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

PROCEEDINGS

ISBN : 978-1-5386-1667-3

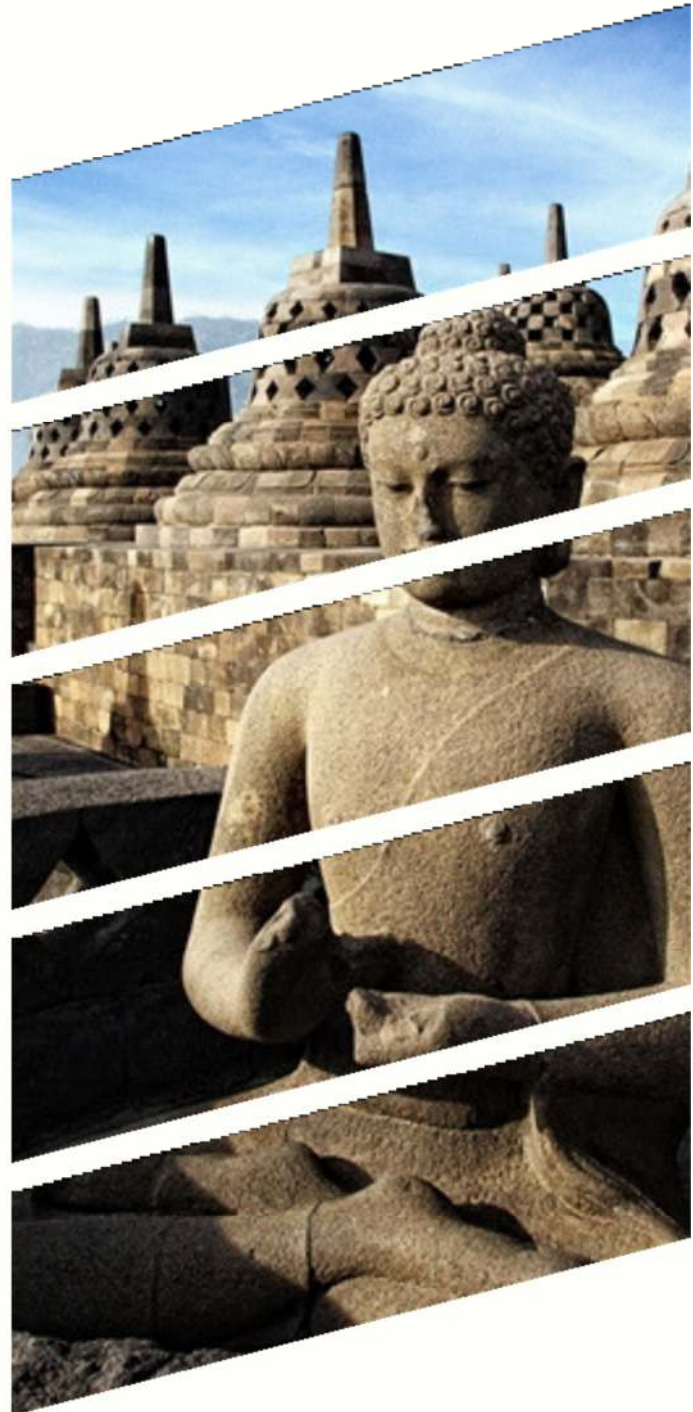
September 26-28, 2017
Tentrem Hotel, Yogyakarta-Indonesia



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:

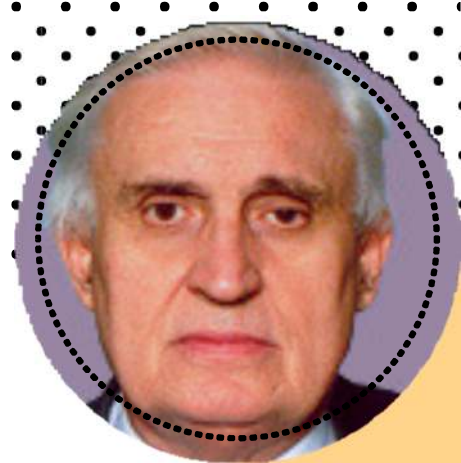
Before the 90s, monitoring system being deployed in isolation. Each application stands by its own. Vendors try to capture their proprietary product in the hope of making so much financial gain as possible. Nevertheless, in past two decades, a lot of research activities have been dedicated to the fields 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 OF SERBIA



"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 Lutfu 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

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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	<i>Analysis Security Metric on BRO IPS Based on CVSS and VEA-bility Metric</i>	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 8x8 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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Low Cost Visible Light Communication Transceiver Prototype for Real Time Data and Images Transfer

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Abstract—Research about Visible light communication (VLC) grows rapidly due to the need of innovation in wireless information transmission system. Previous research about low cost VLC prototype has been conducted. The previous result is still under expectation, the maximum transmission distance was only 15 cm. This research is trying to improve the performance of the low cost VLC prototype by using array LED and array Phototransistor to achieve longer transmission distance. We adding the image transmission feature so that the information in form of text and image can be transferred. The prototype is build by using low-cost components and supported with desktop application as the interface. From the new prototype, the system able to send text and image data perfectly with maximum transmission distance is 98 cm. The maximum acceptance angle for transmission is 70° with maximum baud rate is 19200 bps.

I. INTRODUCTION

Wireless communication requires carrier wave to carry information and travel via free space. The popular carrier wave which is widely implemented for wireless communication is radio wave. The higher society needs of communication, the more radio frequency required while the available radio frequency keeps decreasing. Another carrier wave such as visible light should be considered to be used to fulfill the needs.

Compared to radio wave, visible light supports better security, resistance on electromagnetic interference, and support further research and development since there is no regulation yet. The term visible light communication (VLC) then appears as one of optical wireless communication (OWC) technologies which uses frequency of light where the emitted light is visible [1], [2]. Another factor that supports VLC to be implemented is the fact that people had started to use LED lamp instead of conventional lamp due to its characteristic that saves more energy. LED lamp that emits visible light has high switching speed where it can be switched on and off continuously in high speed where human eyes cannot follow or notice [3]. This high switching speed characteristic then gives an idea to transfer digital data, where logic value 1 is represented in "on" condition of LED, and logic value 0 is represented in "off" condition.

Some research had been conducted to design a VLC system with various implementation. An example of the conducted research was the was done by implementing VLC communication protocol for two toys vehicle interaction with simple transferred

information that achieved 1,9 meters maximum transmission distance [4]. Another similar research was done on railways implementation by using transceiver system attached in the train to do information exchange with the site server [5]. A research to build a low cost VLC prototype system, which able to send 1200 characters simultaneously with maximum acceptance angle is 75° and maximum distance is 15 centimeters [6]. This research is trying to improve the performance of the low cost VLC prototype and adding the image transmission feature. The information in form of text and image are transferred from devices which act as transceiver which optimized from the previous research. The prototype is build by using low-cost components and supported with desktop application as the interface.

II. BASIC THEORY

A. Visible Light Communication

Visible light communication is a technology from optical wireless communication where information is carried by visible light traveling in free space. Some implementation of VLC had been done, including the indoor VLC system adapted from conventional infrared communication system [7]–[9]. The general configuration of VLC and infrared communication are similar, but each uses different wavelength with different sort of light. Some research including this research aimed to implement VLC indoor system by seeing the fact that people started to use LED lamp widely for room illumination which has potential to be used as communication media among devices.

B. Light Emitting Diode

Visible light can be emitted by light source including LED and LASER by setting the operating wavelength. Compared to LASER, LED emitted light incoherently, thus it is used for room illumination lamp. LED is an electronics device which is used to emit light from the given current supply [10]. The basic principle of LED is similar to another diodes where the structure consists of the junction of p-type semiconductor and n-type semiconductor that operate with forward bias. At normal condition when there is no passing current, electrons stay at the valence band which is an outer line of an atom. In a condition where a current with energy above the energy gap passes, the electrons will move to the conduction band. The electron will

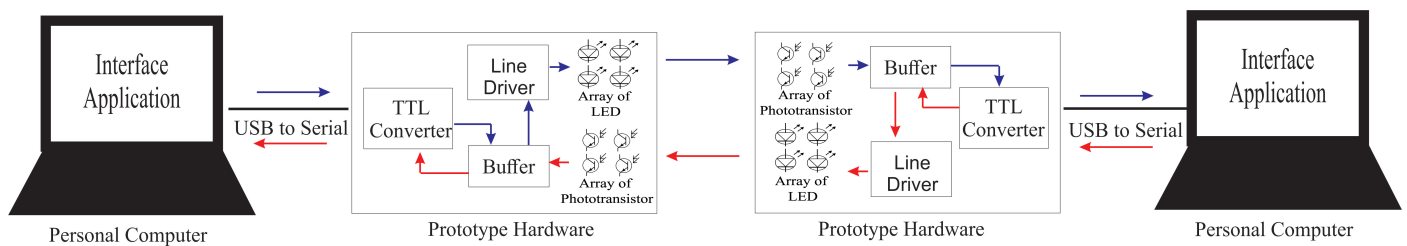


Fig. 1. System model of VLC transceiver

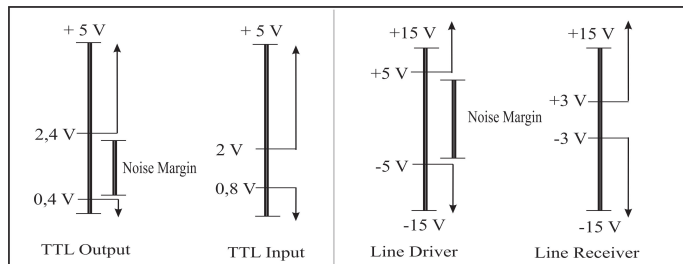


Fig. 2. Voltage level difference of RS-232 and TTL

then do a recombination back to the valence band by emitting energy in form of light. The emitted light disperses to many directions due to the spontaneous emission principle of LED.

C. Photo Transistor

VLC system needs a component that could detect the modulated light. The incoming light should be received then converted back to electrical signal before processed further in the receiving system. The components that could do that function are photo resistor, photo diode, and photo transistor. However, photo transistor is chosen in this research and most related research since it has internal gain and high sensitivity. The light received by photo transistor will generate current at the base region and generate current amplification hundred or even thousand times [11]. Photo transistor act as transducer.

D. RS-232 Serial Communication

RS-232 is a serial communication standard that used for information exchanges among devices. This serial communications commonly uses connector DB9 or DB25. RS-232 serial communication is a sample asynchronous communication which means the data transfered will be sent without using clock signal which is generally used for synchronization. To replace the role of clock signal, a start bit and a stop bit will be sent along the data packet. The sent data frame is arranged in the order of a start bit, followed by data bits, parity, and then a stop bit. RS-232 has its own voltage level which is higher in range compared to TTL voltage level as shown in figure 2 which is required by ICs and other electronic components to work. Thus, a voltage level conversion is absolutely needed which can be done by some ways including the use of IC max232.

III. SYSTEM DESIGN

The VLC hardware design could act both as transmitter and receiver with half duplex communication. As shown in Fig.3 The communication from VLC transceiver devices to computer use DB9 connector where pin no.3 used as data output where -15V to 15V current from USB to serial converter sent to IC max232 that will convert the current into TTL level 5V. Through pin 12 of max232, TTL output can be obtained and proceed to free-noise buffer on pin 8 of IC 7414 which is connected to the base of transistor for high current and voltage amplifier that act as LED array driver. By using RS-232 serial communication protocol, information signal is modulated on LED indicated with the on and off condition switch of the LED. By using IC 7414 schmitt trigger, the modulated light received by the photo transistor would trigger pin no.1, then invert it to pin 2 and inverted again to pin 3 for the revert process. This process is done to amplify the signal right after being received by pin 2 and make the amplified signal has less noise to pin 4 then forwarded to pin 11 of IC max232 where high voltage would be converted to TTL level 5V out to pin 14 which is connected to pin 2 DB9 which is an RX pin. Then the signal is ready to be processed and can be read by the designed software or another serial communication software like Hyper Terminal.

The data is monitored by using a stand alone desktop application. The application used to send and received text and images. To send the text, user has to insert the text in the texts-to-send box. To send image, user can start by choosing images format such as *.jpg, *.bmp or *.png. In the receiver side, the received text was shown directly in the received text box. When receiving the image data, the image can be shown if the number of bits received is same as the numbers of bits transmitted along with the start, parity, and stop bit. The error bits can be known by comparing the bits preview in the receiver side and bits preview in transmitter side.

IV. MEASUREMENT ON TEXT AND IMAGE TRANSMISSION

The quality of the system for text transmission is measured by calculating character error rate (CER), while the quality of image transmission is calculate by using Bit Error Rate (BER). CER is calculated by dividing the sum of error characters with the sum of characters sent. The measurement is done to see the impact of parameters value changes to the CER value. The analyzed parameters are distance, acceptance angle, and transmission/baud rate. The number of characters sent for the testing is minimum 1200 characters.

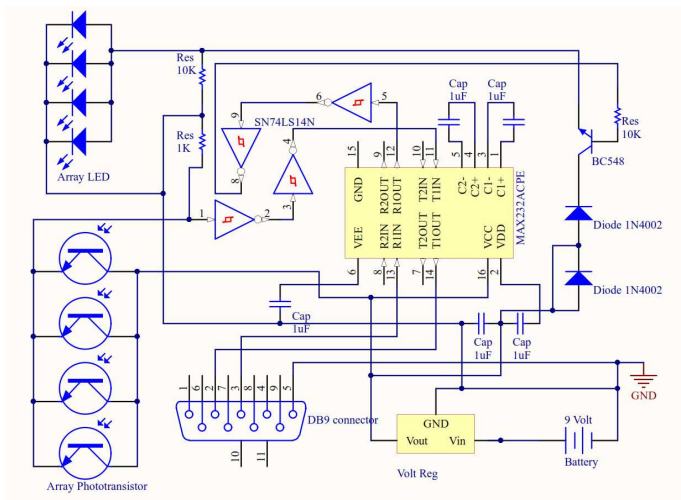


Fig. 3. Schematic Design

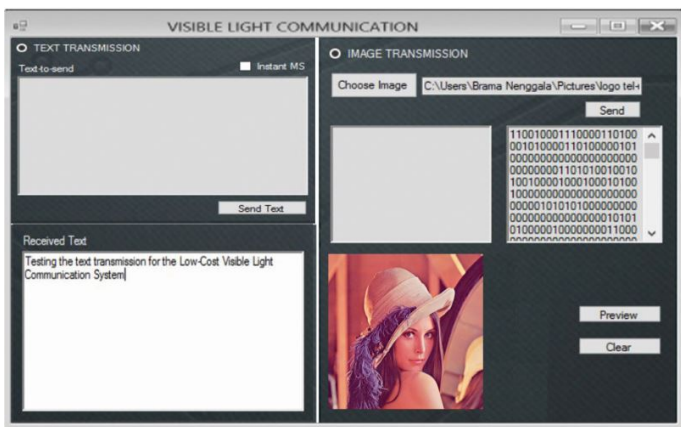


Fig. 4. 'Graphical User Interface

BER calculates error more detail than CER. It is calculate by divide the error bits with the total bits of the image sent. The BER analysis is done by observing the distance, acceptance angle and baud rate. For each parameter value, three tests were done with three different sizes of image, which are 512 bytes, 1024 bytes, and 2048 bytes. The average BER value was calculated from three tests of each parameter value.

V. RESULT AND ANALYSIS

A. Distance Parameter

From the measurement result in Table I, it can be seen that both CER and BER value equals to zero on distance range 1-98 cm which means that all data can be sent completely without any error. The error occurs when the distance set above 98 cm until it reaches the maximum distance for detection which is 115 cm. By using array LED we can increase the transmission range from the previous research. The distance limit on this system is due to the operating power of the LED used that affects the distance it can reach.

TABLE I
SUMMARY OF DISTANCE PARAMETER MEASUREMENT RESULT

Transmission Distance	CER	BER
10 cm	0	0
25 cm	0	0
50 cm	0	0
75 cm	0	0
98 cm	0	0
100 cm	0.192	0.023
115 cm	0.897	0.353
>> 116 cm	N/A	N/A

TABLE II
SUMMARY OF ACCEPTANCE ANGLE PARAMETER MEASUREMENT RESULT

Acceptance Angle	CER	BER
0° - 60°	0	0
70°	0	0
75°	0.368	0.435
80°	0.877	0.916
85°	N/A	N/A
90°	N/A	N/A

TABLE III
SUMMARY OF BAUD RATE PARAMETER MEASUREMENT RESULT

Baud Rate	CER	BER
1200 bps	1	0.8980
2400 bps	0.5251	0.4179
4800 bps	0	0
9600 bps	0	0
19200 bps	0	0
38400 bps	0.3694	0.3447
56700 bps	0.8146	0.6273

B. Acceptance Angle Parameter

Based on the measurement result shown in Table II, both text transmission and image transmission work well without any error occurs on acceptance angle range 0° - 70°. Error starts to occur above 75° and stop at the maximum acceptance angle where devices can detect each other which is 80°. The measurement show a good result for a wide range of acceptance angle where the system can work well. The good result is obtained because of the LED emitting characteristic. With this result, the position of array photo detector from array LED as light source can be more flexible. It can be concluded that using array LED is the right choice for achieving better transmission angle.

C. Baud Rate Parameter

Based on the measurement result shown in Table III, it can be seen that the system can work well with no mistakes on baud rate value 4800, 9600, and 19200 bps. For baud rate value below 4800, error occurs because its below the minimum speed the photo transistor can detect modulated light. Error



Fig. 5. Comparison between sent image and received image

occurs for baud rate value above 19200 bps, where the higher baud rate value the higher error rate occurs. This could happen due to the limit of LED switching speed and photo transistor sensitivity. To gain more maximum speed, the choice of LED and photo transistor is the main issue. The LED used should has higher switching speed and photo transistor should has higher sensitivity for higher baud rate.

VI. CONCLUSION

Based on the designed system for both VLC transceiver prototype hardware and interface application, it can be concluded that the designed system generally can work perfectly with no error at distance range 1-98 cm, acceptance angle is between 0° - 70° , and maximum baud rate is 19200 bps. The maximum distance in which the prototypes can detect each other and send information (with error) is 115 cm with average CER value 0.897 for text transmission and average BER value 0.353 for image transmission. The maximum acceptance angle for device detection is 80° with average CER value 0.877 for text transmission and average BER value 0.916 for image transmission. Error occurs for baud rate below 4800 bps where the lower baud rate, the higher CER value, and occurs for baud rate above 19200 bps where the higher baud rate, the higher CER value.

ACKNOWLEDGMENT

The authors would like to thank all assistants of optical communication system laboratory Telkom University for their help by providing place and equipment for the authors to finish this research.

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