Wearable Near Infrared Spectroscopy for Noninvasive Assessment of Cerebral Oxygenation in Pediatric Sickle Cell Disease

Alex Moazzen
Kennesaw State University

Mark Romine
Kennesaw State University

Saba Mabood
Kennesaw State University

Andrew Boateng
Kennesaw State University

Paul Lee
Kennesaw State University

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About 1 out of every 13 African American infants are born with the Sickle Cell Trait. Sickle Cell Disease (SCD) has a profound effect on the brain due to chronic anemia and abnormal perfusion. Indeed, the risk of stroke is 300 times higher than the general population. Assessment of cerebral oxygenation in SCD is important to screen the risk of stroke and monitoring of therapeutic effects. To address this need, the technical solution that we propose is a photonic device using functional Near Infrared Spectroscopy (fNIRS) that noninvasively measures oxyhemoglobin (oxy-Hb) and deoxyhemoglobin (deoxy-Hb) levels in the bloodstream. We have built our prototype fNIRS device that consists of an ESP-32 microcontroller with a built-in Digital to Analog and Analog to Digital converter channels (DAC and ADC), three Operational Amplifiers (two AD8655 and one OPA363), two LEDs for emitting light into the skin tissue, and a Photodiode for measuring the remitted light intensity. Oxy-Hb has a higher absorption rate at lower wavelengths, while deoxy-Hb has a higher absorption rate at higher wavelengths. Thus, we use 650 nm and 950nm wavelengths to accurately measure oxy-Hb and deoxy-Hb. Using the Beer-Lambert law, we can determine the changes in oxygenation between the two. We are currently conducting performance tests on a set of optical phantoms mimicking biological tissue optical properties. This bench-top verification demonstrates that our prototype can noninvasively track the changes of tissue oxygenation level and will be ready for further validation on human subjects in the future.