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FLUORESCENCE SPECTROSCOPY APPROACH WITH BLOOD INFLUENCE COMPENSATION

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ABSTRACT

At the moment, a number of optical spectroscopy methods have been applied in various fields of medical technology and medicine. Among them, fluorescence spectroscopy (FS) and diffuse reflectance spectroscopy (DRS) are quite widespread methods highly used in practice. The techniques allow for obtaining information on the thickness of the epidermis and dermis, blood content in tissue, the spatial distribution of chromophores and fluorophores within the skin and their relative concentrations, intensity of metabolic processes occurring in the skin. These methods complement each other, and their combined application makes it possible to obtain more information about the functional state of the tissue. One of the most important possibilities is the compensation of the absorption of the fluorescence radiation by blood in biological tissues, which does not allow accurate estimating of any biomarker content. As a result, it is necessary to normalize the resulting fluorescence spectrum in order to exclude this effect.

There are several methods developed to compensate for the effect of blood absorption on fluorescence spectra based on analytical models or reverse Monte Carlo simulations. However, these methods are characterized either by low accuracy or by a relatively long calculation time. For this reason, in this work, an approach is proposed for determining the blood content parameters of a biological tissue using the neural network fitting of the experimental diffuse reflection spectra. The training of the neural network has been done by use of the training set of diffuse reflection spectra simulated by Monte Carlo method.

For this aim, we used an experimental setup based on FLAME spectrometer (Ocean Optics, USA), 365 and 450 nm light sources for excitation, a broadband tungsten halogen source HL-2000 (Ocean Optics, USA), a fibre-optic probe that combines a fluorescence channel and diffuse reflection channel. The study consisted of obtaining fluorescence spectra and diffuse reflectance spectra of the palmar surface of distal phalanx of hand fingers before, during (artificial ischemia) and after (hyperemia) arterial occlusion test (the pressure reached 220 mm Hg). The neural network was previously trained on the model spectra obtained by Monte Carlo method. With the neural network, the blood content in the biological tissue was calculated from the diffuse

reflectance spectra. The obtained numerical parameters were used to correct the fluorescence spectra.

Based on the obtained results, it was concluded that the proposed approach for compensation of blood perfusion with the neural network is a fairly accurate and rapid method. The results are of particular interest for the further development of methods for compensating the influence of chromophores in optical spectroscopy.

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