Functional organization of eye-processor optical-electronic tomograph for breast tissue visualization

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Abstract – **We consider the principle of the optical-electronic polarization tomography with pulse-modulation exposure and eye-processor image reconstruction for breast tissue visualization.**

Keywords – **optical tomograph, polarization, eye-processor image handling, image reconstruction**.

I. INTRODUCTION

Diffuse optical tomography (DOT) is a promising method of imaging the internal breast tissue structure, which allows infrared (700-900 nm) probing with 8.10 cm penetration depth [1]. ODT imaging techniques spatial distribution implements through solving the inverse aim (reconstruction aim) which creates the prospect of breast tissue pathologies accurate diagnosis. The main DOT problem is the low spatial resolution due to multiple scattering of photons, which have no regular trajectories and widespread throughout the studied volume. Developed diffusion tomogram algorithms have relatively high resolution (0.5 cm), but they are not as fast as required for real time diagnosis. This paper objective is to improve the tomograph spatial resolution and to increase its informativty and processing speed for breast tissue pathology visualization using polarization-sensitive optical-electronic technologies for tomograph information-measuring parts combined with the principles of eye-processor image handling [2] used for internal object structure reconstruction algorithms.

II BASIC PRINCIPLES OF TOMOGRAPHY

Proposed optical-electronic tomograph scheme layout implements the principle of probing biological objects with ultra-short laser pulses (10^{-9}-10^{-10}s) [3], which are linearly polarized in order to increase the breast tissues radiation penetration depth and to improve the signal-noise ratio during separation of unscattered part of detected signal .

The scheme has three sources of probing radiation with different wavelengths (700-900 nm). Diode lasers or dye lasers are offered as those sources. Also, there is a space-time light modulator, a scrambler to destroy coherence and a light polarizer. They all form molding channel of linearly polarized light. Formed radiation goes through optical connector, and polarization-sensitive fiber and comes to a cylindrical lens entrance, which converts the light beam in a line. With that line the scanning of biological objects surface is performed. A part of each wavelength radiation is absorbed by the object, and the rest is recorded by ruler of photodetectors, whose outputs are electrically connected to multichannel signal processing and image reconstruction system. This block performs image reconstruction based on the principles of eye-processor image handling [1]. The use of modified parallel algebraic methods creates an opportunity of real time (20 ms) image handling.

To get the image projection of biological objects it is necessary to change position of the light line during the vertical plane scan of biological object and respectively change the position of photodetector line, which receives radiation that passed through the biological object. This thing is reached due to specifically designed optical-mechanical unit, which also contains a glass plate for biological objects fixation, and is linked with stepping motors, which ensure the necessary mechanical movement of the emitter and the photodetectors.

There is an opportunity to set the analyzer in front of the photodetector ruler that allows analysis of anisotropic properties of biological objects. As a combination of layers there have been modified an optical model of plane-parallel inhomogeneous anisotropy sample of biological tissue each characterized by Muller matrix minor raster (3x3) [4] and a set of coordinate distribution of the linear amplitude and phase anisotropy $[\delta]_i$, $[\alpha]_i$, $[\theta]_i$, $[\varphi]_i$, $[p]_i$ and $[\Delta]_i$ parameters values.

III. CONCLUSIONS

Suggested principles of tomograph design will allow increasing the breast tissue probing depth through the use of polarization-sensitive optical-electronic components; increasing tomograph spatial resolution; a real time analysis using eye-processor image handling and will improve the informative indicators by determination of scattering, absorption and anisotropy coefficients of the breast tissue.

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