Master in Photonics – "PHOTONICS BCN"
Master ERASMUS Mundus "EuroPhotonics"

MASTER THESIS PROPOSAL

Dates: April 2021 - September 2022

Laboratory: Medical Optics
Institution: ICFO – The Institute of Photonic Sciences
City, Country: Castelldefels, Spain

Title of the master thesis: Pulsatility assessment of diffuse correlation spectroscopy/ time resolved spectroscopy measurements in human subjects

Name of the master thesis supervisor and co-supervisor:
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Keywords: biophotonics, spectroscopy, blood flow, pulsatility.

Summary of the subject (maximum 1 page):

Cerebral blood flow (CBF) is an important factor that maintains brain function, and prolonged deficiency causes degeneration and irreversible damage. In normal conditions CBF is under physiological control to ensure an adequate oxygen delivery to the brain, however cerebral autoregulation is often impaired in patients who suffer from stroke, edema, traumatic brain injury or under the effects of anesthesia or mechanical ventilation. When cerebral autoregulation is impaired, there is risk for injury from low or high perfusion and there are many conditions and disabilities that can occur as a result from abnormal CBF. Hence cerebral blood flow monitoring is critical and carried out routinely in clinical settings. There are some noninvasive techniques based on near-infrared diffuse optics that have been developed in the last decades.

ICFO-Medical Optics group has developed techniques for continuous noninvasive measurements such as Diffuse Correlation Spectroscopy (DCS) and Time Resolved Spectroscopy (TRS). These devices deliver laser light and detect the diffuse photons in order to calculate the laser speckle statistics. These statistics are then analyzed by a physical model of photon propagation in tissues to quantify parameters such as microvascular blood flow. DCS is combined with TRS which allows higher precision in the acquisition of the blood flow index, by fixing parameters such as reduced scattering and absorption coefficient in DCS fitting procedure. It allows to simultaneously obtain tissue optical properties and autocorrelation function to quantify blood flow index. When using more than one wavelength it also allows to determine oxy and deoxy hemoglobin concentrations, which gives us information about tissue metabolism.

Recently, due to the advancements in DCS technology, measurements with temporal resolution higher than 25Hz can be done, allowing to resolve the pulsatile behavior of blood flow due to the cardiac cycle. Fast (CBF) measurements can enable new applications for DCS, with new potential biomarkers related to the pulsatile signal, such as critical closing pressure CrCP[1], intracranial pressure ICP[2], pulsatility index PI and autoregulatory parameters[3]. One of these potential biomarkers that considers blood flow variability is Gosling Pulsatility Index, calculated as the difference between systolic and diastolic flow velocities divided by the mean velocity. Initially it was defined in Transcranial Doppler Ultrasound to describe the pulsatility of TCD waveforms, and now DCS is an alternative noninvasive approach for pulsatility monitoring.

To realize the clinical potential of DCS pulsatility monitoring, a better understanding of the influences on the measurements is needed in order to estimate pulsatility in a precise manner. In this project we plan to measure human subjects using a DCS+TRS device, analyse and compare these pulsatile signals.

Additional information (if needed):

* Required skills :
* Miscellaneous :

[1]Baker et al. Journal of Cerebral Blood Flow & Metabolism 37 (8). (2017)
[2]Fischer et. al. Journal of Neurotrauma 37. 23. (2020)
Ruesch et al. BOEx 11. 3. (2020)
[3]Parthasarathy et al. Journal of Cerebral Blood Flow & Metabolism 38 (2). (2018)