpolating Redundant Spatial Data from SHUMOO Boat Survey Due to the Current Directions of Anyar River	Putu Harry Gunawan and Ketut Tomy Suhari
5	09.00-09.15	Flood Forecasting Using Holt-Winters Exponential Smoothing Method and Geographic Information System	Mus'ab Abdurrahman, Budhi Irawan and Roswan Latuconsina
6	09.15-09.30	Parallel Processing for Simulating Surface Gravity Waves by Non-hydrostatic Model Using Arakawa Grid	Putu Harry Gunawan and Mintho L. P. Siagian

PARALLEL SESSION

27 September 2017
Session 6 : 09:45-11:30

Tracks : COMP **Room : Bangkirai Room**

No	Time	Title	Authors
1	09.45-10.00	An Implementation of Weighted Moving Average and Genetic Programming for Rainfall Forecasting in Bandung Regency	Budy Putra, Fhira Nhita, A Adiwijaya, Deni Saepudin and Untari Wisesty
2	10.00-10.15	*Analysis Security Metric on BRO IPS Based on CVSS and VEA-bility Metric*	I Made Dwi Suryadinata, Surya Michrandi Nasution and Marisa Paryasto
3	10.15-10.30	Retinal Vessel Detection Based on Frangi Filter and Morphological Reconstruction	Hanung Adi Nugroho, Rezty Amalia Aras, Tri Lestari and Igi Ardiyanto
4	10.30-10.45	Computational Acceleration of Image Inpainting Alternating-Direction Implicit (ADI) Method Using GPU CUDA	Mutaqin Akbar, Pranowo Pranowo and Suyoto Suyoto
5	10.45-11.00	Computing Two-layer SWE for Simulating Submarine Avalanches on OpenMP	Putu Harry Gunawan and Cassrio Agustin Simanjuntak
6	11.00-11.15	Automation System for Controlling and Monitoring Ornamental Plants Using Fuzzy Logic Method	Rihla Ubudi, Budhi Irawan and Randy Saputra
7	11.15-11.30	Solution Path of Newton's Method for Determining Epicenter Earthquake Hazard in Italy 24 August 2016	Putu Harry Gunawan and Nadzar Prakoso

PARALLEL SESSION

26 September 2017

Session 7 : 13:00-14:30

Tracks : COMP **Room : Bakau Room**

No	Time	Title	Authors
1	13.00-13.15	PID Temperature Controlling of Thermoelectric Based Cool Box	Sundayani Sundayani, Dyan Sinulingga, Fabiola Prasetyawati, Firmawan Palebangan, Asep Suhendi, Ismudiati Puri Handayani, Tri Ayodha Ajiwiguna and Indra Fathona
2	13.15-13.30	Quadrotor Model with PD Controller	Harits Anwar Rozi, Erwin Susanto and Prasetya Dwi Wibawa
3	13.30-13.45	Realization of Depth First Search Algorithm on Line Maze Solver Robot	Ahmad Syarif Hidayatullah, Agung Nugroho Jati and Casi Setianingsih
4	13.45-14.00	A Multi-Agent System for Solar Driven DC Microgrid	Diana Severine Rwegasira, Imed Saad Ben Dhaou, Aron Kondoro, Naiman Shililiandumi, Amleset Kelati, Nerey Mvungi and Hannu Tenhunen
5	14.00-14.15	Autonomous VTOL Design in Quadcopter Using Feedback Linearization and Fuzzy T-S	Chalidia Nurin Hamdani, Mohammad Nuh and Rusdhianto Efendi Abdul Kadir
6	14.15-14.30	Control System Implementation and Analysis for Omniwheel Vehicle	Andra Bramanta, Agus Virgono and Randy Saputra

Session 8 : 13:00-14:30

Tracks : COMM **Room : Bangkirai Room**

No	Time	Title	Authors
1	13.00-13.15	Performance Analysis of Hybrid AF and DF Protocol for Relay Networks	Dhoni Putra Setiawan and Hua-An Zhao
2	13.15-13.30	Identifying 4G Service Attributes on Customer Satisfaction in Indonesia Market: Kano Model Approach	Al Bukhari Pahlevi and Muhammad Suryanegara
3	13.30-13.45	Performance Analysis of Message Drop Control Source Relay (MDC-SR) in Maxprop DTN Routing	Aditya Nikolas Putra, Leanna Yovita and Tody Wibowo
4	13.45-14.00	Antenna MIMO 8×8 Array 2 Patch Rectangular H-Slot for 5G Access Radio at Frequency 15 GHZ	Adhie Surya Ruswanditya, Heroe Wijanto and Yuyu Wahyu
5	14.00-14.15	The Anyar River Depth Mapping from Surveying Boat (SHUMOO) Using ArcGIS and Surfer	Putu Harry Gunawan and Ketut Tomy Suhari
6	14.15-14.30	Leveraging Crime Reporting in Metro Manila Using Unsupervised Crowd-sourced Data: A Case for the iReport Framework	Bernie S Fabito, Angelique Lacasandile, Arlene Trillanes and Emeliza Yabut

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Indonesia ancient temple classification using convolutional neural network

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***Abstract*—This paper describes the use of convolutional neural network(CNN) method to classify various image and photo of Indonesia ancient temple. The method itself implements Deep Learning technique designed for Computer Vision task. The idea behind CNN is image pre-processing through a stack of convolution layers to create many patterns that can be easily recognized. The result shows that the learning model has an accuracy of 98,99% on the training set and accuracy of 85.57% on the test set. With GPU performance, the time used to train the model is 389.14 seconds.**

Keywords—Deep Learning; image classification; GPU; CNN; Indonesia ancient temple.

I. INTRODUCTION

Ancient temple in Indonesia is an essential part of a cultural image for the country. The temple uniqueness shows that the cultural and religious value could survive the test of time. Such majestic heritage surely cannot be ignored and forgotten. Therefore, to have a machine classify these temples is one of many methods to cultivate a culture with current technology.

Technology like Artificial Intelligence and Computer Vision could help us identify the right temple with precision. However, to reach a good precision, a machine has to go through a very complicated task. Various shape and material on the temple can be a very challenging and a hard task for a machine to classify. This problem mainly occurs because of a limited dataset to feed on the model and could result in a bad accuracy. Using Convolutional Neural Network (CNN) model to make machine learns features from the image will certainly improve how the machine could classify the temple images with a good accuracy.

CNN is a neural network method to make the model learn better to classify or recognize a visual pattern. This network is made with the assumption that the input used is an image. On each layer of convolution, the input image will be processed with many filters and will create a stack of activation map. These activation maps will create many patterns from some parts in the image that will be easier to classify. The classification progress includes the connection to neurons or activation units just like a simple neural network model. This technique can make the model learn more efficiently and greatly reduce the number of parameters in the network [1] [2]. However, using only CNN model might still result in overfitting the model. This problem could potentially make the model cannot predict the future data very well. Many solutions can solve the case of overfitting. Preprocessing image such as rotating or horizontal flip before inputted to the model is one of the better solutions, especially when the data in the dataset is too little. Another solution is to lower the model complexity with a lot of regularizations. In this paper, we implement the CNN method using image pre-processing, Dropout regularization, Softmax classifier and stochastic gradient descent.

The whole concept to use CNN method is a direct approach to implements Deep Learning principles, as the method itself uses a lot of layers. More layers that will be used in the model will make the network architecture to go deeper, thus requiring a bigger computation time. However, this is not a problem anymore because of GPU performance. The time required for training is why Deep Learning technique largely influenced by stronger computer, large datasets and algorithm to train deeper networks [3].

II. THEORY

A. Convolutional Neural Network

CNN is a neural network devoted to processing data that has a grid structure. The basic example of this model input is a two-dimensional image. This neural network model is first successfully applied in 1998 by Yann LeCun, where he classifies the MNIST digit to document recognition [4]. The convolution name itself is a linear algebra operation that multiplies the matrix of the filter with the image to be processed. This process is called convolution and one of many types of layers in the model. Convolution layer is the most important layer to use in the model. Another layer is the Pooling Layer, which is the layer used to extract the maximum value or the average value of the parts of the pixels in the image. Here's an overview of the Convolution Neural Network architecture.

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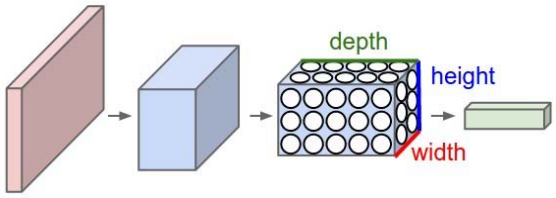

Fig.1. Convolution Neural Network Architecture
Image Source: http://cs231n.github.io

From the picture above each layer has a different volume and is represented with depth, height, and width. The left red block is the input image before being processed with the filter. After the image filtered with convolution, it results in another block with reduced spatial size but deeper depth. The depth is obtained from a stack of activation map from the inputted image with different filters. The next layer shows the block with different size until the last layer where the block converted into 1-dimensional and can be seen as a normal row of neurons which can be connected to the outputs. The quantity gained from each block depends on the filtration result of the previous layer and also the number of filters used. The more filters used in the model will make the depth to be deeper.

CNN works just like a regular neural network but with a different connection from each neuron. A regular neural network uses all connection from the previous neuron to each neuron in the next layer. CNN only uses connection to a certain local region in the next layer depending on the filters used. The local region is the activation map that comes from convolution process and creates the parameters that will determine the end result.

This neural network model has proven to be very powerful in addressing image classification problem. In 2012 Alex Krizhevsky achieved a 15.3% test error on the ImageNet dataset [1]. It shows that visual classification using CNN method is very effective.

B. *Convolution Operation*

Convolution operation is an operation on two functions of a real valued argument [3]. The operation is to applicate an output function as a feature map from an input image. These inputs and outputs can be seen as the two real valued arguments. Formally the operation can be written as in

$$s(t) = (x * w)(t) \quad (1)$$

The function s(t) provides a single output as feature map, the first argument is the input which is x and the second argument w as the kernel or filter. If we look the input as a 2D image, then we can assume t as pixel and substitute it with *i* as row and *j* as column. Alternatively, convolution operation can be treated as a matrix multiplication between the input image and the kernel. Where the output was supposedly computed by dot product.

We can also determine the output volume from each convolution layer with hyperparameters. The hyperparameter is used in below equation to calculate how many neural activations in a single output.

$$(W-F+2P)/S \quad (2)$$

We can compute the spatial size of the output volume as a function of the volume size (W), the filter (F), the stride applied (S) and the amount of zero padding used (P). Stride is the amount we slide the filter through the input image and zero padding is to put zeros around the image border.

C. *Pooling Layer*

A pooling layer is a function with feature map as the input and processed them with a summary statistic of the nearby outputs. Practically in a CNN model, pooling layer usually inserted regularly after a few convolution layer. Pooling layer between successive convolution layers in a CNN architecture could progressively reduce the volume size of output or feature map, thus reducing the amount of parameters and computation in the network, and to control overfitting as well. It is worth noting that choosing many types of Pooling layer can also benefit the model performance [5]. The pooling layer works on every single stack of the feature map and reduces its sizes. The most common form of pooling layer is with filters of size 2x2 applied with a stride of 2 and then operates on every slice from the input. This form will reduce the activation map to 75% from the original size.

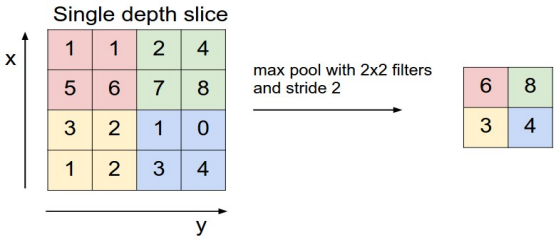

Fig.2. Max Pooling Example
Image Source: http://cs231n.github.io

Pooling layer will operate on every single depth slice of the input volume. In the picture above, the pooling layer uses one of max operation which is the most common operation. Figure 2 shown the operation with a stride of 2 and pool size of 2x2. From 4x4 input size, on each 4 numbers in the input, the operation takes its maximum value and create a new slice size of 2x2.

D. *Fully-Connected Layer*

Fully-Connected layer(FC) is the layer where all the activations from the previous layer have full connections to the neuron in the next layer just like a regular neural network. Every activation from the previous layer needs to be transformed into one-dimensional data before it can be connected to all the neuron in FC layer. FC layer usually used in Multi-Layer Perceptron application and aims to process the data so it can be linearly classified.

The difference between FC and convolution layers is that the neurons in the convolution layer are connected only to a local region in the input and that many of the neurons in a convolution volume share parameters, while FC layer has the whole neuron connected. However, both layer still operate dot products, making their function not so different.

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E. Dataset

The dataset used in this paper contains the image of several ancient temples in Indonesia with the size 150 X 150 pixels. This dataset was categorized into 6 temples. The temples are Borobudur temple, Prambanan temple, Kalasan temple, Sewu temple, Mendut temple and Sari temple. This dataset has 520 training images and 225 test images collected from Flickr repository. Here is the example from each category:

a. Candi Borobudur

Borobudur temple category has 100 training images and 50 testing images.

Fig.3. Borobudur Temple Image Sample
Image source: http://www.flickr.com

b. Candi Prambanan

Prambanan temple category has 100 training images and 50 testing images

Fig.4. Prambanan Temple Image Sample
Image source: http://www.flickr.com

c. Candi Kalasan

Kalasan temple category has 70 training images and 15 testing images

Fig.5. Kalasan Temple Image Sample
Image source: http://www.flickr.com

d. Candi Sewu

Sewu temple has 100 training images and 50 testing images

Fig.6. Sewu temple image sample
Image source: http://www.flickr.com

e. Candi Mendut

Mendut temple has 100 training images and 50 testing images

Fig.7. Mendut Temple Image Sample
Image source: http://www.flickr.com

f. Candi Sari

Sari temple has 50 training images and 10 testing images

Fig.8. Sari Temple Image Sample
Image source: http://www.flickr.com

III. ALGORITHM

In the training algorithm there are 5 main stages, namely pre-processing stage, load training data, training data, and save final weights. During pre-processing stage, image data on the dataset processed in order to increase the amount of data to be trained, for example, the image can be in rotated, horizontally and vertically reversed. This stage can potentially reduce the case of overfitting. Next, in the load training stage, the data in the dataset split into input and output. The next step is the model training stage, which is the training process by entering the pre-processed data to the pre-arranged network model. The training process will run according to how many epoch and batch size are used. After the training process is completed the final weight will be stored for testing purposes.

Fig.9. Training Algorithm Flow

For the testing algorithm, there are 3 main stages, load model stage, load weight, and validation. The load stage model is the stage where CNN model is loaded as the basis for testing. Then at the load weight stage, the weights already stored in the previous training process will be used as the main parameters and will be inputted into the CNN model. Finally, in the validation stage, the network model with the training weights tested with the data in the test set from the dataset. The concepts used by validation basically compare the accuracy of the actual results of the test labels with the prediction given by the model, then from all the comparisons obtained, it will result in an average accuracy.

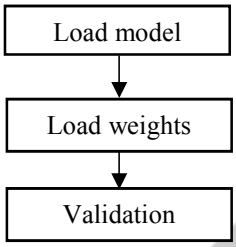

Fig.10. Testing Algorithm Flow

For the CNN model, this paper uses the following layer structure:

INPUT→CONV→CONV→POOL→CONV→CONV→

POOL→CONV→CONV→POOL→FC

CONV is the convolution layer, POOL is the max pooling layer and FC is the Fully Connected layer. The model uses Softmax classifier to determine the class prediction. This function also trained alongside cross-entropy loss function to give the model a nonlinear variant of multivariate output. Each CONV layer also has ReLU(Rectified Linear Unit) activation function, this activation can lead to better performance improvements in deep neural networks without significantly increasing the number of parameters [6] The entire series of layers will be optimized through Stochastic Gradient Descent in order to minimize the error and effectively update the parameters in the model. Throughout the stack of layers, a dropout regularization also inserted to prevent overfitting in a powerful manner yet easy to use. [7]

IV. RESULT

1. Training result

The following analysis will illustrate how the training results from different epochs can affect the training outcomes. The training uses the training set from the dataset, the results can be compared with the following table.

Epoch	*Accuracy*	*Time*
10	85.48%	86.77 seconds
20	95.67%	160.27 seconds
50	98.99%	389.14 seconds
100	100%	759.27 seconds

Fig.11. Training Result Comparison Table

From the table above, it can be seen that the greater the epoch used for training, the training time will be longer. This obviously occurs, because with more epoch being used, there will be more training in one forward feed. One epoch means that the model trained using the entire training set in the dataset.

Judging from the accuracy side, each epoch gives a different result. There is a significant difference between epoch 10 and 20, which is about 10% in between. But between the epochs 20, 50 and 100 did not show a very large difference in accuracy. Only with the epoch of 20, the model can provide accuracy of 95.67%. When the epoch is raised to 50, the model gives an accuracy of 98.99%, 3% more than the previous one. When using the epoch of 100, the model gives the optimal results of 100%. Although accuracy increases with many epoch, from the result it is evident that the use of a very large epoch is not always optimal if we also pay attention to the time for training.

2. Testing result

The following analysis will describe the test results from different training weights. The training weights that used for the test is the result from different training epoch and will be tested with the test set in the dataset, the results can be compared with the following table.

Epoch	*Accuracy*	*Time*
10	74.68%	4.46 seconds
20	78.36%	4.53 seconds
50	85.57%	4.39 seconds
100	86.28%	4.67 seconds

Fig.12. Testing Result Comparison Table

From the table above, it can be seen that the testing time of each epoch is not changed much. This suggests that the weight training generated from a different epoch, will not affect the time to test the model. Another reason why it does not affect time can be seen from the model used because the model used in each test is the same. All training weights have the same number of parameters as long as the same model is used, which differ only the parameter values.

Models that have been trained show better predictions than just guessing (16%). The model with training weight of 10 epoch to 100 epoch has the accuracy exceeding 70%. Obviously, with more epochs, the accuracy is also better. With every epoch that increases in number, the accuracy also increases. In tests with 10 epoch training weights, the model provides an accuracy that is not much different from that of 20 epoch, but when using 50 epoch, the accuracy is increased considerably. This suggests that large training results may not necessarily result in large predictions as well, judging by the

case with 20 epoch where the training results reached 95.67% but with the test results only reaching 78%. Whereas for 50 epoch with 98.99% training result, it can have the test result up to 85,57%. In the 100 epoch test, the test results also did not show significant improvement compared with only 50 epoch, which differed only 0.69%. With this result, it can be concluded that training with 50 epoch is the optimal option for training judging from the test accuracy and training time.

With this result, it can be concluded that image classification of Indonesia ancient temple using CNN model is very effective. As it can reach about 85% accuracy in clasify the test set. If we compare the test result using CIFAR-10 dataset with the same architecture model and the same pre-processing method, there are no much difference with the accuracy. The result with CIFAR-10 test set also shows about 85% accuracy.

3. GPU vs CPU

The model also trained using CPU and the result is the big difference in time compared with the GPU. The accuracy obtained more or less the same when using GPU. The time used to train data with CPU is 10,573 seconds using 10 epoch only, while using GPU only need 86.77 seconds. Training model using GPU almost 120 times faster than CPU. This result shows that training CNN model with GPU significantly increases performance to reduce the time.

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