Canadian Association of Physicists

Association canadienne des physiciens et physiciennes

Contribution ID: **4347** Type: **Oral (Non-Student) / Orale (non-étudiant(e))**

Wearable light-based hemodynamic monitoring device for low resource settings

Friday 31 May 2024 09:00 (15 minutes)

In underserved regions, infants face heightened risks of brain injury due to the prevalence of adverse factors like infections and malnutrition, compounded by the absence of suitable monitoring tools. Detecting early signs of neonatal brain injury through monitoring cerebral blood oxygenation offers hope in addressing this critical need for underserved communities [1]. The goal of this project is to develop a noninvasive, wearable optical device for monitoring neonatal cerebral blood oxygenation in low resource settings.

More specifically, we leveraged widely available consumer electronics to develop a low-cost near-infrared spectroscopy (NIRS) system [2], specifically designed for neonatal neuromonitoring in resource-limited settings. The device was based on a fitness tracking smartwatch (MAXM86146, Maxim Integrated) that includes two photodetectors, synchronization algorithms supporting up to four light-emitting diodes (LEDs), and high-speed real-time data acquisition equipped with advanced noise-canceling algorithms. The MAXM86146 was supplemented with a dual-wavelength LED (SMT730D/850D, Marubeni) emitting light at 730 and 850 nm. We subsequently designed a homemade driver to control the LEDs'power to allow the emitters and detectors to be positioned 3 cm apart for improved sensitivity to deep tissues.

To evaluate our approach, we conducted a cuff occlusion experiment on the forearm of a healthy adult. The device was placed on the subject's skin, and the light intensity from each wavelength was measured in real-time. Next, the measurements were analyzed using an algorithm based on the modified Beer-Lambert law [2] to quantify changes in oxy- and deoxy-hemoglobin (HbO2 and Hb) concentrations over time. The results showed the expected rapid decrease in HbO2 concentration during the arterial occlusion period. Furthermore, the high sampling rate of the device enabled us to monitor heart pulses throughout the experiment.

Future work will include a comprehensive evaluation of the device, including assessing its performance in tissue-mimicking phantoms and in-vivo experiments with healthy volunteers before its deployment in the clinic.

This project is funded by the Western University of Ontario, under a Frugal Biomedical Innovations, Catalyst Grant.

[1] Rajaram, A., et al. Scientific Reports 12.1 (2022): 181.

[2] Ferrari, M., et al. Neuroimage 63.2 (2012): 921-935.

Keyword-1

Near-infrared spectroscopy

Keyword-2

Hemodynamic monitoring

Keyword-3

Brain monitoring in neonates

Author: Dr SAMAEI, Saeed (Department of Medical Biophysics, Schulich School of Medicine & Dentistry, Western University, London, Ontario, Canada)

Co-authors: SIKSTROM, Lee; Dr HOLDSWORTH, David (Western University); Dr DIOP, Mamadou (Western University & The Lawson Health Research Institute)

Presenter: Dr SAMAEI, Saeed (Department of Medical Biophysics, Schulich School of Medicine & Dentistry, Western University, London, Ontario, Canada)

Session Classification: (DPMB) F1-2 Sensors | Détecteurs (DPMB)

Track Classification: Technical Sessions / Sessions techniques: Physics in Medicine and Biology / Physique en médecine et en biologie (DPMB-DPMB)