Loughborough University Opto-physiological Monitoring

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Photoplethysmography (PPG) is an optical bio-monitoring technique that non-invasively measures blood volume changes *in-vivo*. Among its applications, pulse oximetry—the determination of arterial oxygen saturation—is the most widespread thanks to its ability to alert the clinician of the presence of hypoxemia in real time. However, the use of oversimplified PPG models to describe and implement the technology has limited its applicability. Moreover the principles of operation of current contact PPG is typically described based on the Beer-Lambert law, where the measuring site is treated as a blood-filled cuvette with no scattering effects and the light sources are assumed to be monochromatic.

With the increasing availability and accuracy of tissue optical properties in literature, the use of numerical solutions of light propagation in human tissue are providing increasingly valuable insights into such mechanisms. The researchers at Loughborough have been attempting to: 1) consider biological tissue as a set of optical media, 2) study how light interacts with biological tissue, 3) explain optical and physiological phenomena that govern diffused optical bio-monitoring techniques, and 4) finally construct opto-physiological models to describe blood perfusion in a biological tissue structure with pulsatile blood flow.

The research activities have included both Monte Carlo simulations and empirical validation through a multi-layer tissue phantom. The approach to opto-physiological modelling relies on a process of fine-tuning the accuracy of characterization for pulse oximetry and imaging PPG. The propriety opto-physiological model with light propagation in tissue contributes towards achieving blood perfusion segmentation in order to attain balance between accuracy and applicability. Hence, opto-physiological monitoring brings a new insight in biomedical photonics engineering research.