Abstract Title: Pulse Oximetry Signals on the Wrist

Presenting Author: Jake Dove, Ph.D. Technical Fellow, Patient Monitoring Medtronic, Boulder, CO.
Co-Authors: Abel Valdes, Sensor Engineer, Patient Monitoring Medtronic, Boulder, CO.
Anu Tuladhar, Sensor Engineer, Patient Monitoring Medtronic, Boulder, CO.

Introduction: Wearable sensors have emerged as an attractive method of patient monitoring that can bridge the gap between the hospital and home.[1] Typical wearable sensors include heart rate, body temperature and motion. Accurate pulse oximetry, which is a critical tool for clinicians to monitor patient blood oxygenation,[2] has remained an elusive parameter to incorporate into a wearable device.[3] Here, a wearable optical sensor is constructed to fit on the wrist.

Method: Optical physiological signals from the wrist and finger were collected on 10 subjects. A novel mechanical housing was constructed with a 3D printer and used to secure the optical components to the wrist with a band (Figure 1). The prototype device was plugged into a standard Nellcor™ pulse oximeter (N600x). On the same hand, a finger clip probe was placed on the index finger and used as a reference. Optical physiological signals were collected from the wrist and finger simultaneously.

Results: Pulse rate and SpO_2 were recorded from both devices during a stable period of no motion for 5 minutes. The signals collected on the wrist are shown to match the finger within +/- 1.2 BPM for heart rate and +/- 2.3 for SpO_2 (both measures are calculated as the root mean square difference from the finger measurement). The photoplethysmogram (PPG) from the finger was compared to the wrist and the wrist was found to produce on average 15.2 times lower percent modulation. An example PPG is shown in Figure 2 where the wrist signal modulation is approximately 15 times lower than the finger.

Conclusions: The wrist is a low perfused location and the optical physiological signals are weak when using spectral bands common for pulse oximetry. The lower modulation of the PPG on the wrist indicates a lower level of perfusion relative to the finger and the likely cause for difficult integration of pulse oximetry into a wearable. Noise, such as motion, can easily interfere with weak physiological signals and presents significant technical challenges for accurate pulse oximetry at the wrist. However, our early-stage results are promising and indicate that by utilizing a high-quality oximetry system and controlling for motion, physiological parameters (heart rate and SpO_2) measured on the wrist closely matched measurements on the finger (where the signal was 15x greater).

Figure1. Prototype wrist-worn sensor

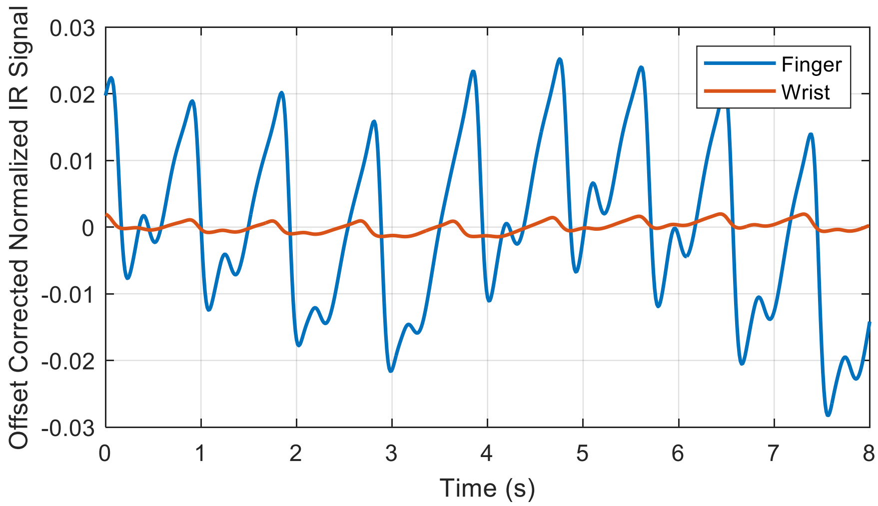

Figure 2 Offset corrected and normalized IR signals from the wrist, blue solid line, and finger, red solid line.

References:

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[3] Z. Zhang and R. Khatami, "Can we trust the oxygen saturation measured by consumer smartwatches?," *Lancet Respir. Med.*, vol. 10, no. 5, pp. e47–e48, May 2022, doi: 10.1016/S2213-2600(22)00103-5.