MONTE CARLO SIMULATION OF OPTICAL RADIATION PROPAGATION IN LASER DOPPLER FLOWMETRY AND FLUORESCENCE SPECTROSCOPY CHANNELS OF A WEARABLE DIAGNOSTIC DEVICE

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New advances in laser physics and photonics have allowed one to create miniaturized implementations of laser Doppler flowmetry (LDF) and fluorescence spectroscopy (FS) methods that fit into a wearable monitor comparable in size to a wristwatch. While new technologies are becoming available to an ever-wider range of users, there is a need to examine the specifics of their operation.

The aim of the present study was to investigate the peculiarities of propagation of optical radiation of LDF and FS channels of a wearable diagnostic device in biological tissues based on Monte Carlo simulation.

When modelling the sampling volume, the peculiarities of the geometry of the emitting and recording parts of the device (size and beam profile of the light source, size and position of the detector, center-to-center separation between them) were taken into account. For this simulation the size of the input photon packets was chosen as 10^6 photons. The commonly used Henyey-Greenstein function was chosen as the scattering phase function. In the simulation, a four-layer skin model was used that included the *stratum corneum*, living epidermis, papillary dermis and reticular dermis. The simulation was carried out in TracePro software. For each of the technologies, the sampling volume was modelled for two skin types: glabrous and non-glabrous skin (the former covers the surface of the palms and soles of the feet; the latter covers almost the entire human body), characterized by different structural and functional features. For the LDF channel, the distribution of probing radiation in the biotissue was taken into account during modeling, and for the FS channel, the distribution of fluorescent radiation was additionally taken into account.

Simulation results showed that for both skin types in the LDF channel implemented using a VCSEL laser with radiation at a wavelength of 850 nm, the probed tissue volume reaches the reticular dermis, and the value of the diagnostic volume is about 3-4 mm^3. For the FS channel, which operates on the wavelength of 365 nm, the calculated diagnostic volume was 1.5 mm^3 for nonglabrous skin type and 4.5 mm^3 for glabrous skin, the probed tissue volume reaches from 30 to 70 % of the reticular dermis in each case.

The obtained results can be used to better understand and improve the quality of diagnostic information obtained by the wearable LDF and FS devices.