

1. PHD PROJECT DESCRIPTION (4000 characters max., including the aims and work plan)

Project title:

Multi-parametric optical coherence elastography for intraoperative cancer detection

1.1. Project goals

The main goals of the project are outlined below. It is anticipated that achieving the goals will lead to the PhD student publishing three first-authored journal publications, as well as several co-authored papers.

Project goals:

- Develop novel methodology in optical coherence elastography (OCE).
- Implement feasibility studies of OCE in human tissue.

1.2. Outline

- Develop novel methodology in OCE. Specifically, the development of acquisition methods and processing algorithms to generate three-dimensional images with contrast based on one or more of nonlinear elasticity, viscoelasticity and poroelasticity. Initially, in the laboratory, the PhD candidate will implement the new methodology on tissue phantoms, before progressing to tissue scanning.
- Implement feasibility studies of OCE in human tissue specimens containing one or more of the following cancers: Breast cancer, prostate cancer, head and neck cancer and colorectal cancer. It is anticipated that at least two feasibility studies will be implemented in collaboration with the Oncology Center in Bydgoszcz. Bioethics approval has been granted for these studies.

1.3. Work plan

A Gantt chart outlining the work plan for the project is provided below, where year is represented by Y and semester is indicated by S:

Task	Y1,	Y1,	Y2,	Y2,	Y3,	Y3,	Y4,	Y4,
	S1	S2	S1	S2	S1	S2	S1	S2
1-Reading background literature, developing experimental skills, learning signal processing techniques.								
2-Developing more detailed research plan.								
3-Implementation of poroelastic OCE								
4-Implementation of viscoelastic OCE								
5-Implementation of Clinical Feasibility Study 1								
6-Implementation of Clinical Feasibility Study 2								

1.4. Literature (max. 10 listed, as a suggestion for a PhD candidate)

- 1) P. Gong, *et al.*, "Quantitative micro-elastography enables *in vivo* detection of residual cancer in the surgical cavity during breast-conserving surgery", *Cancer Research*, 2022.
- 2) J. Li, *et al.*, "Analysis of strain estimation methods in phase-sensitive compression optical coherence elastography", *Biomedical Optics Express*, 2022.
- 3) K. M. Kennedy, *et al.*, "Diagnostic Accuracy of Quantitative Micro-Elastography for Margin Assessment in Breast-Conserving Surgery", *Cancer Research*, 2020.
- 4) W. M. Allen, *et al.*, "Optical palpation for the visualization of tumor in human breast tissue", *Journal of Biophotonics*, 2019.
- 5) B. F. Kennedy, *et al.*, "The emergence of optical elastography in biomedicine", *Nature Photonics*, 2017.
- 6) E. V. Gubarkova, *et al.*, "OCT-elastography-based optical biopsy for breast cancer delineation and express assessment of morphological/molecular subtypes", *Biomed Opt Express* 2019.
- 7) A. A. Plekhanov, *et al.*, "Histological validation of *in vivo* assessment of cancer tissue inhomogeneity and automated morphological segmentation enabled by optical coherence elastography," *Sci. Rep.*, 2020.

- 8) A. L. Matveyev, et al., "Vector method for strain estimation in phase-sensitive optical coherence elastography," *Laser Phys. Lett.*, 2018.
- 9) Li, C., *et al.*, "Detection and characterisation of biopsy tissue using quantitative optical coherence elastography (OCE) in men with suspected prostate cancer," 2015.
- 10) Yuting, *et al.*, "Microscale characterization of prostate biopsies tissues using optical coherence elastography and second harmonic generation imaging," *Lab. Invest.*, 2018.

1.5. Required initial knowledge and skills of the PhD candidate

The main initial knowledge and skills required are a background in physics and, more specifically, some experience and knowledge in optical physics and optical imaging.

1.6. Expected development of the PhD candidate's knowledge and skills

It is expected that the PhD candidate will develop the following main skills during the PhD:

- The capacity to plan, implement and critically analyse novel experimental methodology related to OCE.
- The capacity to create, implement and modify algorithms required in the implementation of novel methodology in OCE.
- The capacity to independently carry out clinical studies using OCE, with guidance from the supervisory team.
- The capacity to clearly communicate research ideas and results in English, both in written and oral formats. Particular emphasis will be placed on writing journal papers and delivering conference presentations.