MASTER IN PHOTONICS – PHOTONICS BCN
EUROPHOTONICS-POESII MASTER COURSE

PROPOSAL FOR A MASTER THESIS

Dates: 2019

Laboratory: Center for Sensors, Instruments and Systems Development (CD6)
Institution: Universitat Politècnica de Catalunya
City, Country: Terrassa

Title of the master thesis: Optical coherence tomography data acquisition and postprocessing

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Summary of the subject:
Optical coherence tomography (OCT) is an imaging technique that relies in the use of partially coherent interferometry. After its invention around 25 years ago it was first mostly exploited by the field of Ophthalmology, since it provided in vivo non-invasive images of the structures of the eye with unprecedented axial resolution and penetration depth, but later on extended to other biomedical and industrial applications. At CD6 we have developed a custom swept-source OCT (SS-OCT), which is the latest generation of classical OCT systems, featuring an advantage in speed and image depth range in comparison with other OCT implementations.

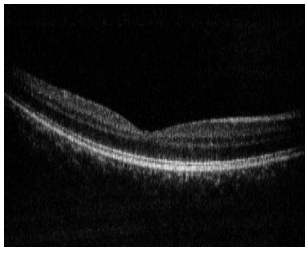
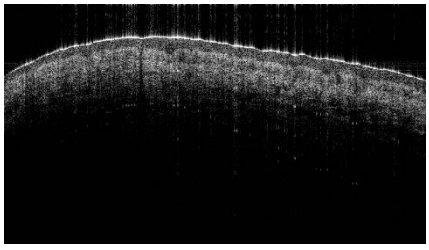
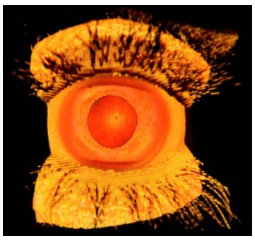

Fig. 1 Examples OCT images acquired with our system. From left to right: in vivo human retina centred at the fovea, hand skin, volume rendering of the anterior segment of the eye.

The raw signals produced by the SS-OCT are spectral interferograms that are acquired and further processed to generate axial scans of the sample, which are then used to generate 2D and 3D reconstructions. Your master project will deal with the data acquisition and processing steps of the signal. You will go through the existing libraries already developed for the system and your goal will be to optimise some of the steps of this process to improve: 1) image quality and 2) speed performance.

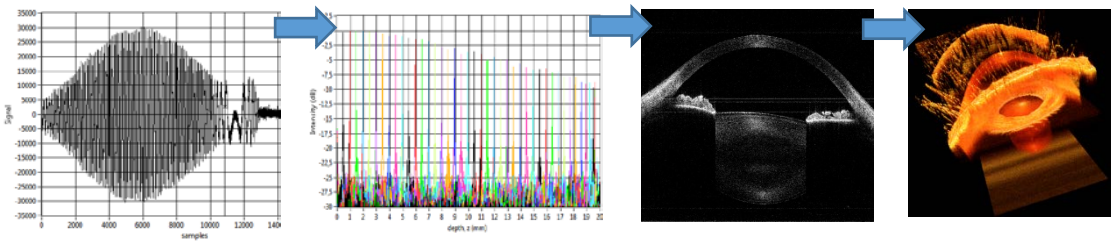

Fig. 2 Typical data processing in SS-OCT from the raw data.

More specifically you will handle typical problems in the postprocessing of SS-OCT that have a great impact on image quality, such as wavenumber calibration, numerical dispersion compensation, fixed-pattern image artefact removal...[1] [2]. Moreover, some OCT systems require very fast data processing, even real time, as it can be the case in intraoperative OCT. In this line, you will seek solutions to improve the speed performance of the system and you will compare the software postprocessing with the implemented in the dedicated FPGA.

Keywords: optical coherence tomography, OCT, biomedical photonics, signal processing

Additional information:

* Required skills: Self-motivated, objective-driven, capable of autonomous working within a multidisciplinary team. Basic concepts in Signal Processing and Image segmentation and MATLAB/Labview knowledge will be considered, but are not essential.

*Do you want more information? Check the references below or contact us!

[1] Wojtkowski, M., Srinivasan, V. J., Ko, T. H., Fujimoto, J. G., Kowalczyk, A., & Duker, J. S. (2004). Ultrahigh-resolution, high-speed, Fourier domain optical coherence tomography and methods for dispersion compensation. *Optics Express*, *12*(11), 2404. https://doi.org/10.1364/OPEX.12.002404

[2] Klein, T., & Huber, R. (2017). High-speed OCT ight sources and systems [Invited]. *Biomedical Optics Express*, *8*(2), 828. https://doi.org/10.1364/BOE.8.000828

[3] Wojtkowski, M. (2010). High-speed optical coherence tomography: basics and applications. *Applied Optics*, *49*(16), D30–D61. https://doi.org/10.1364/AO.49.000D30