1. Abstract in English

Observation of changes in biological tissues allows evaluating the patient's health condition and also helps both in diagnosing and monitoring the progress of treatment of modern civilization diseases such as diabetic retinopathy, hypertension, glaucoma and cancer. These diseases reduce the patient's standard of living, and in their advanced stages prevent normal functioning and professional work.

Physicians are ready to test new methods for diagnosis, monitoring, and treatment of lifestyle diseases that are non-invasive and easy to implement in a clinic. A promising method is optical coherence tomography (OCT), a non-invasive method currently used in clinics for three-dimensional visualization of biological objects transparent to light. In this method, infrared or visible light is directed at the examined biological object. Part of the light is reflected by anatomical layers of tissue and can be registered by a detector and transformed into an image.

The OCT method has much greater diagnostic potential than visualization of structure based on the scattering properties of biological tissue. Tissues in living organisms are active, and optical methods allow us to monitor the physiological or pathological functioning of these tissues. Hence the name "functional testing", which includes phase-based data analysis methods.

The objective of the research proposed in this project is to develop methods for phase analysis of OCT signal allowing quantitative studies of selected physical parameters of tissues for medical diagnostic purposes.

In my work, I have demonstrated selected applications of these methods in Doppler OCT (used for quantification of blood flow in living tissues), OCT elastography (used for quantification of elastic properties of tissues) and optoretinography (used for quantification of the changes in nerve cell retinal layers in response to light stimulus). I focused on several problems associated with phase analysis: time required for data processing and memory requirements, limited range of measurable axial displacements, obtaining displacement information only in the beam axis, influence of object geometry on the measurement, motion artifacts unavoidable in a few-second measurement, phase artifacts resulting from combined analysis of OCT data. I have proposed methods for analysis of phase of OCT signal obtained with widely available spectral OCT systems, which would allow application of new methods with the use of already existing devices. The methods proposed in this thesis allow to reduce phase artifacts and make it possible to obtain reliable results. Experimental results were confirmed by simulations, experiments on real biological data *ex vivo* and *in vivo*. I have designed, optimized and implemented a phase unwrapping algorithm on graphics card processors to speed up computation time.

06-04-2022 Ewelina Pijewska

The projects presented in my dissertation are part of a broad research effort to develop phased methods and increase the functionality of OCT devices, which may in the future help develop bi-omarkers and accelerate the diagnosis of selected civilization diseases.

06-04-2022 Ewelina Pijewska