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Refereed academic journal

[wenxi-306-014-01:2016] Xin Zhu Wenxi Chen Koji Fukuda Hiroaki Shimokawa Yi Zheng, Daming Wei. Transmural, Interventricular, Apicobasal and Anteroposterior Action Potential Duration Gradients are All Essential to the Genesis of the Concordant and Realistic T wave: a Whole-heart Model Study. *Journal of Electrocardiology - Elsevier*, pages 49(4):569–78., 2016.

doi: 10.1016/j.jelectrocard.2016.03.010. Epub 2016 Mar 7.

[zhuxin-306-014-01:2016] Xin Zhu Wenxi Chen Koji Fukuda Hiroaki Shimokawa Yi Zheng, Daming Wei. Transmural, interventricular, apicobasal and anteroposterior action potential duration gradients are all essential to the genesis of the concordant and realistic T wave: A whole-heart model study. *Journal of Electrocardiology*, 49(4):569–578, Jul-Aug 2016.

BACKGROUND: It has been reported that ventricular repolarization dispersion resulting from transmural, apicobasal and interventricular action potential duration (APD) gradients makes the T wave concordant with the QRS complex. METHOD AND RESULTS: A whole-heart model integrating transmural, apicobasal, interventricular and anteroposterior APD gradients was used, and the corresponding electrocardiograms were simulated to study the influence of these APD gradients on the T-wave amplitudes. The simulation results showed that changing a single APD gradient (e.g., interventricular APD gradient alone) only made substantial changes to the T-wave amplitudes in a limited number of leads and was not able to generate T waves with amplitudes comparable with clinical findings in all leads. A combination of transmural, apicobasal and interventricular APD gradients could simulate T waves with amplitudes similar to clinical values in the limb leads only. Adding the anteroposterior APD gradient into the model greatly improved the consistency between the simulated T-wave amplitudes and the clinical values. CONCLUSION: The simulation results support that the transmural, apicobasal, interventricular and the anteroposterior APD gradient are all essential to the genesis of the clinical T wave.

[zhuxin-306-014-02:2016] Yoshinari Enomoto Yasuhiro Oikawa Hiroyuki Tatsunami Rina Ishii Yasutake Toyoda Masako Asami Naohiko Sahara Takahito Takagi Yuriko Narabayashi Hikari Hashimoto Naoshi Ito Shingo Kujime Tsuyoshi Sakai Keijirou Nakamura Takao Sakata Haruhiko Abe Kaoru Sugi Mahito Noro, Xin Zhu. Decreased Defibrillation Threshold

Summary of Achievement

and Minimized Myocardial Damage With Left Axilla Implantable Cardioverter Defibrillator Implantation. *Circulation Journal*, 80(4):80–84, April 2016.

Background: To reduce myocardial damage caused by implantable cardioverter defibrillator (ICD) shock, the left axilla was studied as an alternative pulse generator implantation site, and compared with the traditional implantation site, the left anterior chest. Methods and Results: Computer simulation was used to study the defibrillation conduction pattern and estimate the simulated defibrillation threshold (DFT) and myocardial damage when pulse generators were placed in the left axilla and left anterior chest, respectively; pulse generators were also newly implanted in the left axilla (n=30) and anterior chest (n=40) to compare the corresponding DFT. On simulation, when ICD generators were implanted in the left axilla, compared with the left anterior chest, the whole heart may be defibrillated with a lower defibrillation energy (left axilla 6.4 J vs. left anterior chest 12.0 J) and thus the proportion of cardiac myocardial damage may be reduced (2.1 vs. 4.2 %). Clinically, ventricular fibrillation was successfully terminated with a defibrillation output ≤ 5 J in 86.7 % (26/30) of the left axillary group, and in 27.5 % (11/40) of the left anterior group ($P < 0.001$). Conclusions: Clinically and theoretically, the left axilla was shown to be an improved ICD implantation site that may reduce DFT and lessen myocardial damage due to shock. Lower DFT also facilitates less myocardial damage, as a result of the lower shock required.

Refereed proceedings of an academic conference

[wenxi-306-014-02:2016] Wenxi Chen. Lifelong Healthcare: Seamless Monitoring from Womb to Tomb. In *Engineering Medical Innovation Summit: Medicine for the Future 2016*, 2016.

Aug. 20-21, 2016, the Chinese University, Hong Kong

[zhuxin-306-014-03:2016] Ai Hirasawa Yuri Nemori Xin Zhu, Kenta Asatsuma and Wenxi Chen. Respiratory Signals Derived from Electromyograms in Single-lead Electrocardiograms. In *Proc. IEEE-NIH 2016 Special Topics Conference on Healthcare Innovations and Point-of-Care Technologies*, Cancun, Mexico, 2016. IEEE, IEEE.

Wearable devices demand convenient respiration measurements for the diagnosis and monitoring of respiratory disorders. We proposed a method to derive

respiratory signals from electromyograms (EMG) in single-lead electrocardiograms. Compared with the traditional filter- and feature-based methods to derive respiratory signals from cardiac activities, the proposed method is free from the influence of cardiac arrhythmias and baseline wandering. Based on experiments of 12 subjects using Holter ECG leads, the proposed method demonstrated an average sensitivity 93.3% detection of respiration. This method is especially useful for wearable devices to monitor respiration, and requires no supplementary electrodes or hardware modifications.

[zhuxin-306-014-04:2016] Wenfeng Shen Xin Zhu Yaopeng Hu Yanghua Shen, X Zheng and Ryuichi Inoue. A Cardiac Reaction-diffusion Model Based on TRPM4 Channel. In Wenxi Chen, editor, *Proc. Intl. Conf. BigHealth 2016*, Aizu-Wakamatsu, Japan, 2016. The University of Aizu, The University of Aizu.

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.

[zhuxin-306-014-05:2016] Wenfeng Shen H. Zhang D. Wei K. Xu, Feng Qiu and Xin. Zhu. Parallel Computation for Computer Simulation of Electrocardiograms Based on Tegra K1 Board. In Wenxi Chen, editor, *Proc. Intl. Conf. BigHealth 2016*, Aizu-Wakamatsu, Japan, 2016. The University of Aizu, The University of Aizu.

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. And in order to realize a parallelization on ARM based CPU-GPU architecture and find out the pertinent result of performance and energy efficiency ratio, we utilize the control of the number of core and 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.

Summary of Achievement

Research grants from scientific research funds and public organizations

[zhuxin-306-014-06:2016] Xin Zhu Ryuichi Inoue, Tomohiro Numata. Multiarchial Analysis on the Role of TRPM Family in the Mechanism of Atrial Fibrillation induction, 2015-2018.

Academic society activities

[wenxi-306-014-03:2016] Wenxi Chen, October 2016.

The Joint International Conference of BDAHI-2016 and u-Healthcare 2016

[zhuxin-306-014-07:2016] Xin Zhu, 10 2016.

Program Chair of BigHealth2016

Patent

[wenxi-306-014-04:2016] Xin; Tamura Toshiyo Chen, Wenxi; Zhu. Bathtub ECG Monitoring System, 2016.

[wenxi-306-014-05:2016] Wenxi Zhu, Xin; Chen. Respiration Detection Device, Method and Program, 2016.

[wenxi-306-014-06:2016] Wenxi; Kentaro Shimokado Kobayashi, Toshio; Chen. A device for measuring the identification and reaction function of the subject, and a program that activate and control the measurement of identification and reaction function of the subject, 2016.

[zhuxin-306-014-08:2016] Toshiyo Tamura Wenxi Chen, Xin Zhu. Bathtub ECG monitoring system, 11 2016.

[zhuxin-306-014-09:2016] Xin Zhu and Wenxi Chen. Respiration detection device, method, and program, June 2016.

Advisor for undergraduate research and graduate research

Summary of Achievement

- [wenxi-306-014-07:2016] Ai Hirasawa. Master, University of Aizu, March 2016.
Supervisor
- [wenxi-306-014-08:2016] Yuri Nemori. Master, University of Aizu, March 2016.
- [wenxi-306-014-09:2016] Ayaka Tamokami. Graduation thesis, University of Aizu,
March 2016.
Supervisor
- [wenxi-306-014-10:2016] Taiyo Hoshi. Graduation thesis, University of Aizu,
March 2016.
Supervisor
- [wenxi-306-014-11:2016] Takafumi Yokoyama. Graduation thesis, University of
Aizu, March 2016.
Supervisor
- [wenxi-306-014-12:2016] Tetsuya Okada. Graduation thesis, University of Aizu,
March 2016.
Supervisor
- [wenxi-306-014-13:2016] Tomoki Katsuyama. Graduation thesis, University of
Aizu, March 2016.
Referee
- [wenxi-306-014-14:2016] Hideyuki Yokota. Graduation thesis, University of Aizu,
March 2016.
Referee
- [wenxi-306-014-15:2016] Shumpei Koha. Graduation thesis, University of Aizu,
March 2016.
Referee
- [wenxi-306-014-16:2016] Naoya Suzuki. Graduation thesis, University of Aizu,
March 2016.
Referee

Summary of Achievement

[zhuxin-306-014-10:2016] Yuri Nemori. Sleep Stage Analysis Based on Machine Learning, Graduate School of Computer Science and Engineering, March 2016.

About 21 % of Japanese adults have sleep disorders. Sleep stages are important indexes for the evaluation of sleep quality. Polysomnography is useful for estimating sleep stage and diagnosing sleep disorder. However, the accuracy of automatic sleep stage estimation is far from satisfaction. Sleep stages are manually determined by medical technologists in clinical practice. In this study, we proposed a method based on machine learning for the automatic estimation of sleep stages. In addition, we also expect to improve the agreement rate of automatically classifying sleep stages based on machine learning using less channels. If we able to classify sleep stages using less channels, it is not necessary to use a lot of electrodes for classify sleep stages. We used 7 combinations of 14 parameters from PSG data recorded during sleep. The parameters include might of alpha wave, might of delta wave, might of spindle wave, might of REM, might of SEM, might of EMG of chin, might of EMG of leg, flow rate, might of snore, respiratory effort belt, body position, SpO2, heart rate and pulse wave tradition tame trend. We employed neural networks for the sleep stage classification. For the training and testing of our method, we used PSG data from 20 subjects in Otsuki sleep clinic. The subjects have obstructive sleep apnea syndrome (OSAS) of sleep disorder. We used 70 %, 15 %, and 15 % of total datasets for training, validation, and testing, respectively. We used a 2 layer feedforward network with a sigmoid transfer function, softmax output neurons, 20 hidden neurons. The neural network was trained with scaled conjugate gradient backpropagation. The classification results were compared for each combination of parameters for the estimation of sleep stages, we obtained the highest agreement rate when using 14 parameters, and the lowest agreement rate when using 3 parameters and agreement rate of when using 7 parameters is not much lower than the high agreement rate.

[zhuxin-306-014-11:2016] Shumpei Koha. Estimate Emotion from EEG Using Machine Learning, School of Computer Science and Engineering, March 2016.

This research is estimate emotional state using machine learning for to support handicapped person. Therefore, the purpose of this research is to extract peculiarity of each emotional state from EEG and to classify each emotional states. I collect EEG with music. I analyze the brain waves in welch power spectrum estimates by Matlab and I use SVM for classification learner in Matlab tool.

The result of classification, we can obtain precision of 42.4 %. The result of this research, we can obtain good precision as much as we collect EEG.

[zhuxin-306-014-12:2016] Tomoki Katsuyama. Estimation of Respiration Rate from Electrocardiogram Using Two Analysis Methods, School of Computer Science and Engineering, 2016.

Respiration rate is closely related with ECG, and it becomes information to diagnose various diseases. ECG and respiration wave are acquired at the same time by ECG measurement using respiratory sensors of many medical institutions. However, these sensors give stress to patients and become the factor to raise medical cost. In addition, it becomes the obstacle to measure ECG and respiration wave in daily life. In this research, we obtained respiration wave from ECG and estimated respiration rate. First, we measured the 30-minutes ECG data of 20 subjects using Holter-ECG electrode position. Second, we compared the two analysis methods. The First analysis is using 2nd order Butterworth High-pass filter of 120Hz and digital filter that the triangle window, and the second analysis is to remove P, Q, R, S and T waves to leave only the information of respiratory muscle's EMG. As a result, latter analysis estimated the result of the respiration rate that was better than former analysis.

[zhuxin-306-014-13:2016] Hideyuki Yokota. Evaluation of Mental Stress during Heating Bathing, School of Computer Science and Engineering, 2016.

Comfortable bathing can improve health. The purpose of this study is to analyze the effects of heating bathing on ECG. We measured electrocardiograms (ECG) during bathing and analyzed heart rate variability (HRV) using two analysis methods. Ten subjects took a bath for 15 minutes at 41 degree celsius and 38 degree celsius, respectively in heating bathing. ECG was analyzed in both time and frequency domains. Based the time domain indexes, 8 subjects were more relaxing in heating bathing. Based on the frequency domain indexes, 3 subjects were more relaxing in heating bathing. The relation between water temperatures and mental stress differs person by person. The heating bathing method is generally good but is necessary to be revised.