Internship project: Fighting skin cancer with widefield DRS (experimental validation)

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1 Background information

Skin cancer incidence is growing dramatically and threatening to overwhelm hospital care. In the Netherlands, 77000 patients are diagnosed yearly making it the most common cancer as well as the 4th most expensive one [1]. The good news is that skin cancer is highly treatable when caught early. However, current early diagnostic methods lack both sensitivity and specificity resulting in missed cancers as well as many false positive diagnoses. Cancer statistics show that 80% of patients suspected with skin cancer are in fact cancer-free and unnecessarily referred to dermatologists [2], while 20% of skin cancers are still only caught at advanced stages when they are much more difficult to treat [3]. Diffuse reflectance spectroscopy (DRS) has been shown to be effective at detecting and staging skin cancer [4]. However, it is a fiber-based, point measurement which makes it impractical for large area imaging. We propose to perform many DRS measurements simultaneously using a camera and projector and leveraging a concept from information theory called code-division multiplexing (CDM). CDM allows multiple measurements to be performed at the same time without cross-talk. Utilizing diffusion theory it is then possible to extract information about the optical properties of the sample from the measured reflectance signals. These optical properties can then, in turn, inform us on the health status of the biological tissue by assessing physiological properties such as perfusion, blood oxygenation or relative concentrations of various chromophores (e.g. fat, water etc, melanin, etc.).

2 Proposed work

While preliminary simulations indicate promising results, experimental validation of the proposed combination of Diffuse Reflectance Spectroscopy (DRS) and Coherent Diffuse Measurement (CDM) is necessary. This process involves several steps. First, optical phantoms—samples with known optical properties—must be fabricated [5]. The student will develop a precise manufacturing protocol for these phantoms based on existing literature. Next, the student will conduct conventional, fiber-based DRS measurements, comparing the experimental data to DRS theory and forward Monte Carlo simulations[6]. Finally, the student will utilize the proposed widefield DRS system for measurements and compare these results to point-measurements obtained with the conventional DRS system. This comparison will validate the CDM approach and evaluate the signal-to-noise ratio of the new widefield system.

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 experimental work. Experience in Matlab programming is essential as our current MCX scripts are in this language. Through this internship, the student will gain a in-depth knowledge into the field of optics, including specific subjects such as light transport, Monte Carlo methods, and spectroscopy. Moreover, they will develop valuable, highly transferable skills in modelling, experimental design, and data analysis. 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

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