BLENDING OF AMPLITUDE AND PHASE APPROACHES TO EVALUATION OF DEFORMATIONS IN SOFT BIOLOGICAL TISSUES USING OPTICAL COHERENCE ELASTOGRAPHY

Anton Yu. Potlov, Sergey V. Frolov
Russia, Tambov State Technical University, Department of Biomedical Engineering
E-mail: zerner@yandex.ru

Amplitude and phase approaches to optical coherence elastography (OCE) have their advantages and disadvantages. The main advantage of amplitude approaches is a direct analogy with the correlation methods of displaced structures searching, that are quite popular in ultrasonic elastography. The main disadvantage is the rather low quality of the obtained elastograms, caused by speckle noises. The main advantage of phase approaches is a high sensitivity to structural displacements (especially in case calculation of interframe phase difference) even under relatively weak deforming effects. The main problem is the low resistance of measurements to volumetric displacements of the probe and the tissue under study relative to each other. Even a linear, but not tracked and not compensated displacement of the scanning probe along the tissue under study by only a few tens of microns slurred over the graphs of the dependence of the phase change on depth. In this regard, it is proposed to combine the amplitude and phase approaches.

The proposed method includes: I) generation of a series of sequential structural images based on the lengths of the vectors (amplitudes) of the complex OCE-signals; II) construction of a topological skeleton for each «amplitude image»; III) setting of test points on each topological skeleton; IV) grouping of test points for a set of structural images built only on the basis of amplitude information; V) estimation of vector values of displacements of large segments on a series of analyzed images; VI) evaluation of longitudinal and transverse displacements for the above large segments; VII) selection of the most convenient images for subsequent analysis; VIII) reassembly (for compensating volumetric displacements) of the original complex raw data corresponding to the above most convenient images; IX) Classical OCE based on analysis of phase shifts, but for reassembled raw data.

The proposed method was practically implemented by using the LabVIEW software package. A series of laboratory experiments showed an increase in the reliability of the obtained elastograms by more than 25% in situations where the biological object and the scanning probe are not rigidly fixed.

The study was made by financial support of the Council for Grants of the President of the Russian Federation (project «MK-231.2022.4»).