Advanced Engineering Applications
WSD525/WSP025

Loughborough University

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Optical measurement 1: Opto-physiological monitoring

DAV1.027
2:00pm - 4:00pm, 1st Mar 2020
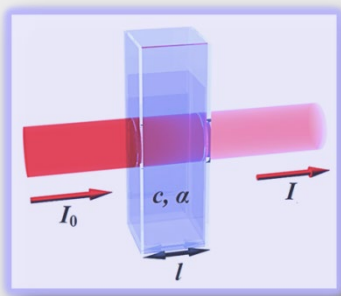
Background

- Opto-physiological monitoring (OPM)

  Based upon the principle of opto-physiological interaction to monitor physiological changes optically.

- Photoplethysmography (PPG)
  An optically obtained plethysmogram, a volumetric measurement of an organ.

- Revised Lambert-Beer law to determine the measurement.

$$I_o = I_i \cdot exp\left(-\mu_{a,s}L_s\right) \cdot exp\left(-\mu_{a,a}L_a\right)$$

I_o: transmitted light $\mu_{a,s}$: absorption coefficient of static component of tissue

I_i: incident light $\mu_{a,a}$: absorption coefficient of arterial blood

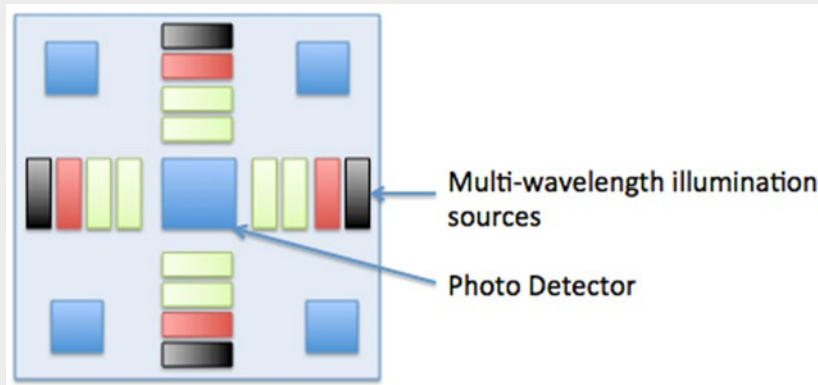L_s: optical path length of static component
L_a: optical path length of arterial blood

Background: OPM System

Carelight Sensor — RS232 cable — DISCO4 Box — USB cable — PC/LabVIEW
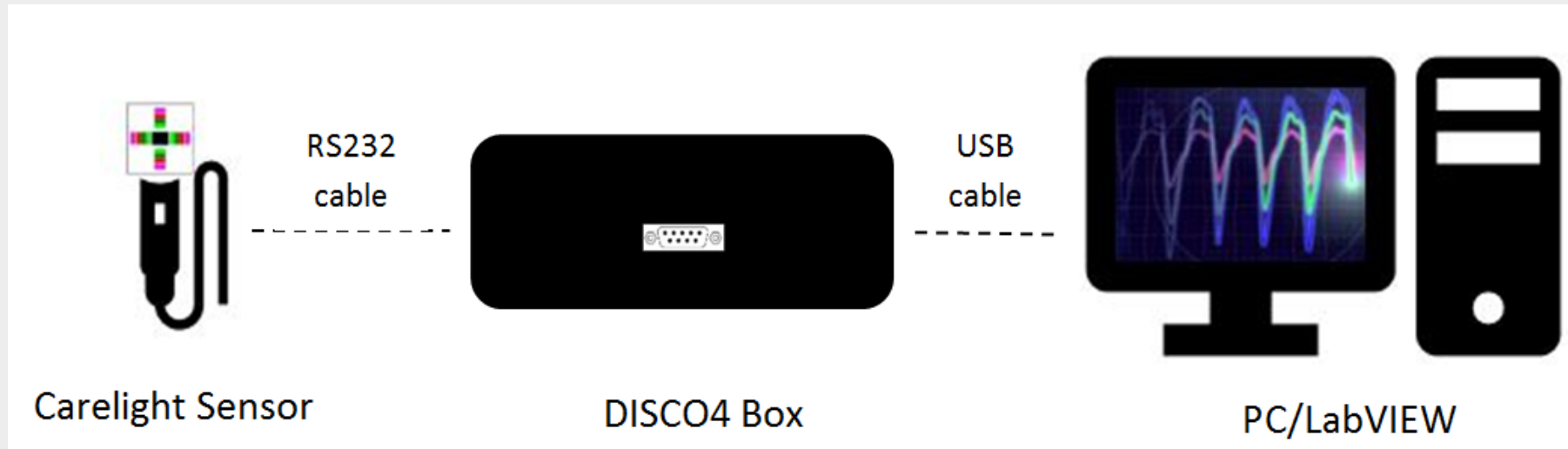
Background: Opto-Electronic Patch sensor

Multi-wavelength illumination sources

Photo Detector

Aims

- To understand the principles of Opto-physiological monitoring and associated monitoring skills through the measurement setting-up.

- To process PPG signals then display these critical physiological parameters with proper algorithms.

Learning Objectives

- Explain the principle of the opto-physiological monitoring

- Explain how to proper manage opto-electronics sensor system, i.e. sensor, Labview based operation package (programme), data acquisitions.

- Explain and implement the procedures of opto-physiological monitoring to acquire and collect raw data on a real-time monitoring platform (namely Carelight).

- Practice the measurement procedures to produce real-time physiological parameters, i.e. Heart rate, Respiration rate, Oxygen saturation (SpO2).

Procedures

1. Read the guideline of Opto-physiological Monitoring Setting-up.
2. Two persons as a group to prepare the measurements.
3. The other groups to observe the measurements.
4. Individually collecting 30 second measurement dataset.
5. Collect raw data from the PC
6. Further analysis via. Matlab based signal processing in the following session.

Anticipated outcomes
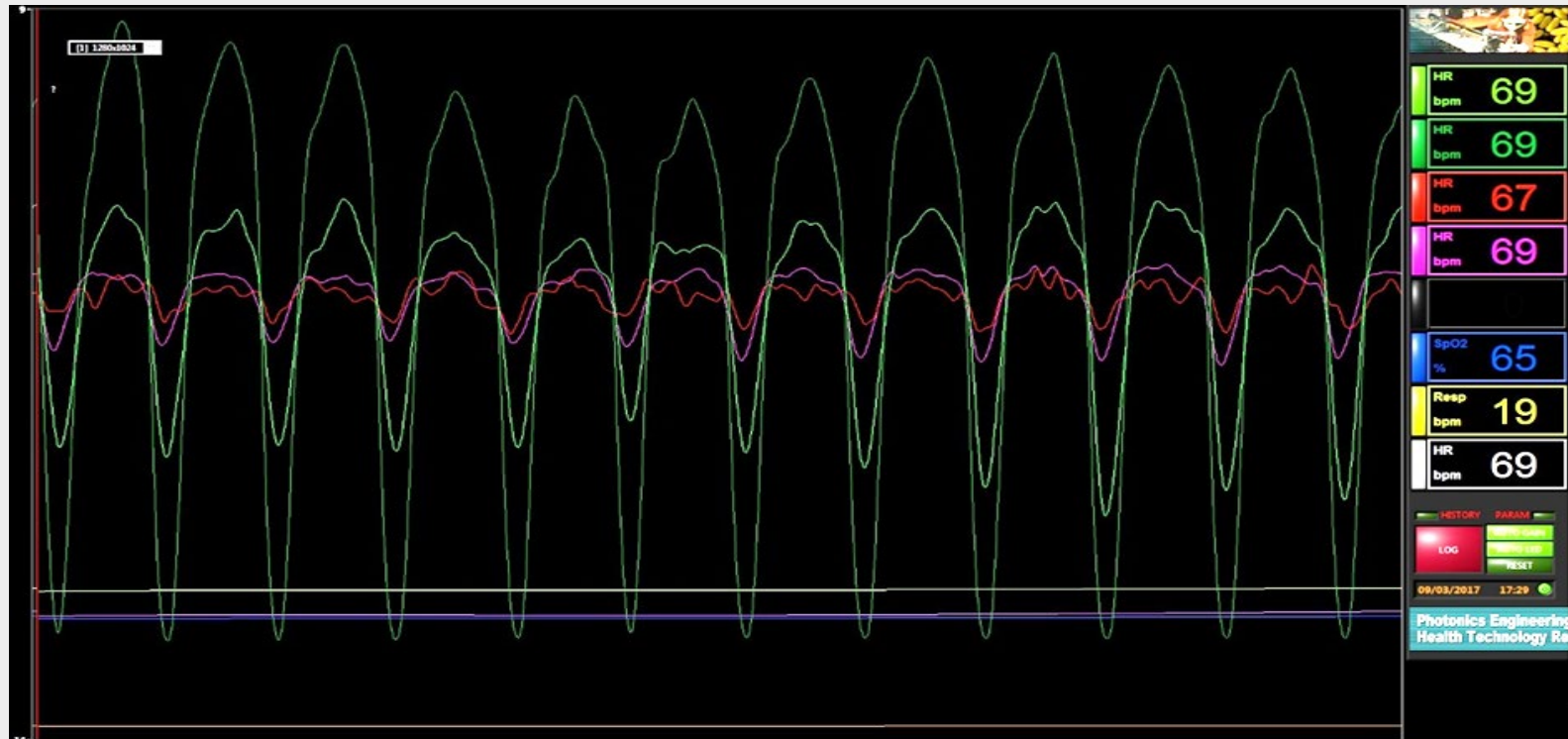
The illumination sources:
1. Light Green: green (525 nm)
2. Green: orange (595 nm)
3. Red: red (650 nm)
4. Pink: IR (870 nm or 905nm)

Questions:

- What is the principle of opto-physiological measurement?

- What are two key components of opto-electronic sensor consisted of photoplethysmography?

- If ask you to design a new smartwatch for opto-physiological monitoring, what do you do? Why?

References

1. Techmann, D; Matteis, D; Bartelt, T; Walter, M; Leonhardt, S. "A Bendable and Wearable Cardiorespiratory Monitoring device Fusing Two Noncontact Sensor Principles" IEEE, J. Biomed Health Inform Heal Inf, Vol. 19 2015, pp 784-793.

2. Alzahrani, A. Hu, S.*, Azorin-Peris, V. "A Multi-Channel Opto-Electronic Sensor to Accurately Monitor Heart Rate against Motion Artefact during Exercise", Sensors 2015, 15, 25681-25702;

3. Hu, S., Azorin-Peris, V. "Opto-physiological sensor and method", Granted Patent, GB2524919, 09.12.2015

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