Internship project: Measuring hydration with a triple OCT system

Supervisor: Xavier Attendu & Ton van Leeuwen

Contact: x.a.attendu@amsterdamumc.nl

Affiliation: Amsterdam UMC

1 Background information

Optical coherence tomography (OCT) is an advanced interferometric technique that enables high-speed, microscopic, cross-sectional imaging of biological tissues [1, 2], as illustrated in Fig. 1. This figure highlights OCT's ability to resolve subsurface structures, providing clinicians with non-invasive insights into the presence or absence of pathological tissue. Beyond its high-resolution imaging capabilities, OCT also facilitates quantitative analysis of the optical properties of samples, offering valuable insights into their biological status [3]. One critical property is hydration, or the measurement of water content, which is essential for maintaining cellular function, regulating body temperature, and ensuring overall health. Dehydration can lead to severe complications, including kidney failure and shock. Traditional methods for measuring hydration levels, such as blood tests, urine analysis, and bioelectrical impedance analysis, can be invasive or imprecise. Our group is pioneering a novel approach to accurately quantify tissue water content using multiple OCT systems [4].

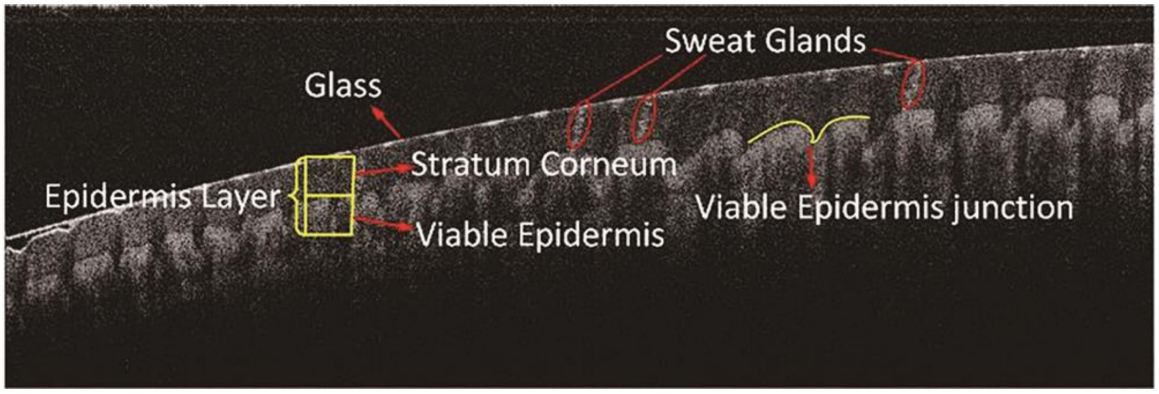

Figure 1: Cross-sectional OCT image of a human finger. Several skin layers are clearly visible as well as sweat glands. Image reproduced from [5]

.

2 Proposed Work

In this project, the student will experimentally validate the theoretical model for our novel OCT-based hydration measurement system. They will develop a rigorous measurement protocol to ensure accuracy and repeatability in the data collection process. Additionally, the student will investigate the system's ability to extract crucial physical parameters from the measurements, including diffusion coefficient, scattering coefficient, water content, and particle size distribution. This comprehensive analysis will contribute to the refinement of the OCT system, enhancing its potential for precise, non-invasive assessment of tissue hydration and other critical optical properties in clinical settings.

3 Requirements & learning outcome

We are looking for a highly motivated Bachelors/Masters student with a solid background in physics and engineering, and a passion for hands-on experimental work. Some experience in programming (Matlab, Python, etc.) is essential for data analysis. Through this internship, the student will gain a in-depth knowledge into the field of optical coherence tomography, spectroscopy and general optics. They will develop valuable, highly transferable skills in modelling, experimental design, and data analysis. Additionally, they will also enhance their abilities in collaboration, scientific writing, and presenting. This internship, expected to last six to nine months (with flexibility to accommodate student needs), offers an exceptional opportunity to contribute to advancements in medical diagnostics at the forefront of the field.

References

[1] W. Drexler and J. G. Fujimoto, *Optical coherence tomography: technology and applications*. Springer Science & Business Media, 2008.

[2] W. Drexler, M. Liu, A. Kumar, T. Kamali, A. Unterhuber, and R. A. Leitgeb, "Optical coherence tomography today: speed, contrast, and multimodality," *Journal of biomedical optics*, vol. 19, no. 7, pp. 071412–071412, 2014.

[3] P. Gong, M. Almasian, G. Van Soest, D. M. De Bruin, T. G. Van Leeuwen, D. D. Sampson, and D. J. Faber, "Parametric imaging of attenuation by optical coherence tomography: review of models, methods, and clinical translation," *Journal of biomedical optics*, vol. 25, no. 4, pp. 040901–040901, 2020.

[4] L. B. Neubrand, T. G. van Leeuwen, and D. J. Faber, "Precision of attenuation coefficient measurements by optical coherence tomography," *Journal of biomedical optics*, vol. 27, no. 8, pp. 085001–085001, 2022.

[5] Q. Miao, H. Wang, Y. Yu, and Y. Zhang, "Application of optical coherence tomography in fingertip biometrics," *Laser & Optoelectronics Progress*, vol. 60, p. 0811012, 8 2023.