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Localization and image reconstruction of inclusions embedded in biological tissue (turbid media) by means of adaptive optical system

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Abstract content
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Localization of alien inclusions embedded in near-surface layers of tissue and noninvasive parameter reconstruction of biological tissue structure elements in the normal and in the diseased state are important biological and medical tasks. Information about the light-scattering and absorption properties of tissue is necessary for both diagnostic and therapeutic methods, such as laser-induced fluorescence to diagnose malignant tissue and laser-induced hyperthermia and photodynamic therapy to treat diseased biological tissue.

The aim of this work is image reconstruction of inclusions, embedded in turbid media. To improve image quality we used well known effect called «coherent backscattering». This effect is the sharp increase of backscattered light intensity in the opposite direction to the incident beam and is observed, when coherent light propagates through turbid media. Therefore, since the backscattered light is still coherent, we can consider its phase (or, to be more precise – some averaged phase) and thus we can use adaptive optical system to detect and recognize the investigated object.

In our experiments we used adaptive optical system that consists of bimorph deformable mirror and Shack-Hartmann wavefront sensor. The principle of its work is the following: the turbid media is radiated with collimated laser beam. Some part of the light is absorbed, other part is scattered in all directions, including the reverse. Then we measured the current phase distribution of the backscattered light by means of wavefront sensor. And after this, according to the phase distribution information, we applied phase conjugation algorithm to compensate for existing wavefront aberrations using deformable mirror.

The use of adaptive optical system together with image reconstruction applying Wiener filter resulted in almost ten time increase of the measure of image sharpness.

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