

Message from Editor:

Dear Valued ECTI Association Members,

First of all, I would like to thank Prof. Kosin Chamnongthai for allowing me to work as the editor for ECTI E-Magazine starting from this issue. Through his dedication and passion, the ECTI E-Magazine has continually served our members during the last 8 years with valuable information and updates. Next year, we hope to continue serving you even more informative review articles, updates and sections in the E-magazine.



In this issue, you may read an article titled "Key Communications within

Glucose Stripe Biosensors: A Basic of Electrical and Chemical Wiring" by Dr. Metini Janyasupab, updates on sponsored conferences, seminars as well as publication list of ECTI Journals.

I would like to wish all ECTI members happiness, success, good health as well productive year ahead.

ECTI E-Magazine Editor

Pornchai Supnithi (King Mongkut's Institute of Technology Ladkrabang)

In this issue:	
Message from Editor	Page 1
ECTI President Message	Page 2
Review Article ("Key Communications within Glucose Stripe Biosensors:	
A Basic of Electrical and Chemical Wiring" by Dr. Metini Jan	yasupas) Page 3
Paper list of ECTI Transaction (CIT, EEC)	Page 18
Reports from Conferences/Seminars/Workshops	Page 19
Announcement/Call-for-Papers	Page 24
ECTI Who's Who	Page 30

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ECTI President Message:

The time really flies, doesn't it?. I hope that all our members agree that this has been another memorable year in your profession and ECTI Association with many sponsored conferences, workshops, seminars as well as membership benfits. Since this is my last Message to all of you (the new Administration will commence in early 2016) as well as the last issue of the ECTI E-Magazine of 2015, I would like to thank all the committee members for their hard work in bringing our Association forward and certainly thank Prof. Kosin Chamnongthai who voluntarily produced the enjoyable and informative E-Magazine issues during these 8 years. We appreciate all the



members and your participation in our flagship conferences as well as the Area activities during this year. **You are the foundation of our Association** and I truly hope that you will serve in various voluntary administrative positions in the near future so that we all grow professionally and personally together.

Thailand has recently finished the two 4G license auctions, and we are witnessing new waves of technologies such as cloud computing, data analytics and grid computing among others. In addition, many technologies relevant to the ECTI Association are being supported or will be emphasized by the Thai government through the government policies in Industrial Clusters and Super-clusters. To name a few, they include digital economy, alternative energy, transportation and logistics, robotics, next-generation automobiles, ICT for agriculture and health, digital divide, smart home and smart electronics. Research, innovation and startups have been envisioned as essential instruments and mechanisms to move Thailand or a country in ASEAN from a lower middle-income nation to a high-income nation. Our researchers and community need to team up and contribute on this road of the future.

I would also like to remind our members on the submission datelines for the upcoming **ECTI-CON 2016**, to be held in Chiangmai, Thailand, as well **ECTI-CARD 2016** to be held in Prachuabkirikhan, Thailand. The first conference emphasizes on new research results and innovations in our fields, whereas the latter focuses on the innovative and project-based practical innovations. You are all encouraged to attend these flagship conferences of our association.

Finally, I would like to wish you all Happy Holidays, filled with happiness and success in the next coming year.

Prayoot Akkaraekthalin, KMUTNB



[Article]

Key Communications within Glucose Stripe Biosensors:

A Basic of Electrical and Chemical Wiring

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Abstract

One of the challenges in several engineering problems is to correlate inter-disciplinary processes embedded within one physical system. In order to accomplish a great design and advancement, it is necessary to establish a good fundamental of the device. Considerably from various engineering backgrounds, a design of classical biosensor is one of great practical examples. The key of the device, in general, is originated from a metal coated with biological elements. Therefore, the device its own is involved with biological compartments, chemical processes, and indeed electrical connections. This review aims to demonstrate common engineering points of view from biomedical, chemical and electronics engineering emerging into one general working principle of biosensors. With little chemical terms or technical jargons, the review is written for self-explaining and easily developing a basic understanding of glucose stripe sensors, the major product of commercially available biosensors. The device will be emphasized to illustrate chemical and electrical connection and their functions to facilitate diabetic patients. As uniquely designed, the device is ultimately considered as one of a very few engineering systems that lack of feedback control; yet becomes viable to global markets and healthcare communities.

Keywords: biosensor, glucose sensor, electrochemistry, glucoses stripe

1. Introduction

The best described and most well-known biosensors in the market are a glucose stripe sensor, invented since 1962 by Clarks and Lyson [1]. Making a broad impact for global diabetic care, the device alleviates those who suffer from an imbalance blood glucose control. Diabetes is a serious public health concern that requires a life-long management and effective monitoring. The symptom is caused by an



impairment of converting blood glucose into the cell due to dysfunctional or lack of insulin hormone as described in Fig.1. Subsequently, accumulated and excessive amount of glucose in blood stream can cause a high blood pressure, a serious skin infection, or a loss of muscle function or internal organ's failure. This condition can be found either *Type 1* (naturally lack of insulin) or *Type 2* diabetes (gradually occurs from dietary habits or metabolic changes). In 2014, the World Health Organization estimated that 9% of adult populations were found with diabetes, and 1.5 million deaths were directly caused by diabetes [2]. Furthermore, tremendous needs of diabetic healthcare lead to a majority market drive toward biomedical sensors for more than four decades [3, 4], and still continue actively growing with a recent estimated value of 1 billion US dollars in 2010 [5].



Fig. 1 Systematic function of glucose (yellow hexagon) and insulin (blue circle), under a normal condition (left) insulin helps glucose in blood entering into muscle cells to store or exploit as an energy source. However, diabetes (right) fail to bring glucose from blood into the cells.

2. Conventional clinical measurements of blood glucose

In clinical diagnosis, three conventional instrumental methods, namely, (1) A1C, (2) fasting plasma glucose (FPG), and (3) oral glucose tolerance test (OGTT), are often selected to facilitate physicians in order to determine diabetes conditions [6-8]. The principle of these methods is underlined by measuring excessive glucose level in blood. In general, the first test A1C (also known as HbA1C or hemoglobin A1C), a specific protein in blood, detects excessive numbers of A1C protein binding with glucose molecules. Under a normal condition, the specific hemoglobin A1C in blood can naturally bind with glucose and form a complex pair, approximately 6.5% in quantity. However, if some abnormalities occur, there will be more glucose in blood. Consequently, more complex pairs can be formed much higher



than 6.5% [9, 10]. Thus, this value can be used as a standard to implicitly quantify the glucose level in blood. As shown in Fig. 2a, the complex pair between A1C in blood and glucose is denoted as the red circle and the yellow polygon, respectively. This bonded pair can be counted under light by labelling a chemical tag (fluorescent) denoted as the blue star, or it can be weighted by mass using High Pressure Liquid Chromatography (HPLC) [7, 10].

In addition to the first method, both FPG and OGTT tests also measure indirect signals of blood glucose level shown in Fig.2b. Both tests require patients to temporarily stop eating prior to the measurement. The given condition as an input of FPG is a long pause of glucose conversion process, called fasting (no eating for a specific period of time). The procedure allows the actual systematic function of glucose-energy conversion can be examined. As a result, the excessive glucose level can be detectable. Slightly different from FPG, the OGTT test allows a series of glucose intake for a shorter period of time into the body, creating a spontaneous impulse of the bodily glucose consumption process. After patients consume some known concentration glucose drink, their blood will be collected. Both tests are also carried out via the chemical processes, involved with biological elements or enzyme to convert glucose into another chemical form. Finally, the detectable product form will be measured its physical properties such as wavelength (frequency) or weight by the same techniques of A1C output counting.





Fig. 2. Working principles of clinical blood glucose measurements: (a) A1C test incorporating the glucose-hemoglobin pair (denoted as red circle and yellow polygon, respectively) detection, seen by fluorescence labeling, and (b) FPG and OGTT tests evaluating glucose products (purple polygon) from enzymatic conversions without any food consumption.

Due to tedious clinical procedures, long waiting periods of time, and trained personnel requirements, diabetes patients often receive medical care based on their accessibilities to the hospitals. All three benchtop testing methods are suitable for different patient conditions and availabilities of equipment. Therefore, the standardization of these tests is significantly important for accurate glucose estimations and therapeutic actions. As shown in Table 1, a criterion for diabetic diagnosis based on outcomes of these methods can be relatively compared. For example, an individual is more likely to have a diabetic condition at the higher value of 6.5% A1C. The test estimates an average of glucose level within the past 3 months based on the red blood cells' life cycle. This is also equivalent to 126 mg.dL⁻¹ in FPG test and 200 mg.dL⁻¹ in OGTT test (milligram per deciliter is the glucose weight in one drop of blood volume). Alternatively, these values can be computed to another standard unit, equivalent to 7 and 11.1 milli molar in SI unit, respectively.

Table 1. Standard criteria for diabetes diagnosis (adapted from American Diabetes Association) [9].

Methods	A1C	FPG [*]		OGT	Т**
Unit	%	mg.dL ⁻¹	mmol	mg.dL ⁻¹	mmol
Level	> 6.5	126	7	200	11.1
* fasting (no food intak	(e) for 8 hours	** fol	low a standard measu	rement of WHO at 2 hours	

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Broadly speaking, the result of FPG is, as a steady state response of the body (system), evaluating an output response of glucose in blood stream without any input glucose signal for 8 hours. On the other hand, OGTT result can be described as an output transient response given by a known impulse glucose input signal. The OGTT procedure is normally performed at every 2 hours after an individual drinks some known glucose concentration beverage. All of these methods are inevitably performed in the hospitals, and, they take from several hours to days to report the patients. Therefore, the need of more simple, portable test motivates developments of glucose stripe sensors, to provide a more reliable and tight monitoring of blood glucose level.

3. Working principle of glucose stripe sensors

Tremendous economic prospects associated with the management of diabetes led to a more selfmonitoring and control strategies with less dependency to clinical measurements. In 1962, Clarks and Lyson developed the first glucose sensor at the Cincinnati Children Hospital. The device was involved with two important processes: a biological recognition and an electron transfer. The former process aimed to specifically target a change of glucose in blood either by a chemical or biological method. The later process would subsequently indicate a detectable signal from the former process and display as a final output. More specifically, Table 2 summarizes inputs and outputs of these two consecutive processes. Within a drop of blood, two initial inputs of the biosensor were glucose and oxygen. In presence of the enzyme, the glucose was converted into two chemical products: (i) gluconolactone and (ii) hydrogen peroxide (H₂O₂) [11], creating intermediate signals. At that time, Clarks designed the biosensor to trace the oxygen consumed in blood. After the biological recognition step was complete, the change of oxygen could indirectly indicate the glucose level in blood. The more oxygen consumed, the more glucose was present in blood. Furthermore, it was also known that oxygen could actively interact with a metal electrode (such as platinum). Under an applied voltage operation, the change of oxygen in blood could be measured by the change of potential between the electrode* (shown in Table 2) and another stable electrode (so-called the reference electrode). Thus, the first glucose biosensor was essentially an oxygen sensor measuring oxygen consumption from an enzymatically glucose conversion process.

Process	Input	Output
1. Biological Recognition	Glucose in blood	Glucose products
	Oxygen in blood	Electroactive chemical (H_2O_2)
2. Electron Transfer	H ₂ O ₂	Current
	Electrode	Electrode*

 Table 2. Two key processes in Clark-type glucose stripe sensors.

^{*}The working electrode under an applied potential that transiently change its own potential.

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After the first invention, the glucose biosensor has significantly gained research momentum. There are several developments, addressing existing issues from the original prototype such as interference signal, voltage drift, and oxygen dependency [12]. More particularly, several chemicals are able to contribute to a change in potential, especially at a negative voltage mode. Note that biosensors are considered as electrolytic cells, meaning that positive and negative polarities (sign convention) are opposite to batteries and other energy storages. In supplemental Fig.S1, the positive voltage mode results in an anodic process, giving electrons from the working metal electrode. On the other hand, the negative applied voltage mode governs the working electrode to accept electrons and oxygen, described as a cathodic process.

Based on this sign convention, the first generation glucose sensor is under a negative potential operation to receive both electrons and oxygen in blood. However, there are several limitations to this approach. For example, oxygen is a chemically reactive and sensitive to pH change. Under several circumstances, pH and oxygen interactions lead to a false output signal and thus lower specificity of the measurement. In addition, a negative applied potential is sensitive, not only for oxygen consumption but also various oxygen derivative forms. Thus, the output signal at the selected potential cannot be reliable for a major change of glucose measurement in blood. Furthermore, the input voltage is applied at the same time as reading the output voltage signal, creating a voltage drift phenomena. Hence, the poor sensitivity and selectivity is observed in this design.

Fig. 3 above shows an alternative approach by monitoring H_2O_2 , an electroactive product from the biological recognition (the output of Process 1, and the input of Process 2 in Table 2). The two primary processes still remain. However, this approach detects an amount of produced H_2O_2 from enzyme conversion. Due to the close physical contacts of both processes taking place, the electrons from the produced H_2O_2 can be transferred to the working metal electrode. Therefore, the change of current and/or



voltage can be detected. A positive applied input voltage mode is also used to avoid other sensible species. More importantly, this approach employs three electrodes in order to separate the voltage reference electrode and the current reference. As previously mentioned, only two electrodes are employed into the first prototype. This design leads to a voltage drift, causing a shift of baseline and diminishing the performance. To minimize this effect, an additional electrode is applied to facilitate the current output measurement. As shown in Fig. 4, it serves as a reference for reading out current and supplying electrons to reduce any ohmic resistance. This enhancement of monitoring the electroactive product and selecting more suitable potential operations becomes a major advancement of the improved designs. The glucose level in blood is simply proportional to the H_2O_2 formation that is contributed to more electron transfer. Ultimately, the current output can correlate to a particular level of glucose, displaying as a value on a glucose meter. By far, this working principle is still the fundamental of current commercially available glucose stripe sensors.

4. Connections between compartments

Today's commercial glucose stripe sensors consist of three electrodes as shown in Fig. 4 from left to right: (1) a reference electrode, (2) a working electrode, and (3) a counter electrode, respectively. The three-working electrode system is very efficient for electrical and chemical wiring. In detail, one end of each electrode is connected to biological elements by coating techniques. Another end is connected to an electrical output reader such as a current meter. In general, printed technologies, such as screen-printing or thin film coating, are often selected for large-scale manufacturing. In this section, communication between the chemical process and the electrical connection will be explained for a typical operation of glucose stripe sensor.

Based on the principle of the device in Fig. 3, the key operation is to translate the electron movement, resulted by a change of glucose in blood, into the output reader effectively. There are three physical compartments necessary for any electrochemical based glucose sensors: (1) enzyme (or other equivalent substitutes), (2) conductive electrodes, and (3) an electronics circuit (normally a voltage supply and a current reader). The connection between the first and the second compartment is described by chemical wiring. In Fig. 4, the first compartment, is the biological enzyme coated on a conductive surface of the working electrode. The enzyme is chemically bonded with polymers or high surface area materials in order to entrap the active biological sites of the enzyme. Desire characteristics of this connection include stable enzyme immobilization, highly conductive material selection, and sufficiently selective filtration.



After H_2O_2 is produced, the electrons will be drawn toward the electrode. This electron essentially becomes the target input of the second process (electron transfer), wiring by a mediator, which is another facile electron carrier. Naturally, many metals will detect the change of electrons on the surface easily. However, the electron transfer process occurs significantly faster with a small assistance of the mediator and some input energy (applied voltage). The target input of this process is detected by matching an appropriate applied potential, from 0.0 to +0.7 V versus the reference electrode (normally made of silver/silver chloride). It is also important to consider that there are other unwanted electro active species in blood. And, both chemical and electrical wiring is a one-directional process, cascading from the enzyme-electrode to the electrode-circuit without any feedback control. Thus, the device its own primarily replies on the excellent working electrode performance. Deliberate designs tends to select a low potential value below +0.3 V to avoid the interferent signals from ascorbic acid (vitamin C) and uric acid in blood. Therefore, an accurate current output signal from H₂O₂ can be achieved by optimizing input potential and enhancing material properties of the three compartments.



Fig. 4. A glucose stripe sensor composing of two metal (gold) electrodes and one reference silver/silver chloride electrode (white)

5. Advancement of technology

Several strategies have long been attempting to overcome the challenge of electron transport, locally apart from the electrode surface. As previously mentioned, various multi-disciplinary engineering approaches and techniques are incorporated to enhance these three physical compartments. To distinguish



major advancement of technology, recent trends and choices of design of each compartment can be discussed as follows:

5.1 Chemical wiring from the enzyme to the electrode

The first generation is a proof-of-concept and primarily focus on the systematic design of equipment and process. The glucose oxidase (GOD) enzyme is first used by physical coating onto the electrode. As described previously, the electro active product of GOD is H₂O₂, carrying out electron output to generate the current signal. There is also another alternative enzyme, namely glucose dehydrogenase (GDH) producing a different electro active product. Table 3 summarized the choices of enzyme selected by major glucose sensors' companies including Abbott, Bayer, LifeScan, Roche, and Nova. In order to optimize the performance, the second generation exploits a mediator whose properties help carrying electrons faster. It can be used with enzymatic cofactors including flavin adenine dinucleotide (FAD), nicotine adenine dinucleotide phosphate (NADP), or, pyrroloquinoline quinone (PQQ) [13]. As shown in Fig. 5 the main enzyme (GOD) is collaborated with a cofactor to boost up the enzyme conversion process. Then, the choice of designs can be selected among many electrochemical mediators such as quinone compounds, ferricyanide, and transition metal complexes [12, 14, 15]. By applying the mediator, a large amount of unwanted interactions will be minimized due to the rapid transport of electron to the electrode. However, the redox mediator itself can be toxic, less stable, and become additional errors to the measurement. The third generation of glucose stripe sensors, therefore, eliminate the mediator by operating at low potential and selecting a charge-transfer materials such as tetrathiafulvalene-tetracyanoquinodimethane (TTF-TCNQ), gold nanoparticles, carbon nanotube, and graphene [12, 16-20]. This design configuration can lower the applied input voltage as low as 0.1 V versus silver/silver chloride reference [21].

Manufacturer	Brand	Enzyme	Detection range (mg/dL)	Testing tim	
				(s)	
			20-500	5	
Abbot	FreeStyle	GDH-PQQ			
	Freedom Lite				
Bayer	Ascensia Contour	GDH-FAD	10-600	5	
LifeScan	OneTouch	GOD	20-600	5	
	UltraLink				
Nova		GOD	20-600	5	
Biomedical	Nova Max				
Roche	Accu-Check	GDH-PQQ	10-600	5	
	Aviva				

 Table 3. Commercially available glucose sensors [3].

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Alternatively, there are also inherited materials serving as both artificial enzyme and conductive electrode. This approach is also known as non-enzymatic or enzyme-free route, using transition metals or metal oxide such as gold or platinum directly detect the glucose in solution. Under a normal condition, blood glucose is presented into α , β , and γ forms. It is observed that the γ -glucose can be directly converted into gluconolactone (one of the chemical process output) without the enzyme. Nevertheless, there is too little of the γ glucose as compared to the other forms (the ratio of α , β , and γ is 37:53:0.003 in the physiological condition) [22]. Other strategies including platinum alloys, input voltage pulse configuration, boronic acid membrane are reported. Although these techniques are partly evidenced for a feasible non-enzymatic glucose sensor development, practical limitations of interfence still remain [23-26].



Fig. 5. Schematic representation of the first-, second-, and third-generation glucose sensors. Electrons are first taken up by the enzyme's cofactor (primary electron acceptor) and transferred to either oxygen, mediator, or directly to the electrode [13].

5.2 Electrical wiring: from the electrode to the circuit

Traditional routine of self-glucose monitoring is involved in drawing a drop of blood by a lancet and loading onto the sensor. The painful procedure is inevitable for diabetic patients, leading to discomfort and infection issues. Therefore, creating a new measurement paradigm is of great interest, especially to electrical, electronics, and telecommunication engineering researchers. Continuous monitoring glucose sensor (CMGS) or wearable device play a significant role over the past decade of product evolution, transforming toward non-invasive diagnosis. Recently, Abbott developed Freestyle Libre that can take glucose readings as many times a day as needed through a patch worn on the back of the upper arm and does not require finger-prick calibration. MediWise's Glucowise is a pain free glucose sensor that



squeezes the skin between the thumb and the forefinger and displays the reading in real time on the screen. Symphony by Echo Therapeutics uses a transdermal sensor and a wireless transceiver in order to display real-time glucose data [27].



Fig. 6. Future glucose monitoring toward minimally invasive and painless measurements [27].

Fig. 6 shows a trend of technological evolution from the basic single-use disposable Clark-type sensors toward a wireless continuous wearable glucose monitoring. The electrical wiring between the conductive electrodes to the electronics circuit no longer needs to be a physical wire contact. Signal transmission and optical detections will be expected more to play an important role as an emerging technology into future glucose sensors. [28-30] Due to a life-long monitoring and more freedom of activities, real-time detections are desirable. Regarding to this development, predictive and programmable artificial intelligence models can be integrated with insulin pump infusion to close the loop of feedback control for diabetic management. Providing future opportunities, these new routes of electrical connection approach can find practical applications not only for glucose biosensors, but also other existing biosensors and point of care devices.



Supplemental Document:



Figure S1. Biosensor (an electrolytic cell) SI sign convention and potential operation mode A. anodic process, giving electrons thereby resulting in a positive current output, and B. cathodic process, receiving electrons and negative current output

Summary

Glucose stripe sensors have long been developed for more than four decades to help diabetic management. The biosensors can serve as a self-monitoring device, similar to clinical measurement in hospitals. Owning the majority of global biosensor's market, the device fascinatingly operates without any feedback control by relying on excellent performance of the working electrode. The first, second, and third generations of the device intensively focus on improvement of chemical wiring from the enzyme to the electrode to overcome interference problems. Between each compartment, the key communications to facility the chemical and electrical processes are enzyme selection, material modification, and input voltage configuration Furthermore, electrical wiring from the electrode to the display becomes recent trends in research and development, translating an invasive measurement paradigm into a real-time painless diagnosis for the future glucose sensor generation.



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A1, and 37 CFR,1.63 App.# 14/427,904). In 2014, she joined Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabanf, as a lecturer in Biomedical Engineering Program. Her primary research interests also include in biomedical sensors, electrochemistry, and energy storage.



Paper List of ECTI Transaction

ECTI Transaction on Electrical Engineering, Electronics and Communications (ECTI-ECC) Webpage: <u>http://www.ecti-eec.org/</u>

--- No updates ---

ECTI Transaction on Computer and Information Technology (ECTI-CIT)

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- 1. Hardware Evaluations of Simple Radio Positioning System Based on Direct Sequence Spread Spectrum Authors : S. Watanabe, M. Okada
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- 6. Impact of high WPPs penetration on the Vietnam Power System Authors : H. Nguyet Nguyen, V. Vittal
- 7. Time Domain Equalization Method for DFTS-OFDM Signal without GI under Highly Mobile Environments Authors : P. Reangsuntea, P. Boonsrimuang, K. Mori, H. Kobayashi
- 8. An Evaluation of Significant Lightness Difference Effective Term for CIEDE2000 Comparative Image Colour Pixels

Authors : W. Benjapolakul, B. Homnan

- 9. Vertical Edge Detection-Based AutomaticOptical Inspection of HGA Solder Jet BallJoint Defects Authors : J. Ieamsaard, P. Muneesawang, S. Yammen, F. E. Sandnes
- 10. Sentiment Analysis of Food Recipe Comments Authors : P. Pugsee, M. Niyomvanich



Report from Conferences/Workshops/Seminars

1. Seminar on "Research Article Writing Techniques" at Rajamangala University of Technology Lanna, Chiangrai. (Reported by Prof. Kosin Chamnongthai)

The delegates of ECTI including Prayoot Akkaraekthalin (KMUTNB), Somsak Choomchauy (KMITL) and Kosin Chamnongthai (KMUTT) visited **Rajamangala University of Technology Lanna, Chiangrai** on**17 November 2015** and organize a seminar on research article writing technique. More than 20 lecturers and students attended the seminar. The delegates had a chance to discuss with the dean of engineering faculty and vice president in academic affairs.





2. The International Reference Ionosphere 2015 (IRI 2015) Workshop



A. Training Week: 2-6 November, 2015

The lecture topics during the training week were: Ionosphere-An introduction, IRI-Introduction and open problems, Comparison of IRI with ionosonde data from the Asian sector, IRIweb and related online services, Ionsonde measurements, Real-Time IRI, Ionosondes in the Asian Sector, Ionosonde data online: GIRO and SPIDR, GNSS data and ionospheric studies, Irregularities at equatorial latitudes, TEC comparisons with IRI in the Asian sector, Access to GNSS data, Coupling between ionosphere and thermosphere at low latitudes, Ion densities and

plasma temperatures, Solar irradiance and Upper atmospheric chemistry, Incoherent scatter radar, and Ionospheric storms. The trainees were divided into 8 teams and the 8 science problems were distributed to the teams via lottery. A lecturer was assigned to each problem to work as adviser with the specific team.







B. Presentation Week: 9-13 November, 2015

[Opening Session]

[Group photo]





During this week, oral and poster presentations were given in the auditorium. The trainees' group presentation were made on Thursday, Nov. 12th. On the last day, Nov. 13th, best presentation awards for trainees were given out as follow.

Gold award: Team 5/ Problem 3 (Chinmaya Kumar Nayak, Adrian Teck Keng TAN, Punyawi Jamjareegulgarn, Ednofri)

Silver award: Team 1/ Problem 1 (Malini Aggarwal, Siti Aminah Bahari, Wang Zheng, Sanit Arunpold)

Bronze award: Team 4/Problem 4 (Dessi Marlia, Azad Ahmad Mansoori, Sarawoot Rungruenwajiake, V. Rajesh Chowdhary)





3. The 2015 IEEE International Conference on Antenna Measurements & Applications ((2015 IEEE CAMA)

Reported by Assoc. Prof. Dr. Titipong Lertwiriyaprapa (KMUTNB)





The 2015 IEEE International Conference on Antenna Measurements & Applications (CAMA) was held at Le Méridien Chiang Mai, Thailand between November 30 – December 2, 2015. The 2015 IEEE CAMA was sponsored by IEEE Antennas and Propagation Society (IEEE AP-S) and Thailand Convention and Exhibition Bureau (TCEB) and very well organized by ECTI. There were more than 100 participants from 24 countries. Also there were 2 special invited speakers, 5 IEEE AP-S invited speakers and 3 special sessions.

4. Special Lecture by Prof. Christophe Caloz

Reported by Assoc. Prof. Dr. Chuwong Pongcharoenpanich (KMITL)

IEEE Antennas and Propagation Society (AP-S) Distinguished Lecturer (DL)Program in cooperation with IEEE MTT/AP/ED Thailand Chapter and Innovative Electromagnetic Academy of Thailand (iEMAT), ECTI Association



have organized the lecture entitled "Metamaterial-Based Electromagnetic Space, Time and Spacetime Dispersion Engineering". by Prof. Christophe Caloz from École Polytechnique of Montréal, Canada.This lecture was held at Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand on December 4, 2015. There are more than 20 participants from 7 universities. After the lecture, there are some fruitful discussions during the lunch time.





New Books

Title "Visible Light Communication"

Number of pages:98

File Size:16.41 MB

Author: Keattisak Sripimanwat



ISBN:9786164060029

Publication date: 4 November 2015

Free copies are downloadable at

http://www.ebooks.in.th/ebook/36821/





2015 International Year of Light and Light-Based Technology

Website: http://www.light2015.org/Home/About/Country/Thailand.html

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Points of Contact:

Dr. Keattisak Sripimanwat

ECTI Association - Information chapter

Email: keattisak.sripimanwat@gmail.com



2nd Announcement & Call for Papers





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Call for Paper

On behalf of Rajamangala University of Technology Lanna (RMUTL) and ECTI Association, we are delighted to welcome all delegates and all the distinguished guests to Chiang Mai for the 13th International Conference that will take place in the downtown of Chiang Mai, northern Thailand in June 28" - July 1st, 2016. This is Chiang Mai's largest annual event devoted to the science and practice of Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology and it will give participants a platform to exchange ideas, discover novel opportunities, reacquaint with colleagues, meet new friends and broaden their knowledge. Accepted papers will be published in the proceedings of ECTI-CON 2016 and will be submitted for inclusion into IEEE Xplore. Acceptance will be based on quality, relevance and originality

Important dates:

Submission of Full Paper: January 31st, 2016 Notification of Acceptance: May 7th, 2016 Submission of Final Manuscripts: May 22nd, 2016 Registration of Authors and Early-bird: May 22nd, 2016

Paper submission

1) Prospective authors are invited to submit original full papers WITHOUT author's names and affiliations, in English, of 4-6 pages in standard IEEE two-column format only, reporting their original work and results, applications, and/or implementation in one or more of the listed areas. 2) Papers must be submitted only by internet through the submission system of the conference website

3) At least one author of each accepted paper MUST register and present paper at the conference in order for the paper to be included in the program. The program will be submitted for inclusion into IEEE Xplore.

1) Devices, Circuits and Systems: Semiconductor Devices, Circuits and Systems, Sensing and Sensor Networks, Filters and Data Conversion Circuits, RF and Wireless Circuits, Photonic and Optoelectronic Circuits, VLSI Physical Design, Biomedical Circuits, Assembly and Packaging Technologies, Test and Reliability, Advanced Technologies (i.e. MEMS Devices, Nano-electronic Devices and Metamaterials), Agritronics, Embedded Systems: 2) Computers: Computer Architecture, Computational Biology, Knowledge and Data Engineering, Multimedia Services and Technologies, Mobile

Computing, Distributed Computing, Pattern Analysis and Machine Intelligence, Software Engineering, Visualization and Computer Graphics;

3) Information Technology: IT Bio/Medical Engineering, Bioinformatics and Applications, Ontology, Business and Information Systems, Information Security and Forensics, Information Retrieval, Data Mining, Knowledge Management, Electronic Commerce, Health and Medicals Informatics, Hybrid Information Technology:

4) Communication Systems: Communication Theory and Information Theory. Antenna and Propagation. Microwave Theory and Techniques. Modulation, Coding, and Channel Analysis, Networks Design, Network Protocols, Network Management, Optical Communications, Wireless/Mobile Communications and Technologies, Green Wireless Networks, Green Radio;

5) Controls, Instrumentation and Measurements: Adaptive and Learning Control System, Fuzzy and Neural Control, Mechatronics, Control Systems and Applications, Robotics and Automation, Data acquisition systems, Measurement of electric and mechanical quantities, Medical and biological measurement, Non-invasive measurement techniques and instrumentation, Sensors/Wireless sensors/ sensory systems, Materials in measurement, Optical measurement and instrumentation. Nano technology in instrumentation and measurement. Fiber optics instrumentation:

6) Electrical Power Systems: Power Engineering and Power Systems, Electromagnetic Compatibility, Energy Conversion, High Voltage Engineering and Insulation, Power Delivery, Illumination, Renewable/Alternative Energy, Energy Policy and Planning,

7) Power Electronics: Power Devices and Components, Power Quality Control, Harmonic Analysis and Compensations, Switching Circuits and Power Converters, Motor and Drives, Smart Grid, Distribution Generation and Electrical Vehicles, Photovoltaic Materials and Solar Cell

8) Signal Processing: Digital Signal Processing Algorithms, Digital Filter Design and Implementation, Array Processing, Adaptive Signal Processing, idio, Speech and Language Processing, Image and Video Processing, Signal Processing Theory and its applications,

9) Other Related Areas



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Website: http://www.ecti-thailand.org/



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"Machine Learning in the Internet of Things Era"

13-15 July 2016 Pullman Khon Kaen Raja Orchid Hotel, Khon Kaen, Thailand

Call for Papers

Topics of Interest

Prospective authors are invited to submit their original and unpublished papers in the areas of computer science and software engineering and the related fields. Topics include, but are not limited to, the followings:

- Algorithmic Bioinformatics
- Cluster and Grid Computing
- Computational Science and Engineering
- Computer and Internet Security
- Computer Networks and Communications
- Computer Vision
- Embedded Systems
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- Information Retrieval
- . Internet of Things
- Knowledge and Data Management
- Machine Learning and Intelligent Systems
- Multimedia and Computer Graphics
- Ontology and Semantic Web
- · Pervasive and Mobile Computing
- Software Engineering

Papers should not exceed six (6) pages including results, figures, and references. All manuscripts must be prepared in the standard IEEE Conference Proceedings format in PDF. Manuscript templates are made available on the website (http://jcsse2016.cs.kku.ac.th). Only electronic submissions in PDF format will be accepted via EDAS submission system. All submissions will be subjected to a double-blind review procedure. Authors are expected to present their papers at the conference upon acceptance. Presenting authors are required to register for the conference. Presented and selected papers will be submitted for inclusion in IEEEXplore* Digital Library.

Selected papers will be invited for further extension before publishing in ECTI-Transaction on Computer and Information Technology (ECTI-CIT), indexed by TCI, (http://www.ecti-thailand.org/paper/journal/ECTI-CIT).

1 April 2016

25 May 2016

10 June 2016

10 June 2016 13-15 July 2016

Important Dates

Submission of Papers Notification of Acceptance Submission of Camera-ready Manuscripts **Registration Deadline** Conference Dates

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Associate Professor Guang-Bin Huang, Ph.D., Senior Member of IEEE School of Electrical and Electronic Engineering Nanyang Technological University, Singapore

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THAILAND SECTION



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ECTI CARD 2016 27-29 กรกฎาคม 2559

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านประชุมวิชาการ ECT-CARD 2016 ครั้งที่ 8 **"การประยุคคิได้เหคโนโออีอย่างชาญออาดเพื่อตอบสบองภาคอุดสาหกรรมหนัยไหน่อย่าง** ซึ่งซึ่น"จัดโดยคณะวิศวกรรมศาสตร์ มหาวิทยาลัยเทคโนโอบิราชมหลาดระนคร สถาบันมาตรวิทยา และสมาคมวิชาการให้ทำ อิเล็กทรอนิกล์ ไหรขมมาคม และสารสนเทศประเทศไทย ที่สุกจัดขึ้นระหว่างบันที่ 27-29 กาญาคม พ.ศ.2559 ณ โรงแรมทั้งหินแรมห์แอนด์หลาซ่า จ.ประจางคิรีรับธ์ อั จุดมู่เรามายหลักของการจัดงานเพื่อรายรวมแลงานวิจัยและหัฒมาเชิดประยุกด์ งานบริตกรม และสิ่งประดิษฐ์รวมอึงเมื่อโอกาลให้บริกร์ ผู้หัฒนาและ ผู้ใช้งานหรือหน่วยงานต่ายๆ ได้มีโอกาสโมการแลงเปรียนรีขึ้งกันและกินและสามารถบริหเลงานที่ดีกิมก็ไปสมกร้อยหรือหวัดห หาดชื่อได้ ขับเคยามที่เล่อกนั้นจะได้รับการคิดเมืองกันผู้เหลาการถบริหเลงานที่ดีกิมก็ไปสมกร้อยหร้องหราย โปรงกรณ์ได้ นำเลนอในที่ประชุม ECT-CARD 2016 จะถูกศิลิทส์ใน ECT-CARD Proceedings ซึ่งสามารถถึงกันได้ชัฐานข้อมูลของสามาณ ECT

หัวข้อบพความที่เกี่ยวข้อง

กลุ่มที่ 1 : เกษรากรวม อุตสาหกรรมงาษตร กลุ่มที่ 2 : เทคโนโลยีชีวภาพ การแพทย์ วิทยาศาสตร์กายภาพ วิทยาศาสตร์การกิหา กลุ่มที่ 3 : การประทยังทสังหาน การจัดการหลังงายบ้านสัตโนมัด กลุ่มที่ 4 : การเรียนการสอบสางไกร การศึกษาบันเห็งคอมพิวเตอร์แยบันเข้น กลุ่มที่ 5 : การกู้ดัย ระบบเดียบภัย และหยากรณ์ กลุ่มที่ 6 : การสื่อสาร การสนับสนุมผู้ใช้ตามบ้าน เครื่อง่ายสังคม เครื่อง่ายไว้ตาย กลุ่มที่ 7 : การขนง่ง การครบคุมขรายุร การจัดการอุตสาหกรณ์ กลุ่มที่ 8 : ธุรกิจการอนาศาร การศุษณฑ์ใจห และกรรโรมเฉน กลุ่มที่ 9 : ระบบความปกอดภัย การครบคุมการเข้าถึงการอินอันด้วยหา ระบบครามปกอดภัย กลุ่มที่ 10 - มาตรวิทยา การสวบคุมม

กลุ่มที่ 11 - หัวข้ออื่นๆ ที่เกื่อวข้อง

การส่งบทความแบ่งเป็น 2 รูปแบบ ดังนี้

http://ecticard2016.ecticard.org/

1. รูปแบบบทความวิจัย เป็นบทความเต็มรูปแบบการประเทรือ ภาษาอังกฤษไม่เกิน 4 หน้ากระดาษ A4 ในรูปแบบนกตรฐาบ 2 คอเลิ่นกับอง IEEE โดยต้องกล่าวอิงที่มาและผลที่ได้รับ รายละเอียด และเทรือการนำไปใช้งาน ซึ่งเกี่ยวร้องกับหรังข้อใดหัวข้อหนึ่งหรือ มากกว่า จากกลุ่มต่างๆ ที่ได้กำหนุดไว้

 รุปแบบลิ้งประทิษฐ์และนวัดกรรมเป็นบทความเส็มรูปแบบ ภาษาไทยหรือภาษาอังกฤษไม่กัน 2 หน้ากระดาษ A4 ในรูปแบบ มาตรฐาน 2 คอลัมน์ของ IEEE โดยผู้เสียงมาตรวามอาจจะนำผลงาน หรือสิ่งประดิษฐ์มาร่ามจัดแสดงในงานประชุมด้วยก็ได้

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 NORKSHOP

 Sesion A

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ISPACS 2016 Phuket, Thailand 24-27 October 2016

2016 International Symposium on Intelligent Signal Processing and Communication Systems



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Call for Papers

The 2016 International Symposium on Intelligent Signal Processing and Communication Systems (ISPACS 2016) will be held during 24-27 October 2016 at Phuket Graceland Resort & Spa, Patong, Phuket, Thailand. The symposium presents every possibility on new technologies based on signal processing and communications. ISPACS 2016 (IEEE Conference Record Number #37442) will include regular sessions on the topics listed below and some special sessions on emerging topics concerning intelligent signal processing and communication systems.

1. Communication Systems

- Radio Propagation and Channel Modeling
- Communication Theory
 Antenna and Propagation
- Wideband Communications
- Wireless Systems
- Intelligent Communication Systems and Network Protocols
- 2. Multimedia and Systems
- Speech Processing and Coding
 Image Processing
- Video Processing and Coding
- Video and Multimedia Technology and Communications
- Audio/Acoustic Signal Processing
 Multimedia Processing for e-Learning
- 3. Signal Processing Digital Filters and Filter Banks
- Wavelets and Multi-rate Signal Processing
- · Adaptive, Non-linear and Multidimensional
- Signal Processing
- · Fast Computations for Signal Processing, and
- Communication Systems Radar, Antennas and Mobile Signal Processing
- · Intelligent Signal Processing for
- Communications and Systems Security Signal Processing
- Optical Signal Processing
- Medical Signal Processing
- Noise Control

- 4. VLSI
- · Analog and Digital ICs for Communications
- Low Power Design and VLSI Physical Synthesis
 Modeling, Simulation and CAD Tools
- VLSI Architecture for Signal Processing
- 5. Circuits and Systems Analog Circuits, Filters and Data Conversion
- Analog and Mixed Signal Processing
- Numerical Methods and Circuit Simulation
 Circuits and Systems for Communications
- · Neural Networks and Fuzzy Logic Processing
- · Sensors and Devices
- Intelligent Instrumentations
- Wireless Sensor Networks

6. Emerging Technologies in Signal Processing and Communications

Important Dates

Submission of Special Session Proposals: 30 April 2016 Submission of Full Papers: 15 June 2016 Acceptance Notification: 15 August 201 Submission of Camera-ready Manuscripts: 10 September 2016

Travelling grants, around 5% of the number of actual participants, will be given to participants who truly need support, especially the ASEAN Economic Community (AEC) members. The applications are required and will be considered by the TPC committee.

or contact ispacs2016@coe.psu.ac.th.

Phuket is one of the most internationally well-known and popular islands. Phuket, known as "Pearl of the Andaman Sea" and its unique combination of the sea and mountains, has many fine white sandy beaches and deep blue sea as well as fascinating history and mixed cultures such as Sino-Portuguese architecture, local traditions, living styles and food.

See more information about Phuket at http://www.phukettourist.com/index.php



Website: http://www.ecti-thailand.org/

For more information about the conference, please visit our official web site: http://ispacs2016.psu.ac.th



http://www.iceic2016.org **ICEIC 2016** International Conference or Electronics, Information, and Communication (ICEIC) 2016 Jan 27 (Wed) ► Jan 30 (Sat), 2016 Hyatt Regency Resort & Spa, Danang, Vietnam IEIE 🛙 **Call for Papers** The 15th International Conference on Electronics, Information, and Communication (ICEIC 2016) is a forum open to all the participants who are willing to broaden professional contacts and to discuss the state-of-the-art technical topics. Especially the participation from Asia-pacific region is encouraged. The general session of ICEIC 2016 will include more than 300 oral and poster presentations. In addition, the conference will offer special sessions, invited talk, keynote speeches, and tutorials to cover a broader spectrum of topics on electronics, information, and communication technologies. ICEIC 2016 is soliciting papers in the following areas, but not limited: Regular sessions Communications Communication & Information Theories, Communication Networks & Systems, Microwave & Optics, Switching and Routing, Microwave, Antennas and Propagation, Intelligent Transportation System (ITS), Wireless PAN/BAN, Future Networks Semiconductor and Devices Analog/Digital Circuits & Systems, , RF Integrated Circuits, Computer-Aided Design & Modeling, SoC Design & Applications, Semiconductors, Materials and Components, Lightwave and Quantum Electronics, PCB & Packaging, Solar Cell & Semiconductor Devices Computer and information Computer Systems & Applications, Software for Smart Systems, Human Computer Interaction (HCI), Convergence Computing, and Multimedia, Graphics, Ubiquitous System, Information Security Signal processing Computer Vision, Digital Signal Processing, Digital Image/Video Processing, Audio, Speech & Acoustic Signal Processing System and Control Vehicular Electronics, Instrumentation and Control, Power Electronics & Circuits **Emerging Technologies** Biomedical Electronics and Bioengineering, Bioelectronics, IT-Convergence, Renewable Energy, Car & Aviation IT Special sessions Special session proposals are invited to ICEIC 2016, and inquiries regarding your submission should be directed to TPC Chair (ihwang@kangwon.ac.kr). The proposal needs to be submitted to the TPC Chair by July 31, 2015. The proposal template can be found at our conference homepage. **Best Paper Awards** The authors of the best papers will be presented Gold, Silver, and Bronze awards. And the selected top quality papers will be recommended to be published on the Journal Semiconductor Technology and Science (JSTS) or a special issue of IEIE Transactions on Smart Processing and Computing. Paper sub The prospective authors can submit their papers by selecting regular oral presentation or poster presentation. The regular papers are recommended to be in 2--4 pages and the poster papers in shortened 2-page format, according to the guidelines by the official website (http://www.iceic2016.org). Only the regular papers will be published in IEEE Xplore^M. Submission date: September 23, 2015 Final papersubmission date: November 18, 2015 - Notification of acceptance date: October 28, 2015 - General information: inter@theieie.org Organized by The Institute of Electronics and Information Engineers (IEIE) and locally co-organized by University of Science and Technology - The University of Danang, Vietnam Technically Co-Sponsored by IEEE Consumer Electronics Society

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