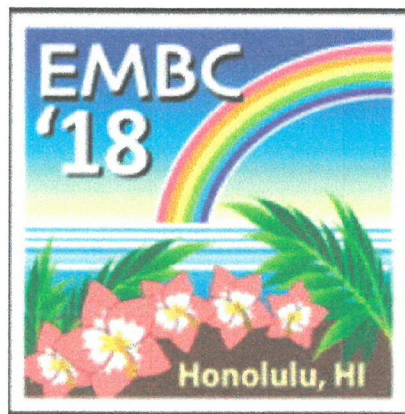


40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society



July 17-21 2018

Hawaii Convention Center
Honolulu, Hawaii

Conference Chairs

James Weiland
Michelle Khine

Program Chairs

Greg Suaning
Olaf Doessel



Indexed in PubMed® and MEDLINE®,
Products of the United States National
Library of Medicine



- 17:15-19:00 FrPoS-29.26
Improving the Reliability of R-Wave Detection by a Microcontroller-Operated Wearable RRI Telemeter
 Chihara, Yuma* (*Kumamoto University*); Shoji, Kento (*Kumamoto University*); Yamakawa, Toshitaka (*Kumamoto University*)
- 17:15-19:00 FrPoS-29.27
A Feasibility Study on the Evaluation of Stress Level by Non-Contact Measurement using Video Images
 Ikarashi, Akira* (*Aino Univ.*); Hayashi, Takuto (*Aino Univ.*)
- 17:15-19:00 FrPoS-29.28
Investigation of Arterial Property Changes based on Blood Pressure Waveform and Photoplethysmogram
 Han, Sangjin (*Chonnam National University*); Shin, Hangsik* (*Chonnam National University*)
- 17:15-19:00 FrPoS-29.29
Design of Blending Algorithm for Rate Adaptive Pace based on Dual Sensors
 Myoung, Hyoun Seok (*Yonsei University*); Lee, Kyoung Joung* (*Yonsei University*)
- 17:15-19:00 FrPoS-29.30
X-Limb: A Soft Prosthetic Hand for Upper-Limb Amputees
 Mohammadi, Alireza* (*University of Melbourne*); Lavranos, Jim (*Caulfield Hospital*); Choong, Peter (*University of Melbourne*); Oetomo, Denny (*University of Melbourne*)
- 17:15-19:00 FrPoS-29.31
Quantitative Analysis of Arthroscopic Operation in Elbow Arthroscopy
 Otsuka, Syuto (*Tokyo University of Science*); Yamamoto, Michiro (*Nagoya University Hospital*); Oyama, Shintato (*Nagoya University Hospital*); Hirata, Hitoshi (*Nagoya University Hospital*); Mizoguchi, Hiroshi (*Tokyo University of Science*); Yokota, Hideo* (*RIKEN Center for Advanced Photonics*)
- 17:15-19:00 FrPoS-29.32
Development of a Self-Administered Epley Maneuver Guiding System based on Head Motion Analysis
 Kwon, Chiheon (*Seoul National University*); Ku, Yunseo (*Chungnam National University College of Medicine*); Ahn, Joong Woo (*Seoul National University*); Kim, Do Youn (*Interdisciplinary Program, Bioengineering, Graduate School, Seoul National University*); Suh, Myung-Wihan (*Seoul National University Hospital*); Kim, Hee Chan* (*Seoul National University*)
- 17:15-19:00 FrPoS-29.33
Does Normalization Affect Phase Space Analysis on Human Movement?
 Rodrigues, Carlos M. B.* (*INESCTEC - Technology & Science Associate Lab*); Correia, Miguel (*Universidade do Porto, Faculdade de Engenharia*); Abrantes, João M. C. S. (*MovLab - ULHT*); Rodrigues, Marco Aurélio Benedetti (*Federal Univ. of Pernambuco*); Nadal, Jurandir (*Federal Univ. of Rio de Janeiro*)
- 17:15-19:00 FrPoS-29.34
Arrhythmia Classification using LSTM
 Lee, JeeEun (*Yonsei University*); Yoo, Sun K.* (*Yonsei University Health System*); Jang, Wonseuk (*Yonsei University*)
- 17:15-19:00 FrPoS-29.35
Ambulatory Assessment of Motor Weakness by Stroke: Forearm Rolling Test with Wearable Devices
 Shin, Yeongcheol (*Yonsei Univ. College of Medicine*); Nam, Hyosuk (*Dept. of Neurology, Yonsei Univ. College of Medicine*); Chang, Hyuk-Jae (*Yonsei Univ. College of Medicine*); Rhee, Yu Mie (*Yonsei Univ.*); Park, Eunjeong* (*Cardiovascular Research Institute, Yonsei Univ. College of Medicine*)
- 17:15-19:00 FrPoS-29.36
Effect of Dual Vibration Stimulation to Biceps Brachii on Elbow Joint Extension Motion Change for Upper-Limb Perception-Assist
 Honda, Koki* (*Kyushu Univ.*); Kiguchi, Kazuo (*Kyushu Univ.*)
- 17:15-19:00 FrPoS-29.37
Silk Hydrogel Microneedle for Glucose Monitoring
 Kim, Hoyjung (*Korea Advanced Institute of Science and Technology*); Seo, Ji-Won (*Korea Advanced Institute of Science and Technology*); Kim, Mi Kyung (*Korea Advanced Institute of Science and Technology (KAIST)*); Lee, Hyunjoo Jenny* (*Korea Advanced Institute of Science and Technology (KAIST)*)
- 17:15-19:00 FrPoS-29.38
Development of a 16bit 8-Channel Functional Near-Infrared Spectroscopy based Neuroimaging System
 Lee, Seungchan (*Gwangju Institute of Science and Technology*); Kumar, Anil (*Gwangju Institute of Science and Technology*); Lee, Heung-No* (*Gwangju Institute of Science and Technology (GIST)*)
- 17:15-19:00 FrPoS-29.39
Piezoelectric Biosensor for Blood Pressure
 Antonio, Mark* (*University of Hawaii at Manoa*); Graves, Toni (*University of Hawaii at Manoa*); Padasdao, Bryson (*University of Hawaii at Manoa*); Boric-Lubecke, Olga (*University of Hawaii at Manoa*); Ben, Bonnie Louis (*University of Hawaii at Manoa*)
-
- FrPoS-30: 17:15-19:00 Exhibit Hall 2
Friday 1 Page Research Poster Paper (I) (Poster Session)
- 17:15-19:00 FrPoS-30.1
Portable Ultrasound Device for Real-Time Intra-Oral Imaging
 Culjat, Martin (*Dthera Sciences*); Johnson, Eric (*Farus, LLC*); Mierzwa, Andrzej (*Farus, LLC*); Nguyen, Kristen* (*Farus, LLC*); Singh, Rahul (*Farus, LLC*); White, Shane (*UCLA*)
- 17:15-19:00 FrPoS-30.2
Cardiovascular Simulator with Simplified Arterial Model for Pulse Wave Study
 Jang, Min* (*Sangji University East-West Medical Engineering*)
- 17:15-19:00 FrPoS-30.3
A Baseline Alignment Evaluation Algorithm in Conjunction with Detrended Fluctuation Analysis
 Park, Jong-Rul (*Sungkyunkwan University*); Jae Chern, Yoo* (*Sungkyunkwan University*)
- 17:15-19:00 FrPoS-30.4
Heart Beat Waveform Variation Evaluation from Recurrence Quantification Threshold Plot
 Park, Jong-Rul (*Sungkyunkwan University*); Jae Chern, Yoo* (*Sungkyunkwan University*)
- 17:15-19:00 FrPoS-30.5
Mechanisms of Airflow Recovery in Obstructive Sleep Apnea
 Gell, Laura* (*Flinders University*); Catcheside, Peter (*Flinders University*); Reynolds, Karen (*Flinders University Medical Device Research Institute*)
- 17:15-19:00 FrPoS-30.6
Soft Robotics Technologies to Implement Human Motor Control Lessons in Work-Oriented Prosthetics
 Catalano, Manuel Giuseppe* (*Fondazione Istituto Italiano di Tecnologia*); Cristina, Piazza (*Centro di Ricerca E. Piaggio - Università di Pisa*); Godfrey, Sasha Blue (*Istituto Italiano di Tecnologia*); Grioli, Giorgio (*Fondazione Istituto Italiano di Tecnologia*); Bianchi, Matteo (*University of Pisa*); Zhao, Kristin (*Mayo Clinic*); Bicchi, Antonio (*University of Pisa*)

Development of a 16bit 8-channel functional near-infrared spectroscopy based neuroimaging system

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

In this abstract, we aim to introduce our functional near-infrared spectroscopy (fNIRS) based neuroimaging system consisting of a system board, photodiode units and dual-wavelength near-infrared (NIR) LED units. In a design of the proposed system, an analog frontend (AFE) integrated circuit (IC) and isolated low-noise power supply circuit enable us to implement the portable and high-resolution fNIRS system. From the system evaluation with mental arithmetic experiment, a clear decrease trend of deoxy-hemoglobin has been found during the mathematical calculation task.

I. INTRODUCTION

Initially, the brain-computer interface (BCI)[1] has been studied to assist people with severe disabilities such as people having difficulty in controlling their peripheral nerves systems due to neurological and neuromuscular disorders. Recently, this technology is being employed to real-world applications due to its potential as a non-muscular communication channel. In order to facilitate the development of real BCI applications, a portable, cost-effective and non-invasive neuroimaging technique is essentially required. A functional near-infrared spectroscopy (fNIRS) is one of the best neuroimaging techniques that meet these requirements. This technique enables to access metabolic and microcirculatory neuronal activity of the cerebral cortex region by measuring the changes in the local concentration of both oxygenated and deoxygenated hemoglobin that utilizing near-infrared optical radiation.

In this abstract, a new concept of fNIRS based neuroimaging system is introduced as a portable, cost-effective and non-invasive neuroimaging technique. Several evaluation results with mental arithmetic experiments shows the significance of proposed fNIRS.

II. MATERIALS AND SYSTEM DESIGN

The proposed fNIRS neuroimaging system consists of a system board and a probe set including photodiode units and dual-wavelength near-infrared (NIR) LED units.

The system board was designed to integrate a 32bit

This research was supported by the Brain Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT & Future Planning (NRF-2016M3C7A1905475). This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIP) (NRF-2015R1A2A1A05001826).

Seungchan Lee, Anil Kumar, and Prof. Heung-No Lee* are with the School of Electrical Engineering and Computer Science, Gwangju Institute of Science and Technology, Gwangju, South Korea (e-mail: seungchan@gist.ac.kr, anilkdee@gmail.com, corresponding author to provide e-mail: heungno@gist.ac.kr).

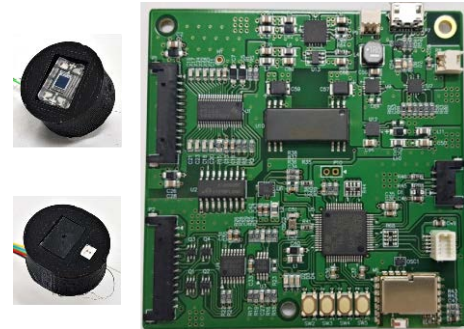


Figure 1. A proposed system board, a photodiode unit and a dual-wavelength near-infrared (NIR) LED unit for fNIRS measurements low-power microcontroller (STM32L4, STMicroelectronics, USA), an AFE IC (ADS8688A, Texas Instruments, USA) [2], a LED driving circuit for 8-channel fNIRS measurements. The AFE IC was integrated with a 16-bit successive approximation register analog-to-digital converter, 8-channel input multiplexer, programmable gain amplifiers, and second-order low pass filters. By using a high-resolution AFE IC, a complicated signal conditioning circuit was eliminated, that significantly simplify the overall system design. To provide stable DC power to the AFE IC, a fully isolated and low-noise power supply circuit was carefully designed.

The photodiode units were based on Texas Instruments OPT101 monolithic photodiodes. The chip-type dual wavelength (730 and 850 nm) AlGaAs LEDs (Opto ENG OE-MV7385-P) were employed for NIR optical emission. These photodiodes and NIR LEDs are soldered onto each customized PCBs along with decoupling capacitors, and housed in a 3D-printed casing.

III. SYSTEM EVALUATION AND SUMMARY

A mental arithmetic experiment has designed to examine hemodynamic difference between the non-trivial mathematical tasking and the non-tasking state. This difference appears as a hemodynamic concentration change of the oxy- and deoxy-hemoglobin, measured by the fNIRS system. From the mental arithmetic experiment results with two subjects, the clear decrease trend of oxy-hemoglobin has found during the mathematical calculation task.

REFERENCES

- [1] Wolpaw, Jonathan R., et al. "Brain-computer interfaces for communication and control." *Clinical neurophysiology* 113.6 (2002): 767-791.
- [2] ADS8688A datasheet, <http://www.ti.com/lit/ds/symlink/ads8688a.pdf>