Program Book

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Lee, Jinseok Wonkwang University School of Medicine; Nam, Yunyoung Worcester Polytechnic Insititute; Jeong, Chang Won Wonkwang University; Joo, Su-Chong Wonkwang University; Yoon, Kwon-Ha Wonkwang University School of Medicine

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Measurement of Shear Force Inside Shoe During Walking Using Electro-Conductive Fabric Sensor
Toyomura, Yoshirou Ritsumeikan University; Okada, Shima Faculty of Science and Engineering, Kinki University; Makikawa, Masaaki Ritsumeikan University; Araki, Takahiro Okamoto Corporation; Soukawa, Chika Okamoto Corporation

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Improvement in the Reproducibility of Noninvasive Blood Glucose Measurements Based on Photoacoustic Spectroscopy
Saito, Takuma Meiji University; Ishihara, Yasutoshi Meiji University

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A Wireless System for Measuring the Vibration Signals Generated by Knee Joints
Wang, Jia-Jung I-Shou University; Chen, Chun-Chien I-Shou University; Liu, Shing-Hong Chaoyang University of Technology, Taichung, Taiwan, ROC; Yen, Cheng-Yo E-Da Hospital; Tu, Yuan-Kun E-Da Hospital; Fu, Shen-Li I-Shou University

15:00-16:30 SaD02.10
Wearable Sized Sudorometer and Sweat Measurement
Kono, Takahiro Tohoku university; Ishii, Kenji Tohoku Univ.; Tsuruoka, Noriko Tohoku Universiity; Haga, Yoichi Tohoku Univ.

15:00-16:30 SaD02.11
A Multi-Channel Current Stimulator Chip Intended for a Visual Cortical Implant
Kameda, Seiji Osaka Univ.; Hayashida, Yuki Osaka Univ.; Tanaka, Hiroki Osaka Univ., The Center for Advanced Medical Engineerings a; Akita, Dai Osaka Univ.; Iwata, Atsushi A-R-Tec. Corporation; Yagi, Tetsuya Osaka Univ., Gard. Eng

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Identify Abnormal Mouse Pancreatic Tissues Using Multi-Frequency Electrical Impedance Measurements
Lu, Huiqi University of Liverpool; Qiao, Guofeng University of Sussex; Wang, Wei University of Sussex; Birch, Phil University of Sussex; Young, Rupert University of Sussex; Chatwin, Chris R University of Sussex

15:00-16:30 SaD02.13
Relationship between Diamond-Like Carbon (DLC) Surface Condition and Cell Proliferation
Sanin, Nurhanisah Tokyo Denki University; Hibino, Mai Tokyo Denki University; Ohgoe, Yasuharu Tokyo Denki University; Hirakuri, Kenji Tokyo Denki University; Saitoh, Hidetoshi Nagaoka University of Technology; Homma, Akihiko Tokyo Denki University; Funakubo, Akio Tokyo Denki University; Fukui, Yasuhiro Tokyo Denki University

15:00-16:30 SaD02.14
Non-Invasive and Real-Time Measurement Techniques of Dopamine, APs and Fpsp Using Carbon Nanotube Multi-Electrode Array Chip
Suzuki, Ikuro Tokyo university of technology; Odawara, Aoi Tokyo Univ. of technology; Gotoh, Masao Tokyo Univ. of Technology

15:00-16:30 SaD02.15
Monitoring Inflammation of RAW264.7 Using Screen-Printing Interdigitated Electrodes by Electrochemical Impedance Spectroscopy
Wang, Kuan Yao National Central University; Chen, Ching-Jung University of Chinese Academy of Sciences; Liu, Jen-Tsai University of Chinese Academy of Sciences; Tsai, Jang-Zern National Central University; Chang, Shwu Jen I-Shou University; Settu, Kalpana National Central University

15:00-16:30 SaD02.16
Simulation of Impedance Changes Due to Cell Attached at Micro Scale Electrode
Huang, Yi Shan National Central University; Liu, Jen-Tsai University of Chinese Academy of Sciences; Chen, Ching-Jung University of Chinese Academy of Sciences; Tsai, Jang-Zern National Central University; Chang, Shwu Jen I-Shou University

15:00-16:30 SaD02.17
Crystal Design and Generation of a New Biocompatible Piezoelectric Mixed Crystal – Ti Doped MgSiO3 – Thin Film
Nose, Kenzo Doshisha University; Nakamachi, Eiji Doshisha University; Uetsuji, Yasutomo Osaka Institute of Technology

15:00-16:30 SaD02.18
A ZnO-Based Biosensor for Label-Free Detection of Prostate-Specific Antigen
Chen, Shih-Jui National Central University

15:00-16:30 SaD02.19
A Cost-Effective Functional Near-Infrared Spectroscopy System with a Novel C-Shaped Probe for Brain Activity Monitoring
Huang, Yu-Chieh National Chiao Tung Univ.; Chiou, Jian-Hau National Chiao Tung Univ.; Yeh, Wei-Lin National Chiao Tung Univ.

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Takahashi, Ken Okayama University Graduate School of Medicine, Dentistry and P; Fukasawa, Taro Okayama University; Kuniyasu, Kizuku Okayama University; Naruse, Keiji Okayama University Graduate School of Medicine, Dentistry and Ph

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Shimada, Naoya The University of Tokyo; Asano, Koji Nagoya University; Ikeuchi, Masashi The University of Tokyo; Ikuta, Koji The University of Tokyo

15:00-16:30 SaD02.23
Nanoplasmonic-Based Colorimetric Detection of MicroRNA Mir-21 in Breast Cancer Cells
Park, Jiyun Yonsei University; Yeo, Jong-Souk Yonsei University

15:00-16:30 SaD02.24
Joint Estimation of Position and Gain for RFID-Tag Assisted Surgery Support System
matsuda, katsushi Nara Institute of Science and Technology; Takahata, Hiromi Osaka Univ.; Oshiro, Osamu Osaka Univ.; Okada, Minoru Nara Institute of Science and Technology

15:00-16:30 SaD02.25
Design of Dry Electrodes for Wireless BCI Systems
Lee, Seungchan Gwangju Institute of Science and Technology; Shin, Younghak Gwangju Institute of Science and Technology; Woo, Soogil GIST; Kim, Kiseon Gwangju Institute of Science and Technology; Lee, Heung-No Gwangju Institute of Science and Technology (GIST)

Design of Dry Electrodes for Wireless BCI systems

Seungchan Lee, Younghak Shin, Soogil Woo, Kiseon Kim, *Senior Member, IEEE,* and Heung-No Lee, *Member, IEEE*

***Abstract*— In this paper, we aim to introduce a design of dry electrodes for wireless BCI systems. They are capable of acquiring EEG signals of good enough quality without usage of conductive gels. To verify the performance of proposed electrodes, we measure contact impedances and compared them with those of conventional wet electrodes. Experimental results show that average impedance of proposed dry electrodes is slightly higher than those of the wet electrodes. But, impedance differences are insignificant without conductive gels. We will improve the impedance characteristic in future research.**

I. Introduction

In wireless Brain-Computer Interface (BCI) systems, electrodes are the most important part. Because amplitude of EEG signals is very small, the signals are sensitive and easy to be affected by various noise sources. Moreover, due to usage of conductive gels, electrode installation is also inconvenient and time-consuming. Therefore, development of improved EEG electrodes which provide high fidelity EEG signals and easy installation is one of the most important challenges.

In this paper, we aim to introduce our design of dry electrodes which do not require the use of the conductive gels for EEG signal acquisition, show their performance in terms of contact impedance, and compare them with that of conventional wet electrodes.

II. Electrode Design

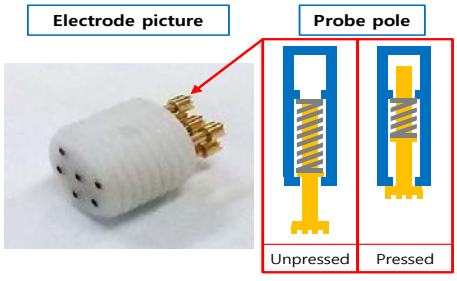

Figure 1. Dry electrode picture and structure diagram

Our dry electrodes are equipped with six probes of spring loaded type. These probes contract their length maximum 2mm when they compressed. This structure provides flexibility and geometric adaptation between the sensors and the irregular scalp surfaces. Because the probes are easy to penetrate with the user's scalp through the hairs, any hair preparation is not needed in their installation process. Figure 1 is a picture of the proposed dry electrode and a diagram showing its structure.

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III. Impedance Test

To verify the contact capability of the proposed electrodes, we measure the contact impedance [1] and compare that with those of conventional wet electrodes (StarDisk, made by Hurev). A lower impedance means a higher contact capability, and facilitates acquisition of high fidelity EEG signals.

In order to measure the electrode impedance, we utilize RZ5 neurophysiology workstation and its impedance check application (made by Tucker-Davis Technology). In the impedance test, we used a single male subject. During 60 seconds, we measured the electrode impedances at Cz, Fz, and Pz positions based on international 10/20 system. Reference and ground electrodes are installed on the both of ear lobes respectively.

IV. Results and Discussion

TABLE I. Electrode Impedance Comparison

Electrode Types	Electrode Positions		
	Cz	*Fz*	*Pz*
Dry	25.9 kΩ	38.0 kΩ	30.4 kΩ
Wet	21.0 kΩ	13.3 kΩ	23.0 kΩ

Table 1 summarizes the average impedance of both the proposed dry electrodes and the wet electrodes under various spatial during 60 seconds. Owing to the usage of conductive gels, the average impedance values of proposed dry electrodes are slightly higher than those of the wet electrodes.

However, according to impedance values of Cz position, the impedance difference between two electrodes is insignificant without conductive gels. Besides, the proposed dry electrodes have advantages such as convenient installation and feasibility of long-term monitoring. We will improve the impedance characteristic in future research.

Acknowledgment

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References

[1] Malmivuo J, Plonsey R. Bioelectromagnetism: Principles and Application of Bioelectric and Biomagnetic Fields. Oxford University Press, New York, 1995.