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of the IEEE Engineering in Medicine and Biology Society

Smarter Technology for a Healthier World

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The Korean Society of Medical & Biological Engineering

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All conference papers were peer-reviewed by experts chosen by the Conference Editorial Board for all contributed, invited and minisymposia papers.

AUTHOR NO SHOW POLICY: EMBS enforces a "no show" policy. Any accepted paper included in the final program is expected to have at least one author attend and present the paper at the Conference. Authors of the accepted papers included in the final program who do not attend the Conference will be subscribed to a "No Show List", compiled by the Society. The "no-show" papers will be removed from the Master DVD and noted as "Author unavailable for presentation" prior to submitting to IEEE for inclusion in Xplore. The "No Show List" will also be made available to all EMBS conference organizers, who can reject submissions from these authors in the following two years, based on their past negative impact on an EMBS conference.

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11:05-11:20 FrBT16.2
Development of Axillary Pressure Feedback System for Crutch Walking
Wada, Chikamune* *(Kyushu Institute of Tech.)*; Nagasaki, Takayuki *(Kyushu Univ. of Nursing and Social Welfare)*

11:20-11:35 FrBT16.3
Ensemble Classification for Robustness Improvement in Image-Based Diagnosis Support Systems
Horio, Keiichi* *(Kyushu Institute of Technology)*

11:35-11:50 FrBT16.4
Ocular Vasculature Analysis using Photoacoustic Microscopy and Random Sample Consensus Algorithm
Jeon, Seungwan *(Pohang Univ. of Science and Tech.)*; Kim, Chulhong* *(Pohang Univ. of Science and Tech.)*

FrCT2: 14:20-15:50 Cho Room
Recent Advances in Ultrasound Medical Imaging (Invited Session)
Chair: Yoo, Yangmo *(Sogang University)*
Co-Chair: Kim, Hyung Ham *(Pohang University of Science and Technology)*

14:20-14:35 FrCT2.1
Ultrasound and Photoacoustic Multimodality Imaging using Laser-Activated Perfluorocarbon Nanodroplets
Yoon, Changhan* *(Inje University)*

14:35-14:50 FrCT2.2
Advances in Ultrasound Imaging: Multi-Modality Fusion Imaging
Managuli, Ravi* *(Hitachi Aloka Medical America, Inc.)*

14:50-15:05 FrCT2.3
Ultrasound-Assisted Photothermal Therapy
Chang, Jin Ho* *(Sogang University)*

15:05-15:20 FrCT2.4
A New Three-Dimensional Automated Breast Ultrasound Imaging System for Women with Dense Breast
Yoo, Yangmo* *(Sogang University)*

15:20-15:35 FrCT2.5
Array Transducers for High Definition Ultrasound Imaging
Kim, Hyung Ham* *(Pohang University of Science and Technology)*

FrCT4: 14:20-15:50 Min Room
Body Sensor Networks – Molecules, Radio, and Machine Learning – III (Invited Session)
Chair: Anzai, Daisuke *(Nagoya Institute of Technology)*
Co-Chair: Sugimachi, Masaru *(Natl Cardio Center Research Inst)*

14:20-14:35 FrCT4.1
An Improved Design of EEG Monitoring System with Dry Electrodes
Lee, Seungchan *(Gwangju Institute of Science and Technology)*; Kumar, Anil *(Gwangju Institute of Science and Technology)*; Shin, Younghak *(NTNU (Norwegian University of Science and Technology))*; Lee, Heung-No* *(Gwangju Institute of Science and Technology (GIST))*

14:35-14:50 FrCT4.2
Percutaneous Auricular Vagus Nerve Stimulation: Assessment of Sensitivity of Neural Activation to Electrode Position
Samoudi, Mohammed Amine* *(Ghent University/iMinds)*; Kampusch, Stefan *(Vienna University of Technology)*; Tanghe, Emmeric *(Ghent University)*; Szeles, Constantin *(University Clinic for Surgery, Vienna General Hospital, Medical)*; Martens, Luc *(iMinds / Ghent University)*; Kaniusas, Eugenijus *(Vienna University of Technology)*; Joseph, Wout *(Ghent University)*

14:50-15:05 FrCT4.3
Molecular Communications for Cardiomyocytes
Lu, Pengfei* *(University of Oslo and Oslo University Hospital)*; Bose, Pritam *(University of Oslo and Oslo University Hospital)*; Albatat, Mohammad *(University of Oslo and Oslo University Hospital)*; Balasingham, Ilangko *(Oslo University Hospital and Norwegian University of Science and)*

An improved design of EEG monitoring system with dry electrodes

Seungchan Lee, Anil Kumar, Younghak Shin, and Heung-No Lee, Senior *Member, IEEE*

In this paper, we aim to introduce our EEG measurement system with dry electrodes. The dry electrode has eighteen spring-loaded probes for dry contact with a scalp without conductive paste. With careful circuit design techniques for lowering noise, the system board was designed to integrate a 32-bit microcontroller, a 24-bit analog-to-digital converter (ADC), and power management circuits for 8-channel EEG acquisition. From the alpha rhythm detection test with the conventional wet electrodes, we show that our system can acquire EEG signals with a sufficient correlation using dry electrodes.

I. Introduction

With the advanced in neurobiological research, various neuroimaging techniques [1] such as Electroencephalography (EEG), magnetoencephalography (MEG) and Functional magnetic resonance imaging (fMRI) are being developed. Among these techniques, the EEG signals can be measured with a low cost and portable system. Therefore, it is widely applied in various medical and research fields such as brain-computer interface, which require real-time neural monitoring [2]. However, it is not easy to acquire high-fidelity EEG signals because of their microvolt amplitudes, hairy scalp, and resulting higher noise sensitivity [3].

In this paper, an efficient EEG measurement system is introduced with dry electrodes for real-time and ambulatory applications, and it is tested for detection of alpha rhythm.

II. Materials and System Design

Our EEG measurement system consists of dry electrodes and a system board. The dry electrodes have eighteen spring-loaded probes, which are connected each other by soldering to a PCB board. Due to their flexible structure, conductive paste is not required for improvement of electrical coupling between probes and the scalp. The electrode housings are manufactured by 3D printing.

The system board was designed to integrate a 32-bit microcontroller, a 24-bit analog-to-digital converter (ADC), and power management circuits for measurements of 8-channel EEG signals from the dry electrodes. To reduce the system noise and electrical interference, the analog circuit including ADC is designed fully isolated from the digital circuits by using dedicated power and logic isolator ICs. In addition, the ultralow noise linear regulators are also used in the power supply for analog circuits. As an ADC in this system, ADS1299 (Texas Instruments, USA) [4] is employed, which integrates eight programmable gain amplifiers, and eight simultaneous-sampling ADCs. The number of measurement channels can be expanded by stacking additional expansion boards.

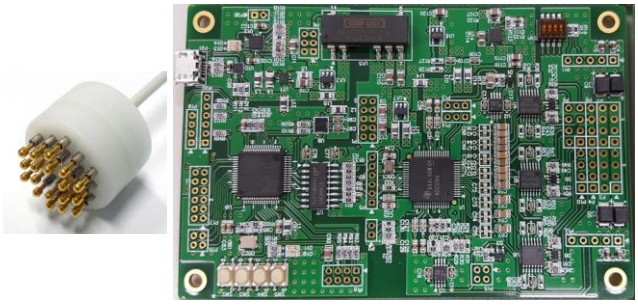

Figure 1. A designed dry electrode and a system board for EEG measurements

III. Test Results and Summary

Among the EEG rhythms, the alpha rhythm, which occupies in 8~12Hz band can be easily maximized by closing the eyes. For verification of EEG measurement, we have measured the alpha rhythm by using our EEG measurement system with dry electrodes, and conventional wet electrodes. The correlation coefficient has been calculated from the two EEG waveforms for 60 seconds. The correction coefficient obtained from these waveforms is 0.88, which evidences our EEG measurement system with dry electrode can acquire EEG signals well. Based on our system design, we will develop a hybrid brain monitoring system by combination with functional near-infrared spectroscopy system in future research.

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[2] Wolpaw, Jonathan R., et al. "Brain–computer interfaces for communication and control." *Clinical neurophysiology* 113.6 (2002): 767-791.

[3] Seungchan Lee, Younghak Shin, Soogil Woo, Kiseon Kim and Heung-No Lee, "Design of Dry Electrode for Wireless BCI systems", *35th IEEE EMBC 2013*, Osaka, Japan, 2013, SaD02.25

[4] ADS1299 datasheet, http://www.ti.com/lit/ds/symlink/ads1299.pdf