

Biomedical Information Technology Laboratory



Wenxi Chen
Professor



Xin Zhu
Senior Associate Professor



Yasuhiro Hisada
Associate Professor

Biomedical Information Technology Laboratory (BIT Lab.) is seeking - to develop diversified methodologies for seamless and persistent monitoring of various vital signs by making use of innovative measurement principles. - to develop algorithms for theoretical simulation, signal processing, image processing and data mining to reveal statistical links between incidence of various diseases and dynamics of health condition. - to construct an integrated infrastructure SHIP (Scalable Healthcare Integrated Platform) for lifelong healthcare by full use of the latest ICT advancement in IoT, AI, big data and etc. - to foster a new discipline Metrology of Health or Healthology to quantify the overall health status from an integrative standpoint and to untangle the causal connections among longevity and relevant determinants such as pathogeny and immunity, meteorological and environmental factors, and social-behavioral-psychoneurotic interactional aspects.

Prof. Chen's research activities continued focusing on the ICT-based healthcare domain to develop a long-term strategy for daily healthcare. Prof. Chen conducted several projects. These studies developed an Internet-based infrastructure, including a series of instrumentation for seamless monitoring of vital signs without disturbing subjects in daily life activities, and a variety of algorithms for in-depth data mining and big data analytics in biomedical application. Several cooperative studies with external institutions and companies were implemented for field trial and exploring possibility of commercialization. - A cooperative study with four nursing homes aimed to collect elderly data and to assess the system performance through field trial. - A cooperative study with Bange Welfare General Hospital collected clinical data from patients suffered from kidney disorder, and evaluated the therapeutic effect during dialysis. - A cooperative study with Simplex Quantum Inc. developed API libraries for healthcare application and relevant commercialized products.

Prof. Zhu's research is focused on biomedical signal processing, image processing, and cardiac modeling and simulation. His collaboration research supported by JSPS with Fukuoka University is to develop an organic model for the study on the mechanism of atrial fibrillation. Currently, he is also studying the computer-aided diagnosis of colorectal polyps from colonoscopy videos/images using deep learning with Aizu Medical Center, Fukushima Medical University.

Prof. Hisada's research relates of health care application and system for monitoring wandering. The self-management support system for diabetic patient and positioning system for wandering person using sensor network are focused. And he studies also the remote sensing field. The environmental monitoring of wetland and the crustal deformation such as volcano and earthquake, landslide using SAR(Synthetic Aperture Radar) data are focused. Moreover, in order to observe ground, he studies the wireless snow weight measurement system and the reconstructing method of 3D model for wetland using UAV video.

Summary of Achievement

Refereed academic journal

[wenxi-306-014-01:2017] Zunyi Tang Wenxi Chen Shigehiko Kanaya Ming Huang, Toshiyo Tamura. A Wearable Thermometry for Core Body Temperature Measurement and Its Experimental Verification. *IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFORMATICS*, Vol. 21(No. 3), May 2017.

pp.708-714

[wenxi-306-014-02:2017] Chen W. Kobayashi T, Ishii Y. A Simple and Quantitative Neuropsychological Test of Face Perception: The Effects of Age and Gender on Perceiving Young Faces. *J Hosp Health Care Admin*, 1:1-9, 1 2018.

Background and Objectives: Developing a new method of easily measure the images discrimination ability of subjects within a few minutes for medical and educational applications. Methods: A touch-screen display panel (DP) of a personal computer was divided into nine cells, three columns and three rows, showing a different photograph of faces of early twenties. The central image was the target and the surrounding eight images were the references. A test participant was required to sit in front of the DP and to touch one of the references images that he/she considered to be the target within 10 secs, which were repeated for 30-times. The correct answer rate and average response time (sec) were obtained according to the 234-participants, 6-85 years old. Results: Participants in their early 20s showed peak capability of discrimination. Results were obtained when comparing participants' responses to images of the same and the opposite gender. Female faces were always better identified than male faces by participants of both genders for aged under 40 years. For participants aged over 40 years, the capabilities were reversed: male faces were a little better identified than female faces by both genders. Discrimination capabilities for different facial imaging angles were also clarified. Limitations: Most of the composition of tested participants were young, under 24 years old. Conclusions: The results suggest that these phenomena represent the age-related neuropsychological characteristics for perceiving the same and the opposite gender. An easy and quantitative method for images perception was developed applicable to medical and education purposes.

[wenxi-306-014-03:2017] Masaki Sekine Ming Huang Wenxi Chen Masaki Yoshida Kaoru Sakatani Hiroshi Kobayashi Zunyi Tang, Toshiyo Tamura and

Shigehiko Kanaya. A Chair-Based Unobtrusive Cuffless Blood Pressure Monitoring System Based on Pulse Arrival Time. *IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFORMATICS*, 21(5):1194–1205, 2017.

In this paper, we present an unobtrusive cuffless blood pressure (BP) monitoring system based on pulse arrival time (PAT) for facilitating long-term home BP monitoring. The proposed system consists of an electrocardiograph (ECG), a photoplethysmograph (PPG), and a control circuit with a Bluetooth module, all of which are mounted on a common armchair to measure ECG and PPG signals from users while sitting on the armchair in order to calculate continuous PAT. Considering the good linear correlation of systolic BP (SBP) and the nonlinear correlation of diastolic BP (DBP) with PAT, a new BP estimation method was proposed. Ten subjects underwent BP monitoring experiments involving stationary sitting on a chair, lying on a bed, and pedaling using an ergometer in order to assess the accuracy of the estimated BP. A cuff-type BP monitor was used as reference in the experiments. Results showed that the mean difference of the estimated SBP and DBP was within 0.2+/-5.8 mmHg (p smaller than 0.00001) and 0.4+/-5.7 mmHg (p smaller than 0.00001), respectively, and the mean absolute difference of the estimated SBP and DBP were 4.4 and 4.6 mmHg, respectively, compared to references. Additionally, five subjects participated in data collections consisting of sitting on a chair twice a day for one month. Compared to the reference, the difference did not obviously increase along with time, even though individualized calibration was executed only once at the beginning. These results suggest that the proposed system has quite the potential for long-term home BP monitoring.

Unrefereed academic journal

[wenxi-306-014-04:2017] Shuxue Ding, Abderazek Ben Abdallah, Wenxi Chen, Zixue Cheng, Qiangfu Zhao. Distinguished University Focusing on Computer Science and Engineering Education for Cultivation of Global IT Innovators. *Computer Education*, 269(5):8–12, May 2017.

[wenxi-306-014-05:2017] Wenxi Chen. Full automatic measurement of electrocardiogram signal during daily bathing and construction of wellness management system. *Automatic Recognition*, pages 42–51, 12 2017.

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Refereed proceedings of an academic conference

- [wenxi-306-014-06:2017] Toshiyo Tamura Wenxi Chen. Measurement and Analysis of Daily Blood Pressure Over a Two-Year Period. In *EMBC2017 Minisymposium -Emerging Technologies for Cuffless Unobtrusive Blood Pressure Monitoring: Celebration of 200th Birth Anniversary of Carl Ludwig*, July 2017.
- [wenxi-306-014-07:2017] Wenxi Chen. A Bathtub System for Automatic Monitoring of Multiple Leads ECG and Wellness Management. In *uHealthcare 2017*, Dec. 2017.
- [wenxi-306-014-08:2017] Xin Zhu Ying Chen, Tianhui Li and Wenxi Chen. Daily Stress Assessment Using Heart Rate Variability of Bathtub ECG Signals. In *uHealthcare 2017*, Dec. 2017.
- [wenxi-306-014-09:2017] Xin Zhu Tianhui Li, Ying Chen and Wenxi Chen. Long Term Analysis of Heart Rate Variability during Daily Bathing. In *uHealthcare 2017*, 2017.
- [wenxi-306-014-10:2017] Wenxi Chen Ying Chen. Finger ECG-based Authentication for Healthcare Data Security Using Artificial Neural Network. In *2017 IEEE 19th International Conference on e-Health Networking, Applications and Services (Healthcom)*, pages 1–6, 10 2017.

Wearable and mobile medical devices provide efficient, comfortable, and economic health monitoring, having a wide range of applications from daily to clinical scenarios. Health data security becomes a critically important issue. Electrocardiogram (ECG) has proven to be a potential biometric in human recognition over the past decade. Unlike conventional authentication methods using passwords, fingerprints, face, etc., ECG signal can not be simply intercepted, duplicated, and enables continuous identification. However, in many of the studies, algorithms developed are not suitable for practical application, which usually require long ECG data for authentication. In this work, we introduce a two-phase authentication using artificial neural network (NN) models. This algorithm enables fast authentication within only 3 seconds, meanwhile achieves reasonable performance in recognition. We test the proposed method in a controlled laboratory experiment with 50 subjects. Finger ECG signals are collected using a mobile device at different times and physical statuses. At the first stage, a General NN model is constructed based on data from the

cohort and used for preliminary screening, while at the second stage Personal NN models constructed from single individuals data are applied as fine-grained identification. The algorithm is tested on the whole data set, and on different sizes of subsets (5, 10, 20, 30, and 40). Results proved that the proposed method is feasible and reliable for individual authentication, having obtained average FAR and FRR below 10 percent for the whole data set.

[zhuxin-306-014-01:2017] Yanghua Shen Xin Zhu Daiki Nemoto Daisuke Takayanagi Masato Aizawa Noriyuki Isohata Kenichi Utano Kensuke Iwamoto Shungo Endo Zhe Guo, Yu Wang and Kazutomo Togashi. Automatic Polyp Recognition from Colonoscopy Images Based on Bag of Visual Words. In *Proc. 8th International Conference on Awareness Science and Technology*, November 2017.

Colorectal cancer (CRC) is a leading cause of cancer. The incidence and mortality rates of CRC are expected to steadily increase in the future. Colonoscopy is the most popular and effect method for curing and screening CRC. However, 25 polyps were reported to be missed during colonoscopy examinations. In this study, we proposed a method to classify polyps from background based on bag-of-visual-words (BoW) from colonoscopy images. This method generates a histogram of visual word occurrences to represent an image. The histograms of a dataset were used to train an image category classifier. Validation was performed on 35 subjects' data with an average specificity of 97.01, an average sensitivity of 99.43, and an average accuracy of 97.8.

[zhuxin-306-014-02:2017] Lin-Hai Kurahara Jun Ichikawa Tomohiro Numata Xin Zhu Ryuji Inoue Yaopeng Hu, Keizo Hiraishi. Numerical model-based investigation on the role of transient receptor potential melastatin sub-family member 4 (TRPM4) channel in cardiac arrhythmogenicity. In *Program IEEE EMBC 2017*, July 2017.

TRPM4 channel is a Ca²⁺-activated monovalent cation channel involved in a variety of biological functions. The present study aims at elucidating its role in cardiac arrhythmogenicity during cardiac remodeling by electrophysiological experiments and numerical simulations. To obtain quantitative data valid for mathematical formulation of TRPM4 gating kinetics, we developed an ionomycin-permeabilized cell-attached recording technique. The obtained gating parameters were incorporated into the action potential model previously created for an immortalized atrial myocyte cell line HL-1. The results of numerical simulations using this model precisely reproduced the observed electrophysiological changes recorded from HL-1 cells, where upregulation of TRPM4

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activity caused prolongation of action potential (AP) and EAD-like premature excitations. We next investigated the impact of cardiomyocyte-fibroblast interaction on atrial excitation/propagation by co-culturing HL-1 cells and cardiac fibroblasts to form monolayer clusters, from which electrophysiological recordings were made by escin-perforated patch clamp technique. At confluency, the clusters generated spontaneous beatings and action potentials (APs) which were synchronized with intracellular Ca^{2+} elevations. Increasing the fibroblast/myocyte ratio resulted in prolonged APs with decreased frequency and upstroke velocity. These changes were abrogated by a gap junction blocker carbenoxolone, and similar extents of AP prolongation and depolarization of diastolic potential were induced in single HL-1 myocytes treated with an inflammatory cytokine TGF β . These changes were almost completely inhibited by 9-phenanthrol at its concentration to selectively inhibit TRPM4 channel. These results suggest that fibroblasts modify the frequency, morphology and propagation pattern of atrial cardiomyocyte APs through both direct electrical coupling and indirect biochemical modification which may involve the activation of TRPM

[zhuxin-306-014-03:2017] Xin Zhu Tianhui Li, Ying Chen and Wenxi Chen. Long Term Analysis of Heart Rate Variability during Daily Bathing. In *Proc of uHealthcare 2017*, 2017.

Long Term Analysis of Heart Rate Variability during Daily Bathing

[zhuxin-306-014-04:2017] Keizo Hiraishi Lin-Hai Kurahara Jun Ichikawa Tomohiro Numata Feng Qiu Wenfeng Shen Xin Zhu Ryuji Inoue Yaopeng Hu, Yanghua Shen. Multi-hierarchical analysis of TRPM4 arrhythmogenicity by experimental and numerical approaches. In *Proc. of Annual Conference of Physiological Society of Japan 2018*. Physiological Society of Japan, 2018.

Multi-hierarchical analysis of TRPM4 arrhythmogenicity by experimental and numerical approaches

[zhuxin-306-014-05:2017] Xin Zhu Ying Chen, Tianhui Li and Wenxi Chen. Daily Stress Assessment Using Heart Rate Variability of Bathtub ECG Signals. In *Proc. of uHealthcare 2017*, December 2017.

Daily Stress Assessment Using Heart Rate Variability of Bathtub ECG Signals

[zhuxin-306-014-06:2017] Xin Zhu Yaopeng Hu Feng Qiu Yanghua Shen, Wen-

feng Shen. A Cardiac Reaction-Diffusion model based on TRPM4 channel. In *Proc. of IEEE EMC 2017*, July 2017.

We proposed a 2D cardiac model based on an anisotropic monodomain system. This model was integrated with a new cardiac action potential (AP) model involving a TRPM4 channel. This model may serve as a platform for studying TRPM4 pro-arrhythmic and anti-arrhythmic effects.

[zhuxin-306-014-07:2017] Xin Zhu Yaopeng Hu Ryuji Inoue Feng Qiu, Wenfeng Shen and Yanghua Shen. An Energy Efficient Parallelization for Computer Simulation of Electrocardiograms Based on TK1 Board. In *Proc. of IEEE EMBC 2017*. IEEE, July 2017.

We employ a Tegra K1(TK1) System on Chip(SoC) board to achieve an energy efficient parallelization for simulation computation of electrocardiograms(ECGs) based on a whole-heart model. Our experiments evaluate the performance and energy consumption in different situations. Finally, we indicate that the energy efficiency of TK1 board notably high than that of the ordinary personal computer(PC), the performance is also close to that of PC.

Unrefereed proceedings of an academic conference

[zhuxin-306-014-08:2017] Xue Zhou Mahito Noro Xin Zhu, Keijiro Nakamura. Preliminary Report on the Study of ECG Automatic Interpretation Program Using Deep Learning. In *Proc. 32th annual conference of Japanese Society of Computed Electrocardiology*. Japanese Society of Computed Electrocardiology, June 2017.

[zhuxin-306-014-09:2017] Xin Zhu Shenyang Hua. Study on a 2D Cardiac Model Incorporating a TRPM4 Ion Channel. In *Proc of Toin International Symposium 2017*, November 2017.

[zhuxin-306-014-10:2017] Keizo Hiraishi Lin-Hai Kurahara Jun Ichikawa Tomohiro Numata Feng Qiu Wenfeng Shen Xin Zhu Ryuji Inoue Yaopeng Hu, Yanghua Shen. TRPM4 channel and its significant implications in arrhythmogenicity. In *Proc. of 32th Annual Conference of Japanese Society of Computed Electrocardiology*, June 2017.

[zhuxin-306-014-11:2017] Xin Zhu Yu Wang. Computer-assisted Diagnosis for The Detection of Polyps from Endoscopy Images. In *Proc. of Toin International Symposium 2017*, November 2017.

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[zhuxin-306-014-12:2017] Xue Zhou and Xin Zhu. Detect the Premature Ventricular Contraction Using 1D Convolutional Neural Network. In *Proc. of Toin International Symposium 2017*, June 2017.

Writing a part of textbook or technical book

[wenxi-306-014-11:2017] Wenxi Chen (Eds.) Toshiyo Tamura. *Seamless Healthcare Monitoring-Advancements in Wearable, Attachable, and Invisible Devices*. Springer, 2017.

Research grants from scientific research funds and public organizations

[zhuxin-306-014-13:2017] Xin Zhu Ryuichi Inoue, Tomohiro Numata. Multihierarchical analysis of TRPM family mechanism in the induction of atrial fibrillation, 2017.

Academic society activities

[zhuxin-306-014-14:2017] Xin Zhu, June 2017.

Chair of the 32th Annual Conference of Japanese Society of Computed Electrocardiology

[zhuxin-306-014-15:2017] Xin Zhu, November 2017.

Program chair of International Conference on Awareness Science and Technology (iCAST) 2017

[zhuxin-306-014-16:2017] Xin Zhu, July 2017.

Organizer of IEEE EMBC 2017 Minisymposium TITLE: TRP channels: multi-hierarchical measurement and modeling

Patent

[wenxi-306-014-12:2017] Yuji Hamada Wenxi Chen, Ying Chen. Authentication device, method, and computer program, 2017.

Advisor for undergraduate research and graduate research

[wenxi-306-014-13:2017] Bingjie Shi. Master, University of Aizu, September 2017.

Supervisor

[wenxi-306-014-14:2017] Kento Asatsuma. Master, University of Aizu, March 2017.

co-referee

[wenxi-306-014-15:2017] Tsukasa Aketagawa. Master, University of Aizu, March 2017.

co-referee

[wenxi-306-014-16:2017] Yanghua Shen. Master, University of Aizu, March 2017.

co-referee

[wenxi-306-014-17:2017] Kai Shimoyama. Graduation thesis, University of Aizu, March 2017.

Supervisor

[wenxi-306-014-18:2017] Yoko Ota. Graduation thesis, University of Aizu, March 2017.

Supervisor

[wenxi-306-014-19:2017] Ai Sakuma. Graduation thesis, University of Aizu, March 2017.

Supervisor

[wenxi-306-014-20:2017] Shohei Matsumoto. Graduation thesis, University of Aizu, March 2017.

Supervisor

[wenxi-306-014-21:2017] Hikari Tamura. Graduation thesis, University of Aizu, March 2017.

Supervisor

[wenxi-306-014-22:2017] Haruto Minezumi. Graduation thesis, University of Aizu, March 2017.

Referee

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[wenxi-306-014-23:2017] Nagisa Ito. Graduation thesis, University of Aizu, March 2017.

Referee

[wenxi-306-014-24:2017] Yuki Suzuki. Graduation thesis, University of Aizu, March 2017.

Referee

[zhuxin-306-014-17:2017] Kento Asatsuma. Master thesis, Graduate School of Computer Science and Engineering, March 2018.

[zhuxin-306-014-18:2017] Tsukasa Aketakawa. Master thesis, Graduate School of Computer Science and Engineering, March 2018.

[zhuxin-306-014-19:2017] Yanghua Shen. Master thesis, Graduate School of Computer Science and Engineering, March 2018.

[zhuxin-306-014-20:2017] Takaya Mizuno. Bachelor thesis, School of Computer Science and Engineering, March 2018.

[zhuxin-306-014-21:2017] Toshihiro Kusanagi. Bachelor thesis, School of Computer Science and Engineering, March 2018.

[zhuxin-306-014-22:2017] Nagisa Ito. Bachelor thesis, School of Computer Science and Engineering, March 2018.

[zhuxin-306-014-23:2017] Yuki Suzuki. Bachelor thesis, School of Computer Science and Engineering, March 2018.

[zhuxin-306-014-24:2017] Haruto Minezumi. Lie Detection Using Photoplethysmograms and Electrocardiograms, School of Computer Science and Engineering, March 2018.

Others

[wenxi-306-014-25:2017] Wenxi Chen. Umemory. trademark registered, 6 2017.

Trademark 2016-132009

Summary of Achievement

[zhuxin-306-014-25:2017] Yanghua Shen Xin Zhu Zhe Guo, Yu Wang. Automatic Polyp Recognition from Colonoscopy Images Based on Bag of Visual Words, November 2017.

Best paper award, iCAST 2017

[zhuxin-306-014-26:2017] Xin Zhu Yu Wang. Computer-assisted diagnosis for the detection of polyps from endoscopy images, November 2017.

Gold Prize, Poster session award, Toin International Symposium

Contribution related to educational planning management

[wenxi-306-014-26:2017] Graduate School of Computer Science and Engineering Graduate Program Instructor Qualification Examination

Other significant contribution toward university planning, management, or administration

[wenxi-306-014-27:2017] Faculty Assembly of Meeting Member, Graduate School Faculty Assembly Meeting Member, Meeting of the Deans Directors Council Member, The Information Systems Division Meeting Member, Competitive Research Funding Evaluation Committee, Cooperative Research, Etc. Acceptance Deliberation committee Member, Employment Duty Related Invention Deliberation council Member, Curriculum Member, Research ethics committee Member,

Contributions related to regional education

[wenxi-306-014-28:2017] Member of Committee for Promotion of Advanced Human Resources Development Business of Medical-related Industry

Did you participate in Public Lectures, and/or Open Campus? (Yes or No) If yes, please describe what you did.

[wenxi-306-014-29:2017] Open Labs 2017(Summer session)(Autumn session) Research Theme/Title:Seamless Monitoring and Comprehensive Interpretation of Physiological Information for Daily Healthcare

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[zhuxin-306-014-27:2017] Open campus participation in August and October 2017

[zhuxin-306-014-28:2017] JST New Technology Seminar, March 2018

[zhuxin-306-014-29:2017] Medical Creation Fukushima 2017, Exhibition

[zhuxin-306-014-30:2017] Keynote speech, Toin International Symposium 2017