*Proceedings of International Conference of*

# *BigHealth-2016*

*The joint international conference of*
*Big Data Analytics in Health Informatics 2016 (**BDAHI 2016**) and*
*the 13th Int. Conf. on Ubiquitous Healthcare (**u-Healthcare 2016**)*

## *Abstracts*


*The University of Aizu, Fukushima, Japan*
*October 29 – 30, 2016*

**ISBN: 978-4-900721-05-0 The University of Aizu Press**
**SICE Catalog Number: 16SY0008**

# *Welcome Message*

*On the behalf of the Organizing Committee, we give a very warm welcome to BigHealth-2016, the Joint International Conference of Big Data Analytics in Health Informatics 2016 (BDAHI 2016) and the 13th International Conference on Ubiquitous Healthcare (u-Healthcare 2016), which will be held Oct. 29-30, 2016 at the University of Aizu, Aizu Wakamatsu, Japan.*

*Since the first meeting in 2004, the annual u-Healthcare has been a focus of communication and discussion of current progress on ubiquitous healthcare technologies worldwide. BDAHI 2016 is the first international conference focusing on big data analytics in healthcare domain.*

*Enhancing welfare for the future requires the strategic change from "recovery from illness" to "maintaining wellness and improving quality of life". Seamless monitoring of various vital data in daily life environments and comprehensive interpretation of their physiological information are of equal importance.*

*BigHealth-2016 is devoted to promoting ICT-based ubiquitous-Healthcare and the pressing challenge of big data analytics in deep-mining physiological significance from huge mountains of vital data collected by diverse modalities. BigHealth-2016 will provide an excellent opportunity for academic researchers and industrial partners as well as policy makers to discuss state-of-the-art advancements, to understand the problems we are currently facing, to exchange innovative ideas, and to anticipate the bright future in relevant domains.*

*The University of Aizu is the first and largest ICT-dedicated University in Japan. The Aizu region is well-known as a han (feudal clan) enthusiastic for education.*

*Aizu Wakamatsu is located in the central area of Japan and is blessed with a rich natural environment such as Mount Bandai and Lake Inawashiro, as well as a strong sense of history and numerous legacies of the samurai era such as Tsuruga-jo castle and Oyakuen herb garden. Autumn is a good season to enjoy splendid maple trees all over the region.*

*We would like to send a sincere welcome to all of you who might be interested in these critical topics, and look forward to your joining BigHealth-2016.*

***Toshiyo Tamura, Ph. D.***
*Visiting Senior Researcher,*
*Future Robotics Organization, Waseda University, Tokyo, Japan*

***Kwang Suk Park, Ph. D.***
*Professor and Director,*
*Advanced Biometric Research Center, Seoul National University, Korea*

***Wenxi Chen, Ph.D.***
*Professor and Director,*
*Biomedical Information Technology Laboratory,*
*Research Center for Advanced Information Science and Technology (CAIST),*
*The University of Aizu, Aizu Wakamatsu, Japan*

# *General Conference Information*

## *Hosted by*

*The University of Aizu*

## *Sponsored by*

*The University of Aizu*

*Nakatani Foundation for Advancement of Measuring Technologies in Biomedical Engineering*

*Fukushima Prefecture*

## *Technical Co-sponsored by*

*Japanese Society for Medical & Biological Engineering (JSMBE)*

*IEEE Engineering in Medicine and Biology Society Japan Chapter (IEEE EMBS Japan Chapter)*

*The Japanese Society of Life Support Engineering (JSLSE)*

*The Society of Instrument and Control Engineers (SICE)*

*Korean Society of Medical and Biomedical Engineering (KOSOMBE)*

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*Masaaki Makikawa (Ritsumeikan University, Japan)*

## *Vitae of Keynote Speaker*

***Toshiaki Miyazaki, Ph.D.***
*Professor and Dean of the Undergraduate School of Computer Science and Engineering,*
*The University of Aizu,*
*Japan*

***Toshiaki Miyazaki*** *is a professor and Dean of the Undergraduate School of Computer Science and Engineering, the University of Aizu, Japan. He received the Ph.D degree in electronic engineering from Tokyo Institute of Technology, Japan. Before joining the University of Aizu in 2005, he has been worked for NTT for 22 years, and engaged in research on VLSI CAD systems, FPGAs and their applications, active networks, ubiquitous network environments. He published more than 350 articles, papers, and reports, and has 18 registered and 53 pending patents. Prof. Miyazaki received the best paper awards from VLSI95, ICCD95, ICOIN2013, and IMCOM2014. He has been serving many IEEE/ACM-sponsored international conferences and invited talks. He was also a visiting professor of the graduate school, Niigata University in 2004, and a part-time lecturer of the Tokyo University of Agriculture and Technology in 2003-2007. His current research interests are in sensor networks, autonomous systems, and reconfigurable systems. Prof. Miyazaki is a senior member of IEEE, IPSJ, and IEICE.*

# *Vitae of Invited Speakers*

***Kwang Suk Park, Ph.D.***
*Professor,*
*Department of Biomedical Engineering,*
*College of Medicine, Seoul National University,*
*Korea*

***Kwang Suk Park*** *received B.S. and Ph.D degree in Department of Electronics Engineering from Seoul National University, Korea in 1980 and in 1985 respectively. He is currently a professor in the Department of Biomedical Engineering in Seoul National University since he joined the department in 1985 as a founding staff member. He is a member of Korean Society of Medical and Biological Engineering and has served as the president in 2014. He also served as the secretary general of World Congress on Medical Physic and Biomedical Engineering which is held in Seoul in year 2006. He is also a member of IEEE EMBS and has been served as an Associate Editor for IEEE Trans. on Journal of Biomedical and Health Informatics since 2005. He is serving for EMBC2017 as the conference chair. He also chaired and co-chaired the annual International Conference on uHealthcare during last 12 years. His main research area is biological signal measurement and processing for the diagnosis. Recently he is focusing his research interest on nonintrusive measurements for ubiquitous healthcare.*

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***Sung-Min Park, Ph.D.***
*Professor,*
*Department of Creative IT Engineering,*
*Pohang University of Science and Technology,*
*Korea*

***Sung-Min Park*** *received the B.S. and Ph.D. degrees in electrical and computer engineering from Purdue University, West Lafayette, Indiana, U.S., in 2001 and 2006, respectively. He is currently a Professor of the department of Creative IT Engineering at Pohang University of Science and Technology (POSTECH, Pohang, South Korea), where he has been with since 2016. From 2006 to 2014, he was with Medtronic (Minneapolis, Minnesota, U.S.) as R&D Manager, leading the award-wining effort in developing the world first MRI conditional pacemaker. From 2014 to 2016, he was with Samsung (Suwon, South Korea) as Director, spearheading healthcare centric mobile device and mobile health service platform development projects. His research interests include mobile healthcare, home healthcare, therapeutic medical devices, and bio-electromagnetics. Dr. Park was a working member of ISO/IEC joint working group that has been developing a MRI safety standard for active implantable medical devices.*

***Kaoru Sakatani, M.D., Ph.Ds*** *(in Medicine & Engineering)*
*Professor,*
*Department of Electrical and Electronic Engineering,*
*College of Engineering, Nihon University,*
*Japan*

***Kaoru Sakatani*** *received the MD from Osaka Medical College, Osaka, Japan, in 1981, the Ph.D. in Medicine from the graduate school of Osaka Medical College (1987), and the Ph.D. in Engineering from the graduate school of Hokkaido University, Sapporo, Japan, in 1998. He is currently a Professor with Nihon University College of Engineering and School of Medicine. He is a Board-certified Neurosurgeon in Japan and his research interests include biomedical engineering, optical engineering, neuroimaging, and neuroscience. He is a recipient of awards, such as the Medical Research Encouragement Prize of The Japan Medical Association (2010), and Asian Computer Tomography Award (1998). He is a vice president of Japan Optical Brain Functional Imaging, and executive members of Japanese Society of Integrative Medicine, Japanese Society of Neuromonitoring, Japanese Society of Neurosurgery, Japanese Society of Stroke, and Japanese Society of Cerebral Blood Flow and Metabolism.*

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***Tatsuo Togawa, Ph.D.***
*Special Researcher,*
*Waseda University,*
*Japan*

***Tatsuo Togawa*** *was born in Tokyo in 1937, graduated Waseda University in 1960, and received Ph.D. from the University of Tokyo in 1965. He had been a professor of Department of Biomedical Instrumentation, Institute of Biomaterials and Bioengineering, Tokyo Medical and Dental University from 1972 to 2003. In this period, he had been involved in studies of biomedical measurements and instrumentation for patient monitoring. Then he served as a professor in Waseda University, School of Human Sciences until 2008. Now he is an adjunct researcher of Advanced Research Center for Human Sciences, Waseda University. He received Doctor Honoris Causa from Linkoping University, Sweden, and is a member of International Academy of Biomedical Engineering, a Fellow of Institute of Physics UK, and a Foreign Member of Polish Academy of Sciences. Looking forward to seeing you at the conference.*

***Daming Wei, Ph.D.***
*CEO,*
*The EKG Technology Lab,*
*Japan*

***Daming Wei*** *was a professor and director of Biomedical Information Technology Lab at University of Aizu, Fukushima prefecture, Japan. He is now a Professor Emeritus of University of Aizu; a visiting lecturer at National Tohoku University Graduate School of Medicine, Japan. He is president of EKG technology Lab, Inc., a company of university ventures since 2005. Dr. Wei is known for the Wei-Harumi heart model and the simulation software of Electrocardiogram called Cardiomaster. He is inventor of synthesized 18-lead ECG, synthesized 12-lead ECG, and other synthesized ECG techniques like TWA analysis.*

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***Junichi Yatabe, M.D., Ph.D.***
*Assistant Professor,*
*Department of Medicine II,*
*Tokyo Women's Medical University,*
*Japan*

***Prof. Junichi Yatabe*** *is an assistant professor at Department of Medicine II, Endocrinology and Hypertension, Tokyo Women's Medical University School of Medicine. He obtained M.D. and Ph.D. degrees from Fukushima Medical University in 2001 and 2011, respectively. He served as a research associate at Department of Pathology, University of Virginia in 2002-2005, and an assistant professor at Fukushima Medical University in 2011-2015. His research is focused on pharmacology, hypertension, and chronic kidney diseases. He is the receiver of Travel Award from ISH (International Society of Hypertension) in 2016, Distinguished Abstract Award in 55th Annual Congress of Japanese Society of Nephrology, and other 7 academic awards. He is also a principal or collaborator of 14 research grants from JSPS, METI, JST, and etc. He also has 26 peer-reviewed publications.*

***Hyung-Jin Yoon, M.D., Ph.D.***
*Associate Professor and Director,*
*Division of Clinical Bioinformatics,*
*Seoul National University Hospital Biomedical Research Institute,*
*Korea*

***Prof. Yoon*** *is an associate professor and director at Division of Clinical Bioinformatics, Seoul National University Hospital Biomedical Research Institute, Korea. He obtained his M.D. and Ph.D. degrees from Seoul National University in 1986 and 2001, respectively. He was a research fellow in Division of Nephrology, Department of Medicine, Brigham and Women's Hospital affiliated to Harvard Medical School in 1997-1998, and a research fellow in Renal Unit, Medical Service, MGH affiliated to Harvard Medical School in 1998-2000. His main research areas are big data analytics and clinical epidemiology including environment and genetic epidemiology, and wearable sensor technology for quantified self.*

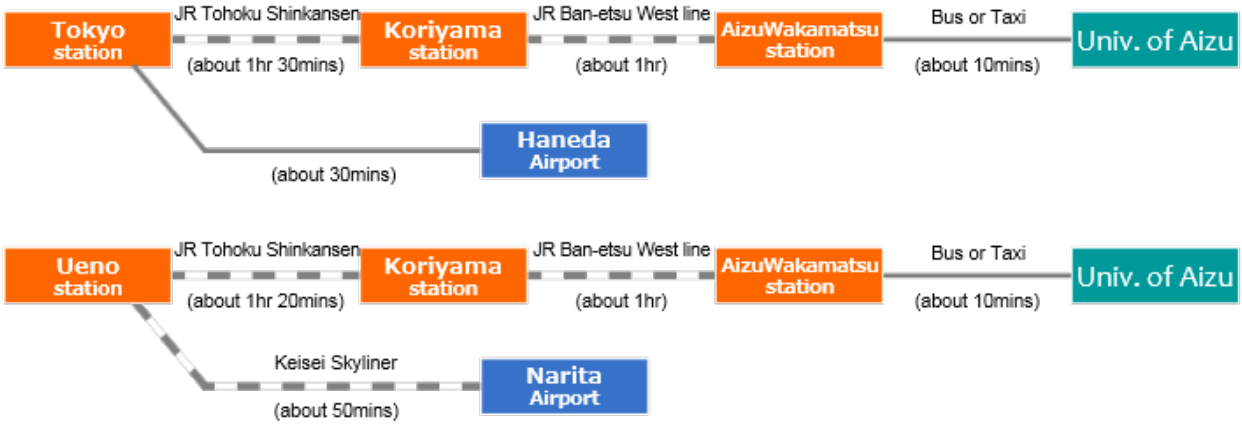
# *Authors Instruction*

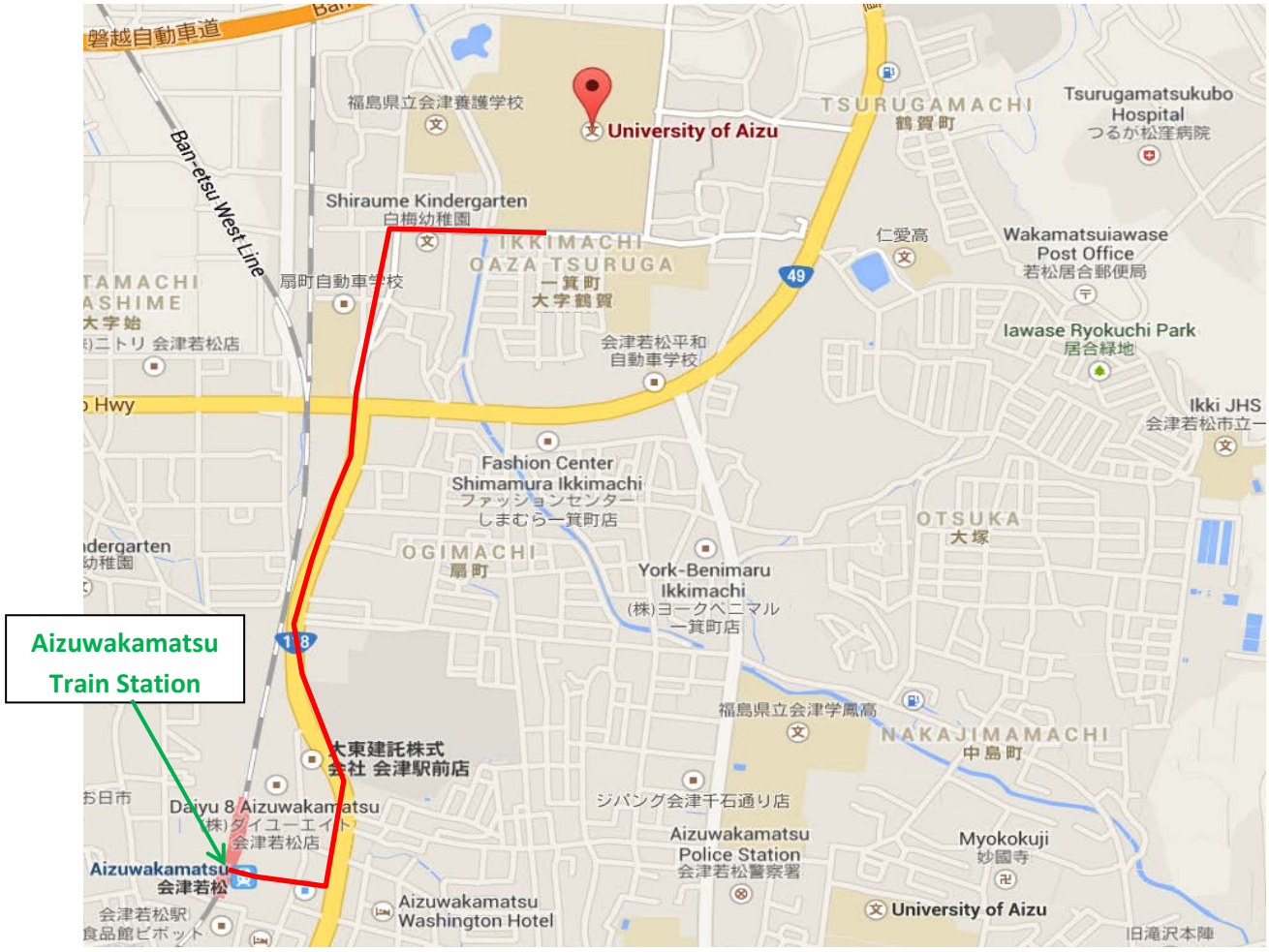
*Please follow carefully these guidelines to prepare your presentation:*

*You will be assigned 10 minutes for presentation + 5 minutes for questions and discussion. You are kindly requested to keep your talk within allocated time slot. The session's chairperson will make sure that the time schedule is kept.*
*You can bring your own computer, either Windows or Mac, with an external display connector for VGA.*

# Access Information

BigHealth-2016 takes place at the University of Aizu located in Aizuwakamatsu city. The university is situated 2.5 Km from Aizuwakamatsu station. It takes about 10 minutes by taxi (around 1500 yen) or about 25 minutes walking. For more detailed information how to arrive to the University of Aizu please check the official university website http://www.u-aizu.ac.jp/en/access/

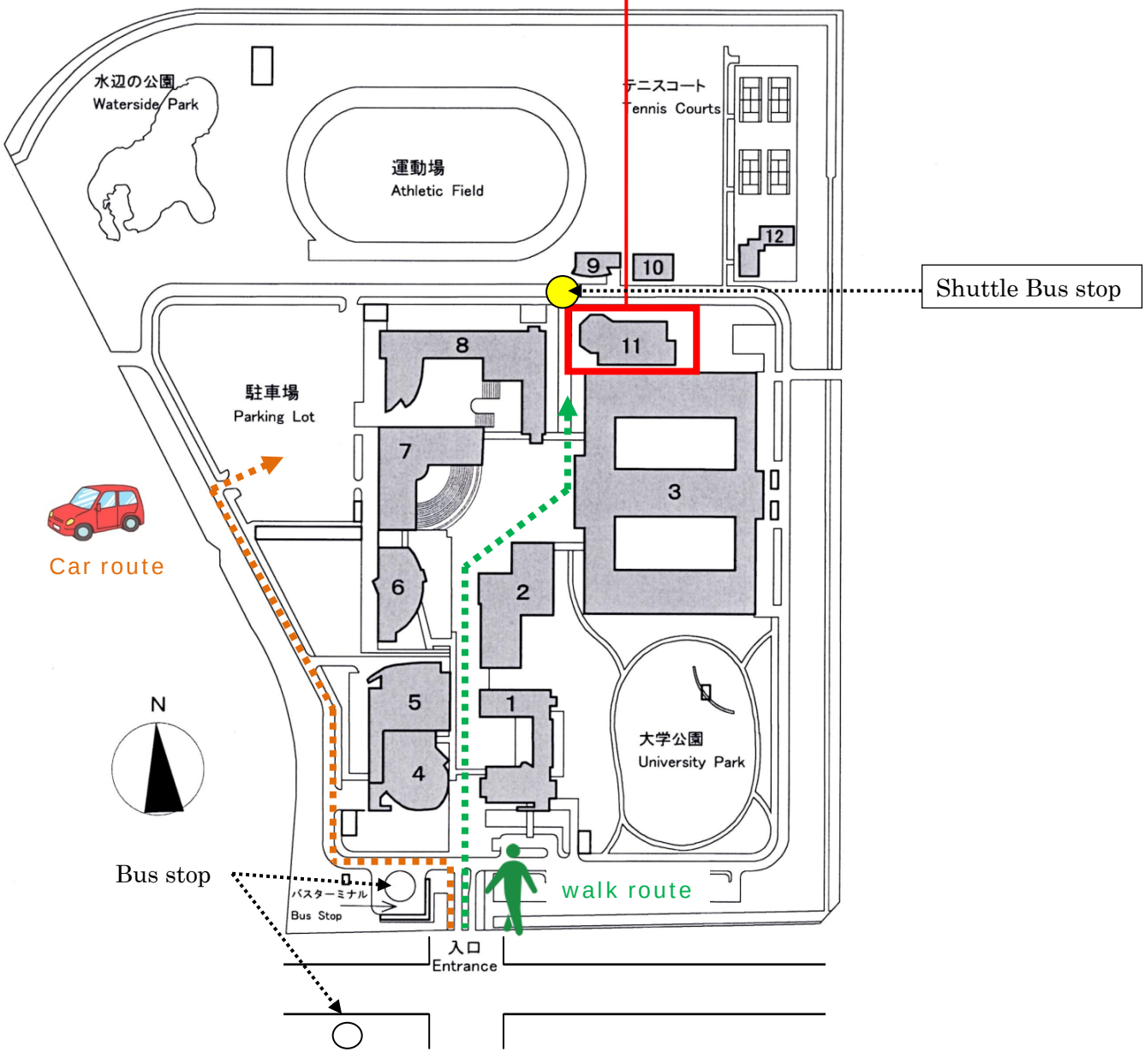


# 施設配置図
# Campus Map

1 管理棟 (Administration Complex)
2 体育館 (Gymnasium)
3 研究棟 (Research Quadrangles)
4 講 堂 (Auditorium)
5 エネルギーセンター (Energy Center)
6 図書館 (Library)
7 学生ホール (Student Hall)
8 講義棟 (Lecture Hall)
9 フィールドハウス (Field House)
10 クラブ棟 (Student Club House)
11 産学イノベーションセンター (University-
12 創明寮 (Soumei House)

## Venue: UBIC(University-Business Innovation Center)
## 産学イノベーションセンター


Bus stop public transportation
(to the station)

## Local Bus Schedule and Taxi information

☆ : No bus services available on Sundays, and national holidays

| ¥170 | | |
|---|---|---|
| | The Univ. of Aizu → | Aizu-wakamatsu station |
| ☆ | 8:04 | 8:15 |
| | 8:39 | 8:50 |
| | 9:34 | 9:45 |
| | 10:59 | 11:10 |
| ☆ | 12:34 | 12:45 |
| | 13:34 | 13:45 |
| | 14:34 | 14:45 |
| ☆ | 15:54 | 16:05 |
| | 17:59 | 18:10 |

| ¥170 | | |
|---|---|---|
| Bus stop in front of station No. 2 | Aizu-wakamatsu station → | The Univ. of Aizu |
| ☆ | 7:40 | 7:50 |
| | 8:15 | 8:25 |
| | 9:10 | 9:20 |
| | 10:35 | 10:45 |
| ☆ | 12:10 | 12:20 |
| | 13:10 | 13:20 |
| | 14:10 | 14:20 |
| ☆ | 15:30 | 15:40 |
| | 17:35 | 17:45 |

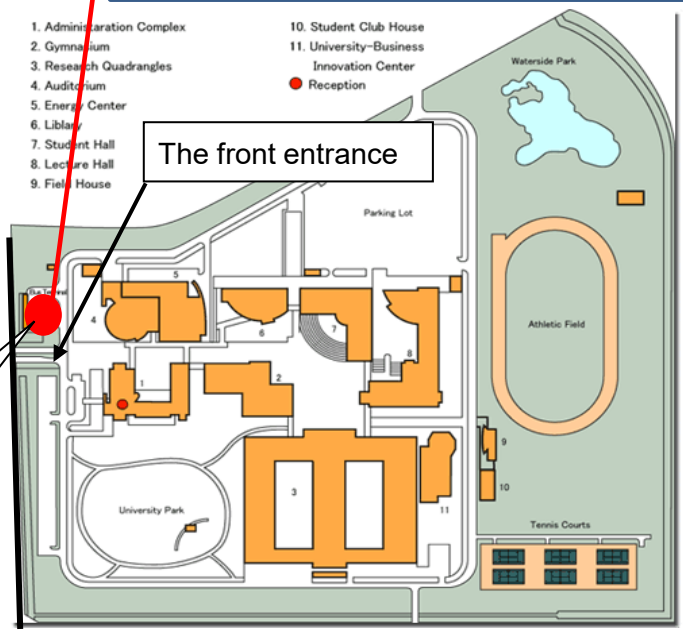
Please note there are two different bus stops: one from the University to the station (outside campus), the other from the station to the University (on campus)

Local Bus stop
The Univ. of Aizu → Aizuwakamatsu st.

Local Bus stop
Aizuwakamatsu st. → The Univ. of Aizu

s t r e e t

The University of Aizu ( CAMPUS MAP )





## Taxi Charge (Middle size. ~ 4 persons)

From Aizuwakamatsu Station to The University of Aizu: About 1500 YEN

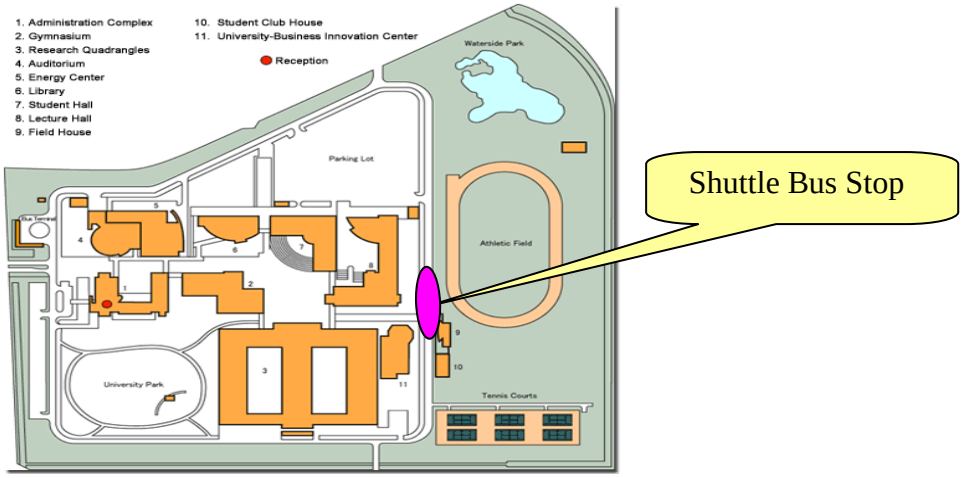
## Phone Numbers:

- Aizu Taxi: 0120-69-2468
- Aizu Kotsu (Wakamatsu Taxi): 0120-54-6700

# Banquet

- Date : From 6:30 P.M., Saturday, October 29, 2016
- Place : Aizuwakamatsu Washington Hotel (2F)
  ☎0242 – 22 – 6111
- Shuttle Bus : Available from the University to Aizuwakamatsu Washington Hotel.

University → Washington Hotel
18:10 → 18:20




# Excursion

**October 30 (SUN)**

| Time 時間 | Event　イベント | Place　場所 |
|---|---|---|
| 11:00 | Tour start<br>出発 | Gather around the Shuttle Bus stop<br>シャトルバス乗り場集合 |
| 12:00-15:00 | Lunch(Sukiyaki) & Hot springs<br>昼食（すきやき膳）と温泉 | Okawaso (Japanese-style hotel)<br>大川荘 (旅館) |
| 15:30-17:30 | Dinner(Soba) & Shopping<br>夕食（そば）と買物 | Ouchi-juku(Post town in the Edo period)<br>大内宿(宿場) |
| 18:30 | Hotel arrival<br>ホテル到着 | Washington Hotel<br>会津若松ワシントンホテル |
| 18:35 | Station arrival<br>駅到着 | Aizuwakamatsu Station<br>会津若松駅 |

Okawaso (Japanese-style hotel)


Ouchi-juku (Post town in the Edo period)

Ouchi-juku lying along Aizu West Road is a small village nestled among lofty mountains that once flourished as post town in the Edo period.
The main road through this village was called Aizu West Road or Shimotsuke Road which played an important role in connecting Aizu-Wakamatsu, a castle town in Fukushima Prefecture, and Imaichi in Tochigi Prefecture.
Many thousands straw rice sacks and commodities were cared overland along this road.

Takato soba  is well known as the specialty food of Ouchi-juku. We have a custom to eat this soba using welsh onions, instead of chopsticks.

# *Conference Program and Abstracts*

## October 29th, Saturday

October 29th, 7:50: Bus pickup in front of Washington Hotel to the University of Aizu

October 29th, 8:00-8:30: Registration

October 29th, 8:30-8:45: **Opening Speech**

Toshiyo Tamura, *Waseda University, Japan*
Kwang Suk Park, Seoul National University, Korea
Wenxi Chen, The University of Aizu, Japan

October 29th, 8:45-9:15: **Keynote Lecture Session**

Chair: Prof. Wenxi Chen (The University of Aizu, Japan)

***Handling Big Data and Information in Disaster Scene***

Toshiaki Miyazaki
The University of Aizu, Japan

***Abstract:*** In September 11, 2011, we had a big earthquake in Tohoku area in Japan. Tsunami caused by the earthquake attacked huge area, and the nuclear power plant accident had robbed many people of their calm lives. The cruel experience provoked us into developing data and information sharing systems that must be used in disaster scenes. In my keynote speech, I will introduce two systems that we are developing. The first one is the demand-addressable sensor network system (DASN), which is dedicated to nation-wide environmental sensing. To handle huge amount of sensed data, e.g., more than one million sensed data per second, a unique distributed database technique and an active sensing concept were introduced to DASN. The second system is the resilient information management system or RIM. By providing a standalone server with WiFi environment, RIM supports rescue actions and information sharing among the people in a disaster-hit region using their smartphones/tablets, even if the Internet and commercial phone/ network infrastructure are not available.

October 29th, 9:15-10:15: **Invited Speech I**

Chair: Prof. Toshiyo Tamura (Waseda University, Japan)

***Authentication Using Physiological Signals for Ubiquitous Healthcare***

Kwang Suk Park, and Ji Hoon Kim
Seoul National University, Korea

***Abstract:*** Authentication is the act of confirming the truth of an attribute of data claimed by the person. With an increase of mobile communication and the services requiring the confirmation of the person, biometric authentication has raised as the strong alternatives replacing the conventional ways of authentication like passwords, personal cards and keys based on their convenience and reliability. Even though finger print and iris are using as representative examples of biometric authentication, they still have some limitations and are difficult to use as a single method of authentication. Biological signals which have been used mainly for the diagnosis of the diseases, can be applied for the authentication and identification of the person. These signals

represent the physiological activities of the person uniquely in contrast to the anatomical characteristics represented by finger print or iris. Since the biological signals are varying upon the function of the organ, their shapes and patterns cannot be same as the organ and the system producing the biological signals are same among the person even they are in normal ranges. ECG and EEG are good examples for this purpose. ECG collected from the two hands and the EEG collected with limited number of electrodes while the subjects are in resting or in special tasks have used for the authentication and identification experiments. ECG have identified the person with 99.51% accuracy from the 50 subjects and authenticated the person with 84.54% accuracy. EEG in resting state showed 96.80% of identification accuracy and 77.99% of authentication accuracy. Biological signals can be used by replacing and supplementing the current biometric authentication methods and also can be used in medical community for the authentication of the biological signals themselves which have transferred through the communiation.in ubiquitous healthcare environment.

***What Can We Do for Realizing Healthy Life in the Remote Future?***

Tatsuo Togawa
Waseda University, Japan

***Abstract:*** Although there are many uncertainty in the near future, remote future is not totally unpredictable but we can imagine the remote future people's life fairly vividly, and we can do many for realizing their good life if we earnestly desire to do so. On the contrary, if we are myopic and behave only for own benefits, many serious problems will appear in the remote future, and it will be too late to solve their problems by themselves. In this talk, I will show some essential problems which are likely to occur in the remote future generations, and discuss our possible contributions for realizing goodness in their life.

**(Coffee Break)**

October 29th, 10:30-12:00: **Session I: Nonintrusive and Noncontact Measurement**
Chair: Prof. Hyung-Jin Yoon (Seoul National University Hospital, Korea)

***Multi-frequency Radar in Non-Contact Fall Detection for Elderly***

Maria Dremina[*1], Lesya Anishchenko[*1], and Maxim Ryzhii[*2]
[*1] Bauman Moscow State Technical University, Russia, [*2] The University of Aizu, Japan

***Abstract:*** This paper describes results of fall detection study with a non-contact bioradiolocation method. The exploration of the advantages of the multi-frequency system for physical activity monitoring over single frequency systems is discussed. We compare two machine learning algorithms: the support vector machines and "K-nearest neighbors" method. The effectiveness of the proposed technique is verified through obtained dataset and sufficient level of accuracy: more than 92% for the least efficient classifier.

***Estimation for Dropping Water Volume of Swinging Water into Toilet Bowls Using Noncontact Temperature Sensors***

Koya Fujita, Juhyon Kim, and Kazuki Nakajima
University of Toyama, Japan

***Abstract:*** A method to measure urine volume by non-contact matrix temperature sensors in a lavatory is described in this paper. Four noncontact matrix temperature sensors were installed under a toilet seat. In the previous study, we reported that water volume was estimated at various flow volumes and flow rates using a real toilet bowl. In this study, the dropping water volume of swinging water was estimated by four noncontact matrix temperature sensors. The regression lines for each flow rate and each swinging stroke were almost equivalent.

***Development of an Electrode for Absorption Volume Evaluation of the Pad Type Diaper to Reduce the Capacitance Change Due to Change in the Posture***

Shujiro Konno[*1], Juhyon Kim[*1], Katsuhisa Sekine[*2], and Kazuki Nakajima[*1]
[*1] University of Toyama, Japan, [*2] Kanazawa University, Japan

***Abstract:*** The disposable diapers of two type, pad-type and tape-type, are used generally for bed-ridden elderly in nursing home in Japan. We developed the capacitive electrode to evaluate the absorption volume of the pad-type diaper from the outer surface of the tape-type diaper. However, this electrode is influenced of their posture change. In this study, we developed a new design of the electrode to reduce the influence of the posture change.

***Measurement of Electrocardiogram in Daily Life with Smart-Wear Developed by Stretchable Conductive Film***

Yusuke Sakaue, Naruhiro Shiozawa, and Masaaki Makikawa
Ritsumeikan University, Japan

***Abstract:*** The electrocardiogram (ECG) is an important vital signal for health management. In our previous works, smart-wear that can measure a human ECG was developed using conductive stretchable film, and the ECGs of subjects were measured on a treadmill. The purpose of the present paper is to clarify the quality of the ECG measured by smart-wear in daily life. A healthy male's ECG was measured in daily life using smart-wear. The measured ECG was evaluated by the visual confirmation of R peaks. The results show that the ECG can be measured at 95.2% in daily life.

***Physiological Significance of Periodic Limb Movements in Insomnia Patients***

Hyunbin Kwon[*1], Jaewon Choi[*2], Yujin Lee[*2], Do-Un Jeong[*2], and KwangSuk Park[*1]
[*1] Seoul National University, Korea, [*2] Seoul National University Hospital, Korea

***Abstract:*** There are contradictory clinical findings about whether the PLMD symptom implies impaired sleep or not. In this study, we investigated physiological differences between heart rate variability change in insomnia patients and normal controls. We carried out three sets of experiments: PLMI > 15 subgroup vs PLMI ≦ 15 subgroup in insomnia; and normal controls; overall insomnia vs overall normal controls. According to the results, a shift of the LF-HF balance in favor of the LF component was appears and it indicates that PLMS induces an increased sympathetic tonus in both with and without insomnia. Moreover, there was no significant physiological difference according to the extent of PLMS. Finally there was increased heart rate variability in insomnia compared to normal controls. This means there is physiological difference in PLMS of insomnia subjects and others.

***Unconstrained Abnormal Respiration Detection using Ultra Wide Band Radar***

MyungJun Koh[*1], HanByul Kim[*1], Haesung Kim[*2], and KwangSuk Park[*1]
[*1] Seoul National University, Korea, [*2] BISWORKS, Korea

***Abstract:*** Respiration is one of the most evident vital signs. Long-term respiration monitoring is needed to find out if the person is in good health condition. Subject's comfort is crucial for long-term monitoring vital signs. The unconstrained method is preferred in such a situation. This study investigated the feasibility of Ultra Wide Band (UWB) radar detecting abnormal respiration. Respiration data was classified by using Support Vector Machine (SVM), Decision Tree (DT) and Random Forest (RF) after features were extracted from the dataset. Reference dataset showed 100% mean recall, 93% mean precision while UWB radar dataset showed 86% mean recall, 82% mean precision. This study expects more application of UWB radar in long-term vital sign monitoring.

**(Lunch)**

October 29th, 13:00-14:30: **Session II: Healthcare System**

Chair: Prof. Sung-Min Park (Seoul National University, Korea)

***Electric Wheelchair Control Using EMG-Based Tongue Interface***

Ryosuke Oikawa[*1], Makoto Sasaki[*1], Mamoru Kikuchi[*1], Isamu Shibamoto[*2], Atsushi Nakayama[*3], and Katsuhiro Kamata[*4]

[*1] Iwate University, Japan, [*2] Seirei Christopher University, Japan,

[*3] Ichinoseki National College of Technology, Japan, [*4] Pattern Art Laboratory Co., Ltd., Japan

***Abstract:*** In this study, we developed a tongue-controlled wheelchair system. Voluntary tongue motions were classified using a tongue interface based on surface electromyography (EMG) signals of the suprahyoid muscles and were linked with electric wheelchair operation commands. Experimental results revealed that classified tongue motions can control a wheelchair.

***EMG-based Classification of Tongue Training Motion***

Shumpei Ito[*1], Makoto Sasaki[*1], Isamu Shibamoto[*2], Atsushi Nakayama[*3], and Katsuhiro Kamata[*4]

[*1] Iwate University, Japan, [*2] Seirei Christopher University, Japan,

[*3] Ichinoseki National College of Technology, Japan, [*4] Pattern Art Laboratory Co., Ltd., Japan

***Abstract:*** In this study, tongue training motions used for dysphagia rehabilitation were classified from surface electromyography (EMG) signals of the suprahyoid muscles. Results show that the classification accuracy of tongue motions by elderly subjects is 87.3 ± 8.3%.

***Remote Rehabilitation System with the Fusion of Noninvasive Wearable Device and Motion Sensing for Pulmonary Patients***

Chung-Kit Tey, Jinyoung An, and Wan-Young Chung

Pukyong National University, Korea

***Abstract:*** This paper presents a novel remote rehabilitation system for a multimodal sensors-based application for patients who have chronic breathing difficulties. The process involves the fusion of sensory data—captured motion data by stereo-camera and photoplethysmogram signal by a wearable PPG sensor—that are inputs to a detection and evaluation framework. Furthermore, we incorporated a set of rehabilitation for pulmonary patients into the system by fusing sensory data. Simultaneously, the system features medical functions that accommodate the needs of medical professionals and those which ease the use of the variable application for patient. Finally, the results indicate the accuracy of pulmonary exercises from the combined data. The proposed system serves a comfortable and cost-effective option in the health-care rehabilitation system.

***Current Status and Trends of mHealth Apps for Smartphones***

Kazuaki Yamauchi, and Wenxi Chen

The University of Aizu, Japan

***Abstract:*** This paper reviews current status and trends of the mHealth apps for smartphones worldwide intensively and extensively. We divided the apps into two categories: Health/Fitness Apps and Medical Apps. We analyze pros and cons of these apps, discuss smartphone embedded functionality and envision future perspectives of smartphone apps in healthcare/medicine domains.

***Continuous Health Monitoring Based on Data-Oriented Estimation of Cuffless Blood Pressure Using a Wristwatch-type Photoplethysmograph Sensor***

Kengo Atomi[*1], Haruki Kawanaka[*1], Md. Shoaib Bhuiyan[*2], and Koji Oguri[*1]
[*1] Aichi Prefectural University, Japan, [*2] Suzuka University of Medical Science, Japan

***Abstract:*** Prevention of the lifestyle related diseases and enhancement of the home healthcare are necessary to extend the expectancy of a healthy life. Blood pressure, which is used for the patient monitoring nowadays, is one of the most useful indexes for prevention of lifestyle related diseases such as hypertension. However, efficient continuous monitoring of blood pressure has never been realized because of discomfort caused by the tightening a cuff belt. We have earlier researched the data-oriented blood pressure estimation without using a cuff. Remarkably, our blood pressure estimation method only uses a Photoplethysmograph sensor. Therefore the application is flexible for sensor locations and measuring situations. In this paper, we have adopted the method and launched a cloud system, which can collect and manage blood pressure data measured by a wristwatch-type photoplethysmograph sensor. And we constructed the applications to visualize life-log data including the time-series of blood pressure.

***The Precision Verification on Pulse Transit Time Detecting Method***

Yuka Maeda[*1], Masaki Sekine[*2], Toshiyo Tamura[*3], and Koichi Mizutani[*1]
[*1] University of Tsukuba, Japan, [*2] Tsukuba International University, Japan,
[*3] Waseda University, Japan

***Abstract:*** The pulse transit time (PTT) have received attention in recent years for cuffless blood pressure monitoring. The aim of this study was to verify the effect of PTT detecting method on precision of computing PTT. Twelve healthy volunteers participated in this study. The coefficient of variation of a ten-seconds PTT was computed from each detecting method, and it was used to evaluate the precision of detecting method. The result shows that pumping phase had higher precision than reflected phase.

**(Coffee Break)**

October 29th, 14:45-16:15: **Invited Speech II**

Chair: Prof. Kwang-Suk Park (Seoul National University, Korea)

***Synthesized Electrocardiogram: A New Technology for Advanced Cardiology and Smart Healthcare***

Daming Wei
The EKG Technology Lab, Japan

***Abstract:*** The electrocardiogram (ECG) is one of the most important vital signs in applications of smart healthcare. Because the way of standard ECG recording is not always convenient and comfortable to applications of healthcare in outside hospital conditions, synthesized ECG 12-laed ECG technique provides an alternative and simple way. Furthermore, because the Synthesized ECG means obtaining ECG signals with less electrodes than usually needed in ECG recordings. The synthesized ECG waveforms are mathematically synthesized from signals actually detected.

***Development of Screening Test of Cognitive Function in Elderly People Using Time-Resolved Near-Infrared Spectroscopy***

Kaoru Sakatani, Y Murayama, Y Sato, and L Hu
Nihon University, Japan

***Abstract:*** **Background:** Neuroimaging techniques such as fMRI and PET are powerful tools for diagnosis of dementia in the elderly. However, they are complex and expensive, so a simple, non-invasive method for

screening cognitive function is required. In the present study, we examined the usefulness of time-resolved near-infrared spectroscopy (TNIRS) for this purpose. Unlike continuous-wave NIRS, TNIRS enables us to measure baseline concentration of Hb in the resting condition by applying a photon diffusion equation. A functional study by TNIRS demonstrated that baseline concentrations of hemoglobin (Hb) in the prefrontal cortex (PFC) reflect regional cerebral blood flow and neuronal activity at rest [1-3]. **Subjects and Methods:** We studied 78 subjects (male 41, female 37, age 71.5±10.7). Employing TNIRS, we measured baseline concentrations of oxy-, deoxy-, total-Hb (μM/L), and oxygen saturation (SO2) (%). We evaluated cognitive functions by mini mental state examination (MMSE) and Touch M, which evaluates working memory function semi-automatically on a touchscreen. **Results:** The mean MMSE and Touch M scores of all subjects were 25.3±4.0 (max 30) and 41.3±22.1 (max 100), respectively. TNIRS revealed moderate but significant positive correlations between Touch M scores and baseline concentrations of oxy-Hb ($r=0.26$, $p<0.02$), total-Hb ($r=0.23$, $p<0.05$), and SO2 ($r=0.23$, $p<0.05$) (Fig. 1). MMSE showed a significant positive correlation with SO2 ($r=0.24$, $p<0.02$), but not other parameters. **Discussion:** The results suggest that TNIRS may be a useful tool as a screening test of cognitive function, particularly working memory function, in the elderly. It should be emphasized that the present method is suitable for elderly subjects with cognitive dysfunction, who cannot response to cognitive tasks.

### *Home Blood Pressure Monitor as a IoT and New Platform for Telemedicine to Manage Hypertension in Japan*

Junichi Yatabe[*1], Midori S Yatabe[*1], Kyotaro Ito[*2], Hirofumi Kasuga[*2], and Atsuhiro Ichihara[*1]
[*1] Tokyo Women's Medical University, Japan, [*2] PORT Corporation, Japan

***Abstract:*** Personal health management including self-management of blood pressure (SMBP) at home may be an easy and useful method to extend healthy life expectancy. Electric sphygmomanometer with automated 3G data transfer and room temperature monitor is used for daily SMBP. Blood pressure variability based on SMBP predicts cardiovascular outcome in patient with hypertension. Room temperature at the time of SMBP significantly correlates with variability of systolic blood pressure. Home blood pressure monitor equipped with environmental sensors as an Internet of Things will provide benefit to maintain ideal blood pressure. Meanwhile, telemedicine without face-to-face communication was permitted in 2015. We developed the integrated Web-based telemedicine platform to allow appointment, medical care and payment without visiting clinic. However, there remains a lack of clinical evidence concerning the efficacy and safety of telemedicine. We appeal herein the necessity of clinical trial to show the advantage of telemedicine over traditional care in a management of hypertension.

**(Coffee Break)**

October 29th, 16:30-18:00: **Session III: Classification, Modeling and Simulation**
Chair: Koji Oguri (Aichi Prefectual University, Japan)

### *Preliminary Study of an Unobtrusive Health Monitoring System for Elderly People in Daily Living*

Zunyi Tang, Linlin Jiang, Lizhen Hu, Yutaka Sato, Yuta Murayama, and Kaoru Sakatani
Nihon University, Japan

***Abstract:*** An unobtrusive system for monitoring the health of elderly people in daily living at home was developed to provide healthcare and improve quality of life. The system is composed of an unobtrusive sensor monitoring sleeping and a digitalized water meter recording daily water consumption. The sleeping sensor can detect heart rate (HR), respiratory rate (RR), body movement (BW), and states on the bed or outside the bed. The collected data can be transmitted to a remote server by wireless home gateway for analyzing the living pattern and rhythm of elderly people. An evaluation feedback can be provided to themselves and their health

advisers. Preliminary results show the effectiveness of the system monitoring the state of health and living pattern and suggest the potential for promoting health of elder people.

***Development of a Wearable Body Core Temperature Monitor***
***— Preliminary Study for Reduction of Power Consumption —***

Shohei Muto[*1], Noriko Sakai[*1], Masamichi Nogawa[*1], Hisashi Naito[*1], Shinobu Tanaka[*1], Tetsu Nemoto[*1], and Tatsuo Togawa[*2]
[*1] Kanazawa University, Japan, [*2] Waseda University, Japan

***Abstract:*** Aiming for realizing a wearable type deep body temperature monitor based on the zero heat-flow method, preliminary experiments for reducing electric power consumption were carried out. Using a commercially available core temperature monitor, the effect of heat insulation of the probe in reducing the power consumption was examined. From the results obtained, it was confirmed that, by covering the probe using heat insulation materials, electrical power consumption of the probe was significantly reduced suggesting possibility of realizing a wearable device.

***A Personalized Model to Predict Human Thermal State Based on Sequential Physiological Measurements***

Ming Huang[*1], Toshiyo Tamura[*2], and Takumi Yoshimura[*3]
[*1] Nara Institute of Science and Technology, [*2] Japan, Waseda University, Japan,
[*3] Tokyo Metropolitan College of Inductrial Technology, Japan

***Abstract:*** Heat exhaustion is dangerous for the occupations involving the exposure to heat, heavy workloads. When the autonomic thermoregulatory system can not dissipate the accumulated heat appropriately heat stroke may be developed. Therefore, there is a paradox between the needs of monitoring and predicting the change of core body temperature (CBT) and the lack of measures to measure and predict CBT continuously. Deep body temperature (DBT) showing the subcutaneous temperature is a good approximation of the CBT and can be measured with wearable thermometer. On the other hand, heart rate (HR) is also an independent indicator of CBT. We thus developed a model to predict the CBT with the continuous measurements of the DBT and HR based on Kalman filter, which can readily be implemented with wearable devices. 10 young male subjects participated in a cycling exercise experiment for 30 minutes in a thermostatic chamber. Measurements of 5 subjects selected randomly were used to build up the model, and all the data was used to validate the model. The overall bias of the model is 0.01 ± 0.16 °C and 95% of all the predictions fall within the [-0.29, 0.32] °C. This preliminary study shows the feasibility to integrate the physiological measurements with wearable devices to provide practical prediction of thermal state for an effective thermoregulation.

***A Cardiac Reaction-Diffusion Model Based on TRPM4 Channel***

Yanghua Shen[*1], Xuming Zheng[*1], Wenfeng Shen[*1], Xin Zhu[*2], Yaopeng Hu[*3], and Ryuji Inoue[*3]
[*1] Shanghai University, China, [*2] The University of Aizu, Japan, [*3] Fukuoka University, Japan

***Abstract:*** In this paper, we present a cardiac propagation simulation model for reaction-diffusion systems in two dimensions by introducing TRPM4 channel. This model is solved by Runge-Kutta methods, which use a 2D anisotropic diffusion tensor with fully isotropy or axially anisotropy around fiber directions.

***Parallel Computation for Computer Simulation of Electrocardiograms Based on Tegra K1 Board***

Kai Xu[*1], Feng Qiu[*1], Wenfeng Shen[*1], Huiran Zhang[*1], Daming Wei[*2], and Xin Zhu[*3]
[*1] Shanghai University, China, [*2] Tohoku University, Japan, [*3] The University of Aizu, Japan

***Abstract:*** The high performance computing is applied more and more toward the compact portable platforms that have advantages of low consumption and good performance, with the coming of lower power consumption

era and the popularity of mobile computing. This paper employs Nvidia Tegra K1(TK1) System on Chip(SoC) board to achieve a parallel computing event for computer simulation of electrocardiograms(ECGs) based on the whole-heart model. Aiming at the unified memory characteristics of CPU-GPU integrated architecture, an optimization was significantly implemented in the GPU section of the parallel computing of ECGs. Furthermore, in order to realize a parallelization on ARM-based CPU-GPU architecture, we utilize the control of the number of cores and the control of frequency. The experiment demonstrates that the typical performance of TK1 board reach approximately the level of ordinary personal computers(PCs), especially it has better energy efficiency compare to the traditional PCs.

***Finite-Difference-Method Calculations of Bio-Impedance of Skeletal Muscles Using Equivalent Elements Representing Bundles of Muscle Cells***

Hiromasa Hirakawa, and Katsuhisa Sekine
Kanazawa University, Japan

***Abstract:*** Utility of a modified method of finite-difference- method calculations for the bio-impedance of skeletal muscles was shown from the comparison between the results of the calculations by the modified and the conventional methods.

October 29th, 18:10: Washington Hotel bus pickup from the University of Aizu

October 29th, 18:30: **Conference Banquet** at Washington Hotel

## October 30th, Sunday

October 30th, 7:50: Bus pickup in front of Washington Hotel to the University of Aizu

October 30th, 8:00-8:15: Registration

October 30th, 8:15-9:15: **Invited Speech III**

Chair: Prof. Toshiyo Tamura (Waseda University, Japan)

***Mobile Healthcare Opportunities and Trends for Personalized Connected Care – Industry Perspectives***

Sung-Min Park
Pohang University of Science and Technology, Korea

***Abstract:*** Over the past few years, a variety of medical products integrated with cutting-edge mobile technologies have been introduced to the healthcare market and shown the capability of revolutionizing the personalized disease management modalities. These mobile medical products ranging from algorithms to devices have a large potential to play a part in the transformation of healthcare that will accelerate discovery, improve patient outcomes and decrease costs. The medical devices with mobility and connectivity anytime anywhere are becoming an informative part of the patients' everyday lives and enabling patient centered connected care. There is a particular opportunity with these devices in transforming the chronic disease management in which the continuous health tracking and modification of lifestyle are critical for the care. In this context, we will discuss some examples of mobile medical products such as insulin infusion systems and cardiac monitors. I will close by commenting on current mobile health industry activities including opportunities and challenges.

***Medical Big Data: Promise and Challenges***

Hyung-Jin Yoon
Seoul National University Hospital, Korea

***Abstract:*** Big data technology is being applied to many industrial areas with some success. Although healthcare sector, although, was once considered as one of the disciplines that would be benefited most by big data technology, the tangible benefits of big data technology in healthcare has not been proved so far. It is desirable to evaluate the outcome of the application of big data technology to healthcare from the practical point of view such as improvement of patient experience or reducing waste. The absence of proved tangible benefits of big data technology in healthcare may be resulting, at least partly, from the inherent complexity of medical science and practice and legal and ethical issues around medical practice, which are distinct from other disciplines.

The concept of big data, commonly characterized by volume, variety, velocity, and veracity, goes far beyond the data type and includes the aspects of data analysis, such as hypothesis-generating, rather than hypothesis-testing. Big data focuses on temporal stability of the association, rather than on causal relationship and underlying probability distribution assumptions are frequently not required. Medical big data as material to be analyzed has various features that are not only distinct from big data of other disciplines, but also distinct from traditional clinical epidemiology. Big data technology has many areas of application in healthcare, such as predictive modeling and clinical decision support, disease or safety surveillance, public health, and research. Big data analytics frequently exploits analytic methods developed in data mining, including classification, clustering, and regression. Medical big data analyses are complicated by many technical issues, such as missing values, curse of dimensionality, and bias control, and share the inherent limitations of observation study, namely the inability

to test causality resulting from residual confounding, reverse causation, or measurement error. Recently, propensity score analysis and instrumental variable analysis have been introduced to overcome these limitations, and they have accomplished a great deal. Many challenges, such as the absence of evidence of practical benefits of big data, methodological issues including legal and ethical issues, and clinical integration and utility issues, must be overcome to realize the promise of medical big data as the fuel of a continuous learning healthcare system that will improve patient outcome and reduce waste.

**(Coffee Break)**

October 30th, 9:30-10:15: **Session IV: Medical Image and Data Analysis**

Chair: Prof. Kazuki Nakajima (University of Toyama, Japan)

***Visualization of Tooth Brushing Skills***

Shota Tanaka[*1], Makoto Sasaki[*1], Fumiya Kato[*1], Mamoru Kikuchi[*1], Atsuko Shishido[*2], Soshi Hanawa[*2], Kazuko Igari[*2], and Keiichi Sasaki[*2]
[*1] Iwate University, Japan, [*2] Tohoku University, Japan

***Abstract:*** In this study, we developed a three-dimensional measurement system for the visualization of tooth brushing skills. Tooth-brushing motion, brushing force vector and its point of application were measured using the developed system.

***Development of Medical Image Viewer Matching System by Diseases***

Si-Hyung No, Ji-Eon Kim, Chang-Won Jeong, Jong-Hyun Ryu, Hong-Young Jun, Tea-Hoon Kim, Jinseok Lee, Su-Chong Joo, and Kwon-Ha Yoon
Wongkwang University, Korea

***Abstract:*** In this paper, we propose a system suitable for a variety of medical image in the medical field that is generated and displayed, but the problem with medical image to confirm the image through the bulk of viewers. For this purpose, we implemented an automatic matching method of the viewer applications based on the tag information of the DICOM standard for medical image information. And we show the results of applications that can control medical image information via a non-contact interface in operating room.

***Two Modes of Speed Adjusting Operation Revealed in Joystick Maneuver of Power Wheelchair — Toward Wheelchair Skills Assessment with Life-Logging —***

Kengo Komoto, and Jun Suzurikawa
Research Institute of the National Rehabilitation Center for Persons with Disabilities, Japan

***Abstract:*** Quantitative assessment of driving skills of power wheelchair (PWC) is important for safety use. The concept of wheelchair life-logging proposed by the authors will be a strong tool for the quantitative skill assessment with a better dynamic range than the existing skill measures. However few studies have reported systematic characterization of PWC skills assessment using life-log. In this study, we attempted to characterize joystick operation focusing on speed adjusting maneuver, which is a key factor for driving safety, but cannot be evaluated by existing skill measures. In the PWC joystick operation during a slalom test drive, two distinct speed adjusting mode were observed, i.e., pulse width modulation (PWM) and amplitude modulation (AM). The mode shift in the same subject was also observed as a response to the modulation in the motor control of the test PWC. These findings in the PWC maneuver strategy of speed adjusting will be deployed to an analytical assessment method of driving skills.

October 30th, 10:20-10:50: **Panel Discussion on Big Data**
**— Acquisition, Analysis, and Presentation of Big Data in Healthcare Domain —**
Chairs: Wenxi Chen (The University of Aizu, Japan),
Toshiyo Tamura (Waseda University, Japan),
Kwang Suk Park (Seoul National University, Korea)
Panelists: Hyung-Jin Yoon (Seoul National University Hospital, Korea),
Junichi Yatabe (Tokyo Women's Medical University, Japan),
Toshiaki Miyazaki (The University of Aizu, Japan)

October 30th, 10:50-10:55: **Announcement on IEEE EMBC 2017**
Kwang Suk Park
Seoul National University, Korea

October 30th, 10:55-11:00: **Closing Speech**
Toshiyo Tamura
Waseda University, Japan

October 30th, 11:00: Bus for Excursion

October 30th, 12:00: Tour including lunch, hot springs and dinner

Memo

# BigHealth-2016 TECHNICAL PROGRAM AT A GLANCE

Joint International Conference of Big Data Analytics in Health Informatics and u-Healthcare 2016

Dates: October 29-30, 2016

Venue: The University of Aizu, Aizuwakamatsu City, Fukushima 965-8580, Japan

| Time | October 29 (Saturday) | Time | October 30 (Sunday) |
|---|---|---|---|
| 7:50 | Bus pickup in front of Washington Hotel to the University of Aizu | 7:50 | Bus pickup in front of Washington Hotel to the University of Aizu |
| 8:00 | Registration | 8:00 | Registration |
| 8:15 | | 8:15 | Invited Speech III |
| 8:30 | Opening Speech | 8:30 | |
| 8:45 | Keynote Lecture Session | 8:45 | |
| 9:00 | | 9:00 | |
| 9:15 | Invited Speech I | 9:15 | *Coffee Break* |
| 9:30 | | 9:30 | Oral Session IV |
| 9:45 | | 9:45 | |
| 10:00 | | 10:00 | |
| 10:15 | *Coffee Break* | 10:15 | |
| 10:30 | Oral Session I | 10:20 | Panel Discussion on Big Data |
| 10:45 | | 10:50 | Announcement on IEEE EMBC 2017 |
| 11:00 | | 10:55 | Closing Speech |
| 11:15 | | 11:00 | |
| 11:30 | | | |
| 11:45 | | | |
| 12:00 | *Lunch* | | |
| 12:15 | | | |
| 12:30 | | | |
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| 13:00 | Oral Session II | | |
| 13:15 | | | |
| 13:30 | | | |
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| 14:00 | | | |
| 14:15 | | | |
| 14:30 | *Coffee Break* | | |
| 14:45 | Invited Speech II | | *Post-conference Excursion (lunch , hot spring & dinner included) (Bus for Excursion at 11:00AM)* |
| 15:00 | | | |
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| 15:45 | | | |
| 16:00 | | | |
| 16:15 | *Coffee Break* | | |
| 16:30 | Oral Session III | | |
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| 17:45 | | | |
| 18:00 | | | |
| 18:10 | *Washington Hotel bus pickup from the University of Aizu* | | |
| 18:30 | *Conference Banquet at Washington Hotel* | 18:30 | |