Proceeding of International Conference on

u-Healthcare 2013

Abstracts

Keio Gijuku in Tsukiji in 1862 (The origin of Keio University)

Hiyoshi Campus, Keio University, Yokohama, Japan
September 12-14, 2013
Welcome Message

On the behalf of the Organizing Committee, may we give a very warm welcome to u-Healthcare 2013, which will be held in Yokohama, Japan, in conjunction with Life 2013. Yokohama was one of the first port to be opened to foreign trade in 1859.

Since our first conference u-Healthcare 2004, this annual meeting has been the site for the communication and discussion of current progress on ubiquitous healthcare technologies. u-Healthcare 2013 is the 10th annual international conference mainly devoted for the promotion of ubiquitous-Healthcare based on rapidly progressing information communication technologies. Enhancement in the welfare for future requires the change to the current healthcare system. Our concern for the healthcare is shifting from ‘recovery from illness’ to ‘maintaining the wellness and improving the quality of life’. For the care of daily health level we need special kinds of methods and technologies that we can be applied into our daily life smoothly. In this point, u-Healthcare 2013 will provide an excellent opportunity for academic researchers and industrial representatives as well as decision makers to discuss the state-of-the-art and trends of u-Healthcare and related biomedical engineering supports.

I would like to send a particular welcome to those of you who might be interested in the u-Healthcare area. This conference offers a wonderful opportunity to understand the problems and exchange ideas about your work in organized sessions and also in an informal, relaxed setting.

Toshiyo Tamura, Ph. D.
Professor, Department of Biomedical Engineering,
Osaka Electro-Communication University, Japan

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

Hosted by
Keio University (Hiyoshi Campus)

Organized by
Osaka Electro-Communication University

Kanto section, Japanese Society for Medical & Biological Engineering

Division of Ubiquitous Healthcare, Life Engineering Section, Society of Instrument and Control Engineering

Technical Co-sponsored by
Public Foundation of Kansai Research Institute

Korean Society of Medical & Biological Engineering (KOSOMBE)

Japanese Society for Medical & Biological Engineering (JSMBE)

IEEE Engineering in Medicine & Biology Society (IEEE EMBS)

Society of Instrument and Control Engineering (SICE)
Conference Committees

Organizing Committee
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Masaki Yoshida (Osaka Electro-Communication University, Japan)
Masaaki Makikawa (Ritsumeikan University, Japan)
Yutaka Fukuoka (Kogakuin University, Japan)
Yasunari Yokota (Gifu University, Japan)
Hisao Oka (Okayama University, Japan)
Norihiro Katayama (Tohoku University, Japan)
Toru Kiryu (Niigata University, Japan)
Naruhito Shiozawa (Ritsumeikan University, Japan)
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Shinobu Tanaka (Kanazawa University, Japan)
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Mitsuyuki Nakao (Tohoku University, Japan)
Satoru Nebuya (Kitasato University, Japan)
Taishin Nomura (Osaka University, Japan)
Tetsuya Yagi (Osaka University, Japan)
Yoshiharu Yamamoto (University of Tokyo, Japan)
Yuji Ohta (Ochanomizu University, Japan)
Kazuhiko Yamashita (Tokyo Healthcare University, Japan)
Wenxi Chen (University of Aizu, Japan)

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Sosuke Tsukamoto (Hiroshima Institute of Technology, Japan)
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Naruhito Shiozawa (Ritsumeikan University, Japan)
Shinobu Tanaka (Kanazawa University, Japan)
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Web Master
Zunyi Tang (Osaka Electro-Communication University, Japan)
Hidenori Inaoka (Kitasato University, Japan)
Vitae of Keynote Lecturers

**Toshikazu Shiga** received the B.S. degree in 1982 from Yamaguchi University, Yamaguchi Japan in electrical engineering, the M.S. degree in 1986 from Hokkaido University, Hokkaido Japan, and Ph.D. degree in 1998 from Hokkaido University, Hokkaido Japan, both in biomedical engineering. In April 1986, he was joined the research and development division of Omron Healthcare Co, ltd. His area of research interest are the measurement of biological signal and all biomedical engineering.

**Hiroshi Nakajima** received the B.Eng. degree in System Engineering from Kobe University, Japan, in 1985, and Ph.D. degree in Systems Information Science from Kumamoto University, Japan, in 2004. He is currently Chief Specialist of Technology at Omron Corporation. Besides long term career at industry, he also has some academic careers as follows;

- **Apr. 2010 – Mar. 2011:** Graduate School of Science GP Fellow and Affiliate Professor at Osaka Prefecture University
- **Apr. 2008- :** Part-time lecturer at Kyoto Saga University of Arts
- **Jan. 2007 – Dec. 2010:** Distinguished Lecturer of IEEE SMC.
- **Apr. 2013:** Visiting Professor at Kyushu Institute of Technology

He has focused on the general solution for improvement of health in humans, machines, and energy consumptions by applying sensory inspection and computational intelligence.
Vitae of Invited Lecturers

**Gilwon Yoon** received his B.S. in Electrical Engineering from Seoul National University, Seoul, Korea in 1977 and M.S. and Ph.D. in Electrical and Computer Engineering from the University of Texas at Austin, U.S.A. in 1982 and 1988 respectively. His work experience includes research fellow at the National Institute for Health and Medical Research (INSERM, U. 279) in France (1989), research engineer at Dixon Utah Laser Institute, Salt Lake City, Utah, U.S.A (1990-1992). Then, he worked as Lab Director at Samsung Advanced Institute of Technology, Samsung Electronics, Korea between 1992 and 2003. Since 2003, he is Professor at the Department of Electronic and IT Media Engineering, Seoul National University of Science and Technology, KOREA. His research interest covers biosignal monitoring, biomedical image processing and bio-spectroscopy.

**Yukihisa Namiki**

Current Research Professions: Central Institute for Experimental Animals (CIEA) as an advisor, Research Institute for Animal Science in Biochemistry and Toxicology (RIAS) as a consultant, and Osaka University as an invited researcher.

Education Background: Dept. of Biomedical Engineering, University of Southern California (USC) for BS degree, Dept. of Biomedical Engineering, University of Southern California (USC) for MS degree, Dept. of Applied Quantum Physics and Nuclear Engineering, Kyushu University for Ph. D.

Dr. Namiki (MIKI) has graduated from USC and Kyushu University. His academic background is biomedical engineering, electrical engineering and computer engineering. His professional background is regenerative medicine, cell engineering, bioinformatics and health-informatics at National Institute of Advanced Industrial Science and Technology (AIST). His research subjects are to develop biological energy transfer systems without external equipment such as electric eel and to analyze characteristic correlations and abnormal traits among human biological information data, physiological information data, genetic information data, psychological information data, life-activity information data and any collectable information data related to human (hereinafter referred to as "BBD": Biomedical Big Data). Based on the research results, his professional R&D is to develop personalized healthcare system, poison control system and antibody bank to sustain and improve human quality of life.
Wan-Young Chung was born in Gyungpook Province, Korea, in 1961. He received his B.S. and M.S. degrees in Electronic Engineering from Kyungpook National University, Daegu, Korea, in 1987 and 1989, respectively and a Ph.D. degree in Sensor Engineering from Kyushu University, Fukuoka, Japan in 1998. And he received Doctor of Science in Technology degree in Electrical and Information Engineering from University of Oulu, Finland in 2009. From 1993 to 1999, he was an assistant professor at Semyung University. From 1999 to 2008, he was an associate professor at Dongseo University. From 2008 to now, he is a Professor in Department of Electronic Engineering, Pukyong National University, Busan, South Korea. His main research field includes Ubiquitous healthcare system. He was awarded Best Award of Korean Patient Property in 2001, Silver Medal in Korea Venture Fair in 2002, Best Scientific Researcher Award of the Year from The Korean Sensor Society in 2007 and Presidential Excellent Paper Award of Science & Technology in 2012, and Busan Science & Technology Award. He is now an Editor in Chief of Journal of Sensor Science and Technology, and an Editorial Board Member of Sensor Letters and Journal of Healthcare Engineering, respectively.

Wenxi Chen received B.S. degree and M.S. degree in biomedical electronics from Department of Biomedical Engineering, Zhejiang University, China in 1983 and in 1986, respectively. He received Ph.D. degree in biomedical instrumentation from Institute of Biomaterials and Bioengineering, Tokyo Medical and Dental University, Japan in 2001. He is currently a professor in Biomedical Information Technology Lab in the University of Aizu. He has been participating 12 major R&D projects funded by Japanese governmental ministries and Fukushima prefecture totally valued more than 500 million JPY since 1998. These activities produced 34 patents (20 registered) and more than 150 papers. Some academic outcomes have been commercialized, and reported by various mass media. He is a member of Japanese Society for Medical and Biological Engineering, and a member of IEEE-EMBS. He co-organized several international conferences and served program committee for many international conferences. His current research interests focus on developing diversified modalities to detect physiological information under daily life environment, and performing comprehensive interpretation of multifarious longterm data to reveal statistical links and causalities among diseases as well as how they interact with various factors in temporal/spatial domains.

Kwang Suk Park received B.S. degree, M.S. degree and Ph.D degree in Department of Electronics Engineering from Seoul National University, Korea in 1980, in 1982 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 also director of Advanced Biometric Research Center in Seoul National University. He is currently the President-elect of Korean Society of Medical and Biological Engineering and has 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 Journal of Biomedical and Health Informatics since 2005. His main research area is biological signal measurement and processing for the diagnosis, mainly focusing on nonintrusive measurements for ubiquitous healthcare. Recently he also extended the research interest to biological signal communication for disabled persons.

Toshiyo Tamura received his BS and MS degrees from Keio University, Japan, in 1971 and 73, respectively and Ph.D. from Tokyo Medical and Dental University in 1980. He is currently a Professor, Department of Physical Therapy, Faculty of Biomedical Engineering, Osaka Electro-Communication University, Japan. He also holds several adjunct positions in universities in Japan and Singapore.
His research interests include biomedical instrumentation, biosignal processing, telemedicine telecare and home care technology. His research has resulted in over 100 reviewed articles.
**Venue**

*from Hiyoshi station to the conference venue*

To Shibuya and Meguro

Hiyoshi Station (Tokyu Toyoko Line, and Tokyu Meguro Line)

Conference Venue
*(Independence Wing, 4th building “Dokuritsukan”)*

Lunch / Banquet
*(Faculty Lounge, Raiosha)*

To Yokohama

3rd floor map

Conference Venue (D309)

Elevators

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**Authors Instruction**

- **Oral Presentation**
  Please follow carefully these guidelines to prepare your presentation:
  You will be assigned 15 minutes time for presentation + 5 minutes for questions and discussion. Authors are kindly requested to keep their talk within allocated time slot. The sessions’ chairperson will make sure that the time schedule is kept.
  You can bring your own computer. If you are using Mac, please bring the connector for your Mac. Also, a computer with PowerPoint and Acrobat Reader will be available.

- **Poster with Short Talk Presentation**
  This year we try Poster with Short Talk for good understanding of your work. Poster with Short Talk Presentation will be a hybrid between traditional poster and podium presentations. Poster presenters will give 3 minutes oral introductions to their studies. Please appreciate that strict time keeping will be necessary in order to ensure the meeting runs to schedule. We recommend 3 slides for short presentation.
  The size of poster is a portrait A1 (including the title). Preparing your Poster Presentation before the Conference. Your poster should cover the KEY POINTS of your work. The ideal poster is designed to:
    * attract attention
    * provide a brief overview of your work
    * initiate discussion and questions.
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<td>Fr2. <strong>Data Collection</strong></td>
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<td>18:00</td>
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<td><strong>Banquet</strong> (at Faculty Lounge)</td>
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Abstracts
Abstracts

September 12th, 10:00-11:20: **Network**
Chair: Nambu, Masayuki (Osaka Electro-Communication University, Japan)

[Invited Lecture 1]

**Methods of Individual Health Monitoring System based on Local Area Network, Internet and Smartphone**

Yoon, Gilwon; Park, Jin-Hee; Kim, Jong Hoon
Professor, Department of Electronic & IT Media Engineering, Seoul National University of Science and Technology, Korea

*Abstract:* Individual health monitoring should be connected to a remote healthcare center (RHC) through wireless network so that RHC can provide with appropriate medical treatments. The rapid progress of information technology facilitates various types of network system. In this presentation, two methods of implementing the wireless network system were introduced. The other part of our work was devoted to increase the performance of health monitoring devices which we called as Biosignal Monitoring Unit (BMU). The first network configuration was based on a Zigbee-WLAN-Internet connection. This was suitable for monitoring a group of people in the local area such as the sanatorium, emergency room and medical examination center. BMUs transmitted individual biosignal through a Zigbee sensor network system since the data rate of bioginal was usually low compared to other communication systems. Through a gateway between WLAN and Zigbee, a WLAN module collected all the data from BMUs. The WLAN module relayed data to a monitoring computer in the same building through cables, or through the internet if the healthcare center was remotely located. Other method was to use a smartphone. In this case, any individual with a BMU and smartphone could be connected anywhere in the world. The smartphone served two functions; wireless network and a personal healthcare database due to its capability of powerful computation and graphic display. Our BMU measured various biosignals such as ECG, PPG, skin temperature and others. BMU should be designed to be compact, less power consuming and secure. First, transmission time was reduced by decreasing the duty cycle of transmission and data size was reduced by data compression. Transmission data were lossless-compressed based on the Huffman coding that encoded the difference between the current and previous values. Real-time monitoring data of ECG and PPG had a compression ratio of 50 ~ 60%. Secondly, data security in u-Health system can be an important issue because wireless network is vulnerable to hacking. However, it was not easy to implement a proper security algorithm in an embedded u-health monitoring because of hardware constraints such as low performance and limited memory size. Four different symmetric key algorithms (DES, Blowfish, AES and RC4) were tested. Results recommended AES since it had a longer key and required lower memory usage even though it was the slowest algorithm. Thirdly, an error correction algorithm was studied to increase reliability. For this purpose, a forward error correction algorithm was tested in order to reduce communication errors. 8-byte interleaving and the Hamming coding were implemented and errors in real-time monitoring of ECG and PPG could be reduced. However, only certain simple errors could be removed due to the limitation of computation power. Further studies should be followed.

**Th1.1 Reliable Transmission of Bio Data for Mobile Healthcare Service at 6LoWPAN Multi-Hop Wireless Networks**

Woo, Yeon-Kyung; Park, Jong-Tae
Kyungpook National University, Korea
Abstract: In mobile healthcare applications, the reliable transmission of the bio-data is very important. In this article, we present a reliable bio-data transmission technique for mobile healthcare monitoring service at 6LoWPAN multi-hop wireless networks. In particular, we propose the reliable path construction for 6LoWPAN aimed to reliably provide mobile healthcare service over wireless sensor network, using IPv6 network. Detailed procedures and algorithms are presented. Simulation results show that performance is greatly improved, compared with the existing protocols.

Th1.2 Security Management and Emergency Transmission Management for Highly Reliable Health Monitoring Service in Wireless Mesh Network
Chun, Seung-Man; Woo, Yeung-Kyung; Park, Jong-Tae
Kyungpook National University, Korea

Abstract: This article proposed the architecture of security management and emergency transmission management using the personalized policies for highly reliable health monitoring on wireless mesh networks. In U-healthcare monitoring service, the highly reliable bio data management as well as the emergency data transmission management is very important because the emergency bio data is directly related to life. More specifically, it is important that the technology of the identity authentication of the collected bio data, the personalized emergency status diagnosis of the authenticated bio data, and emergency data transmission. To do this, we designed the policy structure and protocol of the identify authentication management, the resilient routing protocol based on wireless mesh network for the reliable emergency bio data transmission.

September 12th, 11:30-12:10: Monitoring – Application of Accelerometry
Chair: Okada, Shima (Kinki University, Japan)

Th2.1 Monitoring of the Respiratory Frequency by using Three-axis Acceleration Sensor Contained in a Micro Bio-signal Wireless Transmitter
Sato, Masami; Isoyama, Takashi; Saito, Itsuro; Kusakabe, Yoshinori; Abe, Yusuke
The University of Tokyo, Japan

Abstract: We have been developing a remote monitoring system of in-home patient using a micro bio-signal wireless transmitter that can transmit the electro-cardiogram (ECG) through the mobile Internet communication. To obtain more detailed diagnosis, detection of the respiratory frequency using the three-axis acceleration sensor contained in the transmitter unit was tried. The unit was attached on the left chest wall of a healthy subject. The breathing periods were fixed to 2, 5, 10 and 20 s. The measured data were analyzed with discrete Fourier transformation (DFT). The results showed that x axis (orientation of left and right) and z axis (orientation of the front and back) strongly reflected the frequency that corresponded to respiration. However, when the breathing period is 2 s, the respiratory frequency was difficult to distinguish from the adjacent spectrum even in the result of x axis or z axis. The next subject is to measure respiratory frequency precisely regardless of the period of breathing and to realize a real time monitoring of respiration.

Th2.2 Preliminary Study on the Estimation of Swallowing using a 3D-Accelerometer
Nakajima, K1; Nishitani, K1; Tsuduki, Y1; Doi, I1; Kim, J1; Nakabayashi, M1; Tsubouchi, N2; Hayashi, K2
1University of Toyama, Japan; 2Riunen, Special Elderly Nursing Home, Japan

Abstract: The acceleration at the skin surface of the neck region in healthy young subjects was monitored to estimate swallowing in this study. A 3D-accelerometer was attached to the neck surface over the musculus digastricus region, and the accelerations were recorded both at rest and while swallowing 2 g or 10 g of
pudding. The results showed that the integrated acceleration during swallowing was significantly larger than that at rest.

September 12th, 13:20-14:00: Monitoring in Marine
Chair: Nebuya, Satoru (Kitasato University, Japan)

Th3.1 Telemedical Assistance of Patients on Board Ships Activity of Centro Internazionale Radio Medico (CIRM), the Italian Telemedical Maritime Assistance Service (TMAS)
Amenta, Francesco1,2; Capone, Luciano2; Sibilio, Fabio2
1Università di Camerino, Italy; 2Fondazione Centro Internazionale Radio Medico, Italy

Abstract: This paper summarizes activity in 2010-2012 of Centro Internazionale Radio Medico (CIRM), the Italian Telemedical Maritime Assistance Service (TMAS). CIRM started its activity in 1935 and from its headquarters in Rome provides free telemedical advice to ships without a doctor on board of any nationality and sailing in all the world. In the three years under analysis CIRM has assisted via telecommunication systems (primarily e-mail) 9,071 patients on board ships, fishing vessels and airplanes in flight. Pathologies most often assisted were accidents followed in the decreasing order by digestive system, urinary and genital systems diseases, dermatological problems, cardiovascular and locomotor system disorders. Days of treatment were approximately 5 per patient and evacuations for medical reasons were necessary in approximately the 3.5% of cases in 2010 and 2011 and the 2.2% in 2012. Medical assistance of remote patients on board ships is probably one of the oldest experiences of telemedicine. Unfortunately the limited technical medical facilities and training on board ships do not allow to provide the high quality assistance allowed by technology currently available.

Th3.2 HEALTHY SHIP: A New Project for Improving Medical Care of Sailing Seafarers
Degli Angioli, Rolando1,2; Saturnino, Andrea2; Sibilio, Fabio2; Amenta, Francesco1,2
1Università di Camerino, Italy; 2Fondazione Centro Internazionale Radio Medico, Italy

Abstract: This paper summarizes the project Health Protection and Safety on Board Ships (acronym: HEALTHY SHIP) an initiative of Centro Internazionale Radio Medico (CIRM), the Italian Telemedical Maritime Assistance Service (TMAS). The project is aimed at improving standards of telemedical assistance of seafarers on board ships using telemedicine according to IMO MSC/Circular 960/2000. The main pillar of HEALTHY SHIP is the development on an electronic health record (HER) of seafarers on board ships of companies subscribing with CIRM the occupational medicine service compulsory for Italian. The Healthy Ship HER collect medical information obtained with fitting visits of seafarers which are implemented by BMI, Audiometry, ECG, Spirometry, Blood analyses collected occupational medicine visits on board ships. Access to these records is allowed to the occupational medicine team, to the doctors on duty for TMAS service at CIRM and each worker. Workers can access their health information worldwide via the Healthy Ship WEB site using a dedicated username and password. Delivery of high quality medical assistance requires a given technological background, but primarily the clinical history of a patient. Information collected for medical fitness and health surveillance of seafarers can be used for providing assistance in case of diseases or accidents on board. This could represent a way for providing without particular extra costs first class medical assistance to patients on board ships.
September 12th, 14:00-14:40: Education
Chair: Shiozawa, Naruhiro (Ritsumeikan University, Japan)

**Th4.1 Foreign Patient-Physician Communication in the Digital World**
Huang, Echo¹; Kaelin, Lukas²; Körtner, Ulrich²
¹National Kaohsiung First University of Science and Technology, Taiwan;
²University of Vienna, Austria

*Abstract:* For foreign patients such as overseas students, tourists, new immigrants, communication in situations of medical need is difficult. As health literacy (HL) is depending on language skills and the knowledge of the medical system, systemic and language barriers cause difficulties in the exchange of information with physicians during a medical visit. Unfortunately, the current solution involving interpreters who have to be booked in advance, or using unqualified friends or family members to translate, are unsatisfactory. Thus, we propose an innovative model with two agents (e-Translator and e-Medicine) of innovative communication mechanisms to examine the three stages of shard decision-making process during a medical visit and how this varies by patients’ health literacy and language barriers. With the particular concern of foreign patients communicative HL and their physician-patient communication in terms of perception of medical advices and health behaviors.

**Th4.2 e-Health and Telemedicine Education: A Need for Larger Development of ICT in Health Services**
Amenta, Francesco; Khosrow Tayebati, Seyed; Tomassoni, Daniele
Università di Camerino, Italy

*Abstract:* The interest in applications of communication technologies in medical interventions (e-Health and telemedicine) is increasing, but educational initiatives in the field are sparse and not articulated. This paper presents initiatives of the University of Camerino in terms of undergraduate and postgraduate activities. In an area with high technological contents such as e-Health and telemedicine, articulated university training programmes are necessary for allowing a larger diffusion and development of the culture of information and communication technology applications to health science and services.

September 12th, 15:10-16:00: Poster Presentation (with short oral presentation)
Chair: Tanaka, Shinobu (Kanazawa University, Japan)

**Th5.1 The Suggestion of Parameters to Prevent Hypotension in Hemodialysis**
Fueda, Yuri¹; Katayama, Toshiro¹; Ohyama, Toshiharu²; Minato, Kotaro³
¹Himeji Dokkyo University, Japan; ²Kouseikai Takai Hospital, Japan;
³Nara Institute of Science and Technology, Japan

*Abstract:* Hemodialysis (HD) patients can’t excrete water and regulate electrolyte not to work kidney. Therefore they need to perform HD treatment a few times a week. HD is varied circulating blood volume (CBV) to remove the excess water by ultrafiltration. We showed the change of CBV in the mathematical model. In this study, we examined whether the model can utilize in case which physical influences such as hypotension, nausea or muscle cramp occurred. We used the curve fitting for the patient’s data points. As a result, the patients appealed for some symptoms after the real data fell below the model line. The staffs, who work at hospitals and clinics, administered a liquid medicine to the patients. In conclusion, we considered that we could predict the indications of hypotension and other physical influences by using the mathematical model. We might offer a medical care to HD patients safely.
Th5.2 Experiment System of Noninvasive Deep Body Temperature Thermometer Based on Dual-Heat-Flux Method and its Application on Initial Response Measurement

Yanai, Issei1; Huang, Ming1; Tamura, Toshiyo2; Chen, Wenxi3; Kitamura, Kei-ichiro4; Nemoto, Tetsu4
1Nara Institute of Science and Technology, Japan; 2Osaka Electro-Communication University, Japan; 3The University of Aizu, Japan; 4Kanazawa University, Japan

Abstract: According to the results from finite element analysis [1], a lower-in-height and larger-in-radius design will improve the performance, i.e., the accuracy and the temporal response, of the thermometer based on dual-heat-flux method (DHF). In order to validate the improved design of the noninvasive deep body temperature (DBT) thermometer based on DHF, prototypes and an experiment system were constructed. Being a two-concentric-cylinders construction, the height of the probes are 8 mm, and 14 mm respectively, while the radiuses are consistently 22 mm. The experiment system comprises of a data acquisition module, body-mimicking module and data-processing module. In the preliminary test of the initial response, it is shown that the thinner one needs 12-20 minutes while the thicker one needs about 30 minutes to reach a thermal equilibrium state.

Th5.3 A Sensor for Preventing Self-extubation of Intubation Tube

Watanabe, Takuro; Maeda, Koji; Tsukamoto, Sosuke; Maki, Hiromichi; Ogawa, Hidekuni; Yonezawa, Yoshiharu
Hiroshima Institute of Technology, Japan

Abstract: A proximity sensor for detecting self-extubation of intubation tube was developed. The sensor consists of a Colpitts oscillator and an antenna. The sensor is designed to alarm when the patient’s hand came closer to the intubation tube that the antenna is attached. A simple experiment using imitation hand showed that the oscillation frequency increases as the imitation hand approaches to the antenna.

Th5.4 (withdrawn)

Th5.5 Observation of Motor Unit Action Potentials Conducted to the Different Orientations by Surface EMG Topography

Hattori, Takumu1; Minato, Kotaro2; Yoshida, Masaki3
1Hiroshima Institute of Technology, Japan; 2Advanced Scientific Technology and Management Research Institute of Kyoto, Japan; 3Osaka Electro-Communication University, Japan

Abstract: The surface electromyogram (sEMG) indicates muscle activity and is important to sports training and rehabilitation. Generally the electrodes should not be placed over the innervation zone. In the innervation zone, there are many neuromuscular junctions, which are the origins of motor unit action potentials. Therefore, in recent years, methods of identifying the innervation zone by the high-density electrodes are used. We proposed a visualization method of high-density sEMG in order to obtain the total aspects of muscle activity at a glance. At the first step of this method, we obtained 56-channels sEMGs from the grid electrodes. Then, we interpolated the 56-channel signals along x direction by the cubic spline function and after that interpolated them along y direction also by the same cubic spline function. And we obtained a continuous potential distribution on x-y plain surface by such interpolation and repeating this process on all sampling data. Using this distribution, we could edit an animation where each frame showed the potential distribution as a curved surface on the x-y plain. We can clearly recognize the total spatial and temporal aspects of time varying potential distribution on the skin surface using this surface EMG topography. In this study, we observed the motor unit action potential which conducted to different directions by surface EMG topography. By this visualized expression, we might clearly find the anatomical
position of neuromuscular junction and also the interference of two independent motor unit action potential waves.

September 12\textsuperscript{th}, 16:10-17:00: Health Informatics – Future Scenario
Chair: Park, Kwang Suk (Seoul National University, Korea)

[Invited Lecture 2]

Complementary Preventive Medicine based on Genotype and Biological Information
Namiki, Yukihisa
President,
World Intellectual Property Holdings, Inc., Japan

Abstract: Japanese social security system gives all nations medical treatment insurance and medical treatments covered by the insurance are preferably provided by Japanese medical doctors. When a patient prefers a treatment not covered by the insurance, the patient covers all the treatment cost. The patients cannot combine insurable treatments and non-insurable treatments by Japanese medical regulation. Hence, patents have to decide either treatments and defray the medical cost. As non-insurable treatments and services are fairly affordable, there is a good amount of demand not only for patients but also for healthy people to use the treatment and the services. Complementary Preventive Medicine (CPM) is a complementary information and assistive system for people to sustain healthy and fit and to improve their quality of lives. CPM is extracted and made from Biomedical Big Data (BBD), which means human biological information data, physiological information data, genetic information data, psychological information data, life-activity information data and any collectable information data related to human collectively. BBD is used to analyze individual health conditions such as normal condition and abnormal condition. Since each individual has different healthy conditions, the characteristics of BBD differ from others. Therefore, comparing only biological information data of different individuals for the purpose of diagnosis and evaluation of health conditions is not practical. Diatheses of each individual are different and genotype information of an individual is essential to determine and predict the spontaneous tendency of the individual health conditions, sensitivities for drugs, supplements and nutrition, and sensitivities for becoming diseases such as cancers, cerebral infarction, diabetic, cardiopathy, neural diseases and so on. Based on the tendency of genetically related health conditions, measurable biological information and life-activity-related-information-data are analyzed to evaluate quality of the prevention and the life. These qualitative analyses are helpful to navigate personalized healthcare paths for people to maintain their wellness. Since each individual has different genotype and the traits, BBD related to the personal genotype is analyzed and the correlations to the phenotypes are guided as CPM. The goal of CPM is to provide useful healthcare information to each individual by fairly low cost cheaper than insurable treatments and to be used by each individual as much as needed by the individual to sustain and improve the quality of life. That is to utilize personalized healthcare management system in the society like electricity, water and gas as a social infrastructure.
September 13th, 9:00-10:00: **Keynote Lecture**  
Chair: Tamura, Toshiyo (Osaka Electro-Communication University, Japan)

[Keynote Lecture]  
*Introduction of ICT Based Healthcare and Systems Healthcare*  
Shiga, Toshikazu; Nakajima, Hiroshi  
Omron Co., Ltd., Japan

*Abstract:* In recent years, mobile computing devices and ICT technology evolved greatly. As one of the counter measure, the smart health care which utilized these infrastructures by these technologies attract attention from each field. And arrival of a future super-aged society serves as the background. Furthermore, the increase in the lifestyle-related disease accompanying it or population requiring care is assumed. Moreover, increase of the medical expenses by these serves as a social big issue. Practical use of smart health care is expected as one means of this problem solving. The information acquired by acquiring individual information by monitoring of a living body or a lifestyle is accumulated and analyzed, and information effective for each individual is fed back. It becomes important to carry out management of the lifestyle related diseases and maintenance improvement of health by this. For that purpose, biomedical information, including blood pressure, heart rate, etc., is daily measured with human body sensing technology, and it becomes important to analyze the change. However, the lifestyle not only used as this but this cause, i.e., physical activity, diet, and sleep, is measured every day, that feature is analyzed separately, and it is necessary to analyze causal relationship with the human body information as a result. We called this concept SYSTEM HELTHCARE from a viewpoint of system intelligence, and it has proposed that concept. Moreover, we are doing the measure which embodies this concept in the enterprise of WM (Watashi Move) and ML (Medical Link). WM is service direct to the consumer in a wellness region, and ML is the medical service which passed medical institutions, such as a hospital, and a doctor in the medical region. In the first half of this lecture, device development of blood pressure monitor, activity monitor, a sleep sensor, etc. is introduced as an example of the human body and lifestyle information measurement which is to the foundations of this SYSTEMS HEALTHCARE. In the latter half of this lecture, introducing the knowledge acquired from accumulation of these pieces of device information while introducing these WM and ML, the concept of SYSTEMS HEALTHCARE is explained, and the directivity of future deployment is considered.

September 13th, 10:00-11:30: **Data Collection**  
Chair: Yoon, Gilwon (Seoul National University of Science and Technology, Korea)

[Invited Lecture 3]  
*Mobile Based Cloud Computing for Continuous Health Monitoring*  
Chung, Wan-Young  
Professor, Department of Electronic Engineering,  
Pukyong National University, Korea

*Abstract:* u-Healthcare is one of big application area of emerging mobile could computing. Advances in sensor technology, personal mobile phones, wireless broadband communications, and Cloud computing are enabling real-time collection and dissemination of personal health data to patients and health-care professionals anytime and from anywhere. Mobile phone based cloud computing system is designed for the continuous health monitoring in our study. A noncontact ECG measurement method is employed to capture biomedical signals from users. Healthcare service is provided to continuously collect biomedical signals from multiple locations. To observe and analyze the ECG signals in real time, a mobile phone is used as a mobile monitoring terminal. To ensure a seamless and continuous health tracking system, a web server cloud computing system is implemented into the healthcare service. The cloud computing system for health monitoring, the noncontact ECG measurement are integrated in followings.
- Car seat for the ECG measurement during driving
- Sofa and chair for the measurement staying at home or office
- Backpack for the measurement during hiking or mountain climbing
- Chest belt of the patient or elderly

The above are the clients of the cloud computing system. The server, which is a combination of PHP scripts and SQL database, serve and share resources with the clients via the Internet. In addition, a personalized healthcare assistant is extended on the mobile device; several healthcare features such as health status summaries, medication QR code scanning, and reminders are integrated into the mobile application. Health data are being synchronized into the healthcare cloud computing service (Web server system and Web server dataset) to ensure a seamless healthcare monitoring system anytime and anywhere coverage of network connection is available. Together with a Web page application, medical data are easily accessed by medical professionals or family members. Web page performance evaluation is conducted to ensure minimal Web server latency. The system demonstrates better off-site and up-to-the-minute patient data, which can help detect health problems early and keep elderly patients out of the emergency room, thus providing a better and more comprehensive healthcare cloud computing service.

[Invited Lecture 4]

From Gold Mining to Data Mining - Big Data Analytics in Healthcare Application

Chen, Wenxi
Professor, Biomedical Information Technology Laboratory,
The University of Aizu, Japan

Abstract: 165 years ago, California Gold Rush boosted the “Gold Mining” industry, and eventually boomed “Silicon Valley”. Nowadays, we are creating 2.5 quintillion bytes of data every day. Big Data come from everywhere: sensors used to gather climate information, posts to social media sites, digital pictures and videos, purchase transaction records, mobile phone signals, and personal information. Using state of the art atomic-scale magnetic memory technologies, researchers have demonstrated the possibility to store one bit of data by only 12 atoms which is potentially 100 times denser than today’s hard disk drive technology. Changes in quantity must bring on changes in quality — Big Data are more than simply a matter of size. It paves the way for new and emerging realms, opens the door to a substantial world of opportunities for us to explore, to make our work more agile, our life cozier, and to answer questions that were previously considered beyond our reach. In this talk, a pioneer project, “Challenge to 100 years of age” which was funded by Japanese government and involved more than 600 residents in West Aizu village since 1994, will be reviewed; the latest advancements of Big Data challenge in healthcare domain worldwide will be briefly outlined; some of our outcomes in recent studies on system development and data analysis in cooperation with nursing homes and local hospitals will be introduced. These studies utilized multiple vital signs, spanned several years, and covered various subjects, including pregnant women, healthy subjects, chronic patients and elderlies. Data analysis was conducted on different temporal basis, such as daily, weekly, monthly and seasonal. The results reveal long-term dynamics in health condition change of patient and healthy subjects, unveil elder and younger daily behaviors, contribute to a better understanding of maternal cardiac changes during pregnancy and after delivery, and find insights of more sensitive vital parameters from Big Data analytics. Prospects on future houses as hubs for daily healthcare will be envisioned.
**u-Healthcare 2013 - abstracts**

September 13th, 11:30-12:10: Monitoring in Muscle Activities  
Chair: Yoshida, Masaki (Osaka Electro-Communication University, Japan)

**Fr3.1 Evaluation of Dynamic Activity Recognition using Lower Extremity Surface Electromyography for Health Monitoring Shoe System**  
Han, Jung Min; Yoon, Hee Nam; Kim, Han Byul; Hwang, Su Hwan; Park, Kwang Suk  
Seoul National University, Republic of Korea

*Abstract:* Activity recognition system is developed to monitor daily activities for various purpose. Present activity recognition systems are based on using multiple or single accelerometer sensor applied with various classification algorithms and achieved high accuracy up to 97%. In advance to that, recent study proposed activity recognition system using surface electromyography (SEMG) to monitor both biological information such as muscle fatigue, injuries in muscles and daily activities. Since dynamic activity involves movement of lower extremities, we conceptually proposed implementing health monitoring system on shoes for practical application. Though several monitoring system embedded on shoes exist, yet SEMG based system is not developed. We measured SEMG near ankle (Peroneus Brevis) to evaluate feasibility to be used in activity recognition. Testing performance is done by comparing system using SEMG from one of reference muscles and system with single 3-axis accelerometer. We applied k-nearest neighbor classification algorithm with 2 features extracted from single SEMG and achieved average 56% of accuracy for 4 dynamic activities.

**Fr3.2 Effect of Conductive Polymer Foam Surface on Dry EMG Electrodes**  
Kim, Han Byul; Lee, Jung Su; Han, Jung Min; Lee, Hong Ji; Ryu, Ho Seok; Park, Kwang Suk  
Seoul National University, Korea

*Abstract:* Most EMG dry electrodes have rigid surface, so the quality of signal can be degraded when the skin has high impedance due to hair. In this study, conductive polymer foam surface was suggested to overcome the problem. The signals from both rigid and foam type dry electrodes were compared with standard Ag/AgCl electrodes. As a result, foam-based electrodes showed higher correlation coefficients in both time and frequency domain. We expect the presented electrodes can be used to monitor EMG with no skin preparation.

September 13th, 13:20-14:30: Ubiquitous Monitoring I  
Chair: Nakajima, Kazuki (University of Toyama, Japan)

[Invited Lecture 5]  
**Ballistocardiogram for Ubiquitous Healthcare**  
Park, Kwang Suk  
Professor, Department of Biomedical Engineering, College of Medicine,  
Director, Advanced biometric Research Center,  
Seoul National University, Korea

*Abstract:* Ballistocardiogram (BCG) is heart beat-induced repetitive recoil movements of the human body. Even though its clinical merits are inferior to the electrocardiogram (ECG) currently widely using in clinical application, BCG has its own merits of non-intrusiveness and ease of measurements which is the primitive requirement for ubiquitous healthcare application. BCG can be measured and monitored continuously with several types of mechanical sensors, air-mattress, accelerometer, load cells, and film type sensors. During the lecture, I am going to introduce the studies done based on BCG. We have devised the methods to continuously monitor BCG during sleep. Two air-cells are combined into the air-mattress bed, four load-
cells are installed under the legs of the bed and the film type force sensors of PVDF are installed on the bed to monitor BCG. From the measured signals peaks of the BCG is detected to find the time of the heart beat and its characteristics are compared with those of the ECG, which showed the clinically equivalent results. Then, heart rate variability (HRV) can be evaluated from the heart beat dynamics of the BCG and can be applied widely. In our studies, we have applied BCG derived HRV dynamics to evaluate sleep stages nonintrusively without attaching any sensors to the body surface. After sleep and wake are differentiated by the movement of the subject during sleep, sleep stages among light sleep, deep sleep and REM sleep can be differentiated based on the HRV dynamics. Results showed the 4-level sleep staging accuracy of 77% with the Kappa value of 0.58. The BCG also can be applied to estimated blood pressure by measuring pulse transit time in combination with the ECG. BCG can replace the role of PPG which is used for pulse transit time measurements. By installing BCG sensors on chair, bed or weighing scale with the capacitively coupled ECG sensors, pulse transit time is continuously monitored and the systolic and diastolic blood pressures can be estimated. Since all the measurements of BCG are done easily which can be extended into our ordinary home environment, I believe that BCG will extend its role continuously in the ubiquitous healthcare.

[Invited Lecture 6]
Future of Unobtrusive Monitoring
Tamura, Toshiyo
Osaka Electro-Communication University, Japan

Abstract: The development of unobtrusive monitoring has become a major research topic. Among the elderly society, the concept of unobtrusive monitoring is very important, although current devices are not very accurate. The advantages of unobtrusive monitoring are that the devices are easy to handle (in fact, no handling is required), daily habits and health conditions are monitored, and patient motivation is not important (the daily activities are monitored regardless of motivation). Only privacy is an issue. To use these devices, patient permission is required. The greatest disadvantage is that it was very difficult to get strong evidence of a problem. Aging in place is now an accepted concept in elderly care. The elderly living in the community—either alone or with a spouse—need good care and support. Unobtrusive physiological monitoring has great potential for the remote monitoring of activities, as well as cardiovascular and respiratory functions. Evidence-based health is a difficult issue, and we need to continue to collect data in new ways. Furthermore, physicians and medical staff are not greatly interested in “health” as health insurance only covers the treatment of disease. Consequently, if subjects are healthy, medical and care insurance are not applicable. Physicians need to understand the main problems with this concept and to create more in-home uses.

September 13th, 14:50-16:50: Ubiquitous Monitoring II
Chair: Chen, Wenxi (The University of Aizu, Japan)

Fr5.1 Long-term Monitoring of “In-bed” and “Out-of-bed” Status of Nursing Home Residents
Zhou, Xina; Zhu, Xin; Chen, Wenxi
The University of Aizu, Japan

Abstract: A completely unconstrained system “Umemory” is used for long-term monitoring of “in-bed” and “out-of-bed” status of nursing home residents. When a resident lies in a bed, his/her weight can trigger a tactile switch to initiate the DC power supply through a delay controller. Then, the resident’s pressure variations due to heart pulsation, respiration, and body movement are sensed by a pressure sensor under a pillow or mattress. The corresponding digital signal is sent to a database server via Internet and processed by our program to obtain heart rate, respiration rhythm, and body movement epoch during sleep. 1167 days’ data obtained from 17 residents in two nursing homes were used in this study. “In-bed” and “out-of-bed” circadian rhythm can be observed for each resident, and the profiles of “in-bed” status can be classified into
5 clusters. As “in-bed” and “out-of-bed” status may be related to the disease severity, daily life style, mental status, and dependency of a resident, this system may provide important evidence for nursing home staff to offer better service for residents and lessen nursing home staff’s labor burden.

Fr5.2 The Advantage of Contact Pressure to the Photoplethysmography Sensor
Maeda, Yuka1; Sekine, Masaki2; Tamura, Toshiyo2; Mizutani, Koichi1
1University of Tsukuba, Japan; 2Osaka Electro-Communication University, Japan

Abstract: This report evaluates the efficacy of contact pressure to the sensor of photoplethysmography. Pulse rates obtained from photoplethysmograph sensors are important for monitoring cardiovascular condition. The problem facing photoplethysmograph sensors is motion artifact superimposed on photoplethysmography during body movement. Motion artifacts are caused by several reasons such as sensor attachment, measuring sites and light sources. Here, we considered motion artifacts based on the light source and sensor attachment. To discuss the effect of light sources on the motion artifact, Additionally, we compared the effects of pressure applied to sensor of photoplethysmograph sensor. Seven young healthy subjects without any indication of peripheral arterial disease and gait disorder were recruited to participate in the experiment. They attached photoplethysmography with the infrared and green lights on the upper arm with either no pressure or applied contact pressure of 30 mmHg and monitored heart rate as a standard. To produce artifacts, the subjects were asked to walk at a speed of 4 km/hr on the treadmill. Then the photoplethysmography and ECG signals were measured for 2 minutes. Photoplethysmography magnitude and intervals were calculated by peak detection using predetermined thresholds, and the error rate between the pulse rate and the heart rate was then compared. As the result, the signal with green light and contact pressure showed the lowest error rate at 3.6%. In the green photoplethysmography, the error rate of 30 mmHg was significantly-decreased in comparison to that of no pressure (p < 0.05). In conclusion, the pressure applied to the green photoplethysmography applied 30 mmHg may be a useful for pulse rate monitoring during walking.

Fr5.3 Design of Non-Intrusive ECG Sensor Embedded in a Smartphone Cover
Seo, Sangwon; Kwon, Sungjun; Park, Kwangsuk
Seoul National University, Republic of Korea

Abstract: A smartphone is expected to be an appropriate device for serving a personal healthcare based on daily physiological monitoring. Among a variety of biological signal, we utilized heart rate variability (HRV) as a signal for daily healthcare. Observing that when we have a phone conversation, we contact both an ear and a hand to a smartphone, we proposed a concept of non-intrusive ECG monitoring sensor embedded in a smartphone cover. By realizing a prototype of proposed concept, we verified our concept by experiment. We took 5min 30sec experiment to three subjects and took some data processing offline using MATLAB. There were some R peak data losses during phone conversation because of artifact. As the losses were not significant, we used interpolation method and then analyzed and compared the HRV of the Smartphone cover sensor data with that of reference ECG signal. The result shows that there were no significant differences between HRV parameters of both smartphone cover collected signal and reference signal.

Fr5.4 Measurement of Regional Lung Density using Electrical Impedance Tomography (EIT) during Mechanical Ventilation
Nebuya, Satoru1; Koike, Tomotaka2; Imai, Hiroshi3; Brown, Brian H.4; Soma, Kazui1
1Kitasato University, Japan; 2Kitasato University Hospital, Japan; 3Mie University, Japan; 4University of Sheffield, UK

Abstract: The consistency of regional lung density measurements as estimated by Electrical Impedance Tomography (EIT), in eleven patients supported by a mechanical ventilator, was validated to verify the feasibility of its use in intensive care medicine. There were significant differences in regional lung densities
between the normal lung and diseased lungs associated with pneumonia, atelectasis and pleural effusion (Steel-Dwass test, p < 0.05). Temporal changes in regional lung density of patients with atelectasis were observed to be in good agreement with the results of clinical diagnosis. These results indicate that it is feasible to obtain a quantitative value for regional lung density using EIT.

**Fr5.5 Quantitative Sleep Monitoring System of Rats Aiming at the Construction of the System to Get Natural Sleep for Human Health Care**

Yazaki, Koji; Nakamura, Shinya; Kimura, Tatsuhiro; Aki, Fumitaka; Okamoto, Katsuro; Yamazaki, Kiyoyuki; Tadokoro, Hiroyuki
Tokai University, Japan

**Abstract:** To develop sleep health care promoting system, fundamental study was carried out using rat electrophysiological measurement system (MUPREMS). Electro encephalogram (EEG), electro oculogram (EOG), electro myograph (EMG) and behavioral data were recorded from rats and analyzed to classify into each sleep state. Observed data showed a similarity between rat sleep EEG and that of humans. Using this system, detailed sleep structure were revealed. The results suggested that it might be helpful to deal with sleep irregularity of modern human based on the rat’s sleep characteristics with poly-phasic sleep pattern.

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**September 14th, 9:00-10:00:** **Signal Processing I**
Chair: Tsukamoto, Sosuke (Hiroshima Institute of Technology, Japan)

**Sa1.1 Color-Model Based Detection of Face and its Direction**
Bae, Chunmuk\(^1\); Okada, Shima\(^2\); Makikawa, Masaaki\(^1\)
\(^1\)Ritsumeikan University, Japan; \(^2\)Kinki University, Japan

**Abstract:** This paper presents our new method to detect face and its direction in real time from color camera images aiming at the evaluation of human attention. In our face detection method, skin color model is used first to detect skin region and face candidate is acquired by segments connected each skin region. Then, morphological method is applied for each face candidate to extract face features, i.e. eyes and mouth; face candidate having two eyes and one mouth is detected as a face. Face direction is detected by comparing central point of face with central point of face features. Face direction is expressed in five states, i.e. Left, left-front, front, right-front and right. Experimental results showed that presented method has fast detection speed and suitable in real time face and its direction detection.

**Sa1.2 A Real-time Driver Fatigue Detection System Based on Non-stationary Analysis of Heart Rate Variability**
Li, Gang; Chung, Wan-Young
Pukyong National University, South Korea

**Abstract:** A real-time driver fatigue detection system based on non-stationary analysis of photoplethysmogram-derived heart rate variability (HRV) is proposed. Several experiments are conducted to verify the feasibility and effectiveness of the proposed system for detecting the normal driving state, the wakefulness maintenance state (WMS) and the natural sleepy driving state. Using receiver operating characteristic (ROC) analysis, the best two wavelet-based features are selected for two-class classification (normal driving and WMS driving). Experimental results show that wavelet-based features of 1-minute HRV signals suit well for driver fatigue detection with outstanding ROC performance. However, conventional Fast Fourier Transform based LF/HF ratios just show effectiveness in longer term HRV evaluation.
**Sa1.3 Efficient Implementation for the Real-time Estimation of Heart Rate Variability using FIR Filter System**

Cho, Dong Rae; Kim, Jong In; Lee, Boreom
Gwangju Institute of Science and Technology, South Korea

**Abstract:** The role of the heart is most important for us to live. For analyzing the physiological and dynamical cardiac movements, people who engage in the medicine and engineering have studied for a long time. Specially, heart rate variability (HRV) is quantized varying RR–interval signal of heart rate which depends on the autonomic nervous system. But it is difficult to acquire the usual RR interval data which is recorded during 24hour. However, according to the advances in science and technology, it is possible to record and analyze the data in real time. The purpose of this study is to find optimized filtering method and reduce the computation for real-time application.

**September 14th, 10:00-11:00: Signal Processing II**
Chair: Chung, Wan-Young (Pukyong National University, Korea)

**Sa2.1 A Study for the Relationship among Body Activity, Energy Expenditure and Respiratory Quotient**
Hwang, Chansong1; Lim, Youngchul1; Im, Jaejoong1; Kim, Heesun2
1Chonbuk National University, Republic of Korea; 2UnC Co., Ltd., Republic of Korea

**Abstract:** Devices for the estimation of energy expenditure have been developed to help management of obesity, and existing devices use accelerometers to predict energy expenditure caused by physical activity of the body. However, our body uses various energy sources based on the exercise strength, which affect the amount of energy consumed. RQ (respiratory quotient) represents the ratio of exhausted carbon dioxide to the adopted oxygen, and it could tell more detailed information regarding energy expenditure. Objectives of this study was to find the relationship among actual energy expenditure values, RQ values obtained from gas analyzer, and parameters extracted from 3-axis accelerometer. Results showed high correlation between energy expenditure and activity parameters, but RQ values did not show high correlation. However, changes in RQ values show the similar trend as energy expenditure under the running condition. That is, it is necessary to allow enough time for VO2 or VCO2 exchange for the estimation of RQ values.

**Sa2.2 Analysis of Frequency Components to Find the Relationship between Voice Signal and Energy Expenditure**
Lim, Youngchul1; Hwang, Chansong1; Im, Jaejoong1; Kim, Heesun2
1Chonbuk National University, Republic of Korea; 2UnC Co., Ltd., Republic of Korea

**Abstract:** Devices for the measurement of energy expenditure has been developed to help healthcare management. Existing devices use 3-axis accelerometers to predict energy expenditure caused by physical activity of the body. However, since energy is consumed not only by the body activities but also by the voice, it would be necessary to find the relationship between energy expenditure and the parameters extracted from voice signals. In addition to that, voice signal is generated by air flow through respiration. That is, since energy is consumed by respiration, exchange of oxygen and carbon dioxide, voice signals with different frequency components results in the different amount of energy consumption. Results of this study proved that the frequency components of voice signals reading same text differs from the subjects, especially for men and women. It was concluded that the frequency analysis could be used for more accurate estimation of the energy expenditure, and for defining basic mechanism to understand relationship between respiration and energy expenditure.
**Sa2.3 Fall Risk Classification with Multivariate Analysis**

Zakaria, Nor Aini¹; Kibinge, Nelson Kipchirchir¹; Tamura, Toshiyo²; Kanaya, Shigehiko¹

¹Nara Institute of Science and Technology, Japan; ²Osaka Electro-Communication University, Japan

**Abstract:** This study aims to show that the fall risk among elderly can be classified using the multi parameters simultaneously. Well known standard assessment test; Timed Up and Go (TUG) test were used in this study in evaluating the falling risk among elderly. The use of wearable inertial sensors enables to extract acceleration signal and angular velocity signal for offline analysis. 38 elderly from Fujimoto Hayasuzu Hospital were participated in this experiment. Subjects were categorized into two groups as Low Fall Risk (LFR) and High Fall Risk (HFR) with 13.5 seconds of time duration taken to complete the test as threshold. In providing more specific result, analysis was carried out in phases in this study. In order to classify the fall risk among elderly, previous study classified there were using 1-dimensional of time parameter. In this study, 78 parameters were obtained from extracted acceleration signal in phases. By using Principle Component Analysis (PCA), the most important parameters were selected from gathered parameters. In regard to this result, classification to HFR and LFR were implemented using Discriminant Analysis (DA). It is found that the subject exhibit well classification into HFR and LFR by 18 parameters and 72.56% of average recognition rate is achieved.

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**September 14th, 11:00-12:00: Signal Processing III**

Chair: Lee, Boreom (Gwangju Institute of Science and Technology, South Korea)

**Sa3.1 Simulation of Ascending Aortic Flow using a Computational Model of the Entire Cardiovascular System: Evaluation by Wave Intensity**

Abe, Ryota¹; Niki, Kiyomi¹; Yauchi, Shiori¹; Olishima, Mari²; Fujisawa, Kei²; Takagi, Shu²; Liang, Fuyou³; Sugawara, Motoaki⁴

¹Tokyo City University, Japan; ²University of Tokyo, Japan; ³Shanghai Jiao Tong University, China; ⁴Himeji Dokkyo University, Japan

**Abstract:** Wave Intensity (WI) is an index to evaluate the interaction between the heart and the arterial system, which can be defined at any site in the circulatory system. However, non-invasive ultrasonic measurements of WI are confined to the carotid artery. Computational model has the potential for obtaining flow parameters from any regions where the measurements are difficult. We estimated carotid arterial and ascending aortic WI by using simulation model. Simulated WI in the carotid artery showed the higher initial positive peak, which was due to lower vascular resistance. By using measured carotid arterial data, vascular resistance was modified, which made the calculated WI agree better with the measured WI. Simulation of aortic and carotid flow with multi-scale modeling and its modification by measured WI has potential to obtain the flow dynamics in large arteries.

**Sa3.2 A Novel Method of Nonnegative Sparse Coding for Sparse Representation and Data Clustering**

Tang, Zunyi¹; Sekine, Masaki¹; Tamura, Toshiyo¹; Yoshida, Masaki¹; Ding, Shuxue²; Chen, Wenxi²

¹Osaka Electro-Communication University, Japan; ²The University of Aizu, Japan

**Abstract:** We present a novel algorithm to solve sparse representation problem with nonnegativity constraint on representation coefficients. This objective problem can be viewed as an expansion of conventional nonnegative matrix factorization (NMF) and sparse representation problems, therefore our work extends the range of applications of NMF and sparse representation. In the proposed algorithm, basis matrix updating and nonnegative sparse coding are executed alternatively by using parallel coordinate descent strategy.
instead of frequently used matching pursuit or linear programming methods. Our numerical simulations indicate that the proposed algorithm can perform well sparse representation with nonnegativity constraint and has high robustness of anti-noise. Moreover, it is well qualified for data clustering and performs almost as well as K-means.

**Su3.3 Estimation of Duration of Sleep Stages Only Using Load Cell-Based Movement**

Yoon, Hee Nam\(^1\); Hwang, Su Hwan\(^1\); Jung, Da Woon\(^1\); Seo, Sang Won\(^1\); Lee, Yu-Jin G.\(^2\); Jeong, Do-Un\(^2\); Park, Kwang Suk\(^1\)

\(^1\)Seoul National University, Korea; \(^2\)Seoul National University Hospital, Korea

**Abstract:** We propose a new method to estimate duration of sleep stages only using body movement. The body movement was assumed that it is a result of internal or external disturbance to subject to go into deeper sleep. Therefore, the movement-related information aroused during sleep is related to duration of slow-wave sleep (SWS). The variables that reflect characteristics of the movement were extracted from the data, noninvasively acquired from the load cells installed underneath bed legs. Using these variables, we generated the model to estimate duration of wakefulness and slow-wave sleep (SWS) with the multiple linear regression analysis. To evaluate its effectiveness, Leave-One-Out-Cross-Validation (LOOCV) was performed for 8 subjects and the estimation error showed 8.54% for wakefulness, 17.53% for SWS, and 2.29% for non-SWS respectively, compared with the reference. Duration of sleep stages provides information about structural stability of the sleep. With this reason, its methodological simplicity is suitable to apply for home-based sleep monitoring system.