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HYPERSPECTRAL IMAGING TECHNIQUE FOR SKIN CHROMOPHORES AND BLOOD OXYGENATION ASSESSMENT

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ABSTRACT

Spectral images of skin and other tissues contain information about the spatial distribution and concentrations of biological chromophores, such as hemoglobin (oxy-/deoxy), melanin, bilirubin, and carotene. The combination of fast and compact hyperspectral camera with a broadband light illumination allows for multiparameter estimation of tissue properties. Potential applications of the proposed technique are of high social impact and include monitoring and diagnostics of diabetic ulcers formation, diagnosis of melanoma and other malignancies, quantitative skin screening, wound healing control, assistance and support of laser surgical procedures.
In this study, two-dimensional spatially resolved diffuse reflectance of human skin was acquired with the compact handheld hyperspectral snapshot camera. The camera is based on micro Fabry-Perot interferometer and has the spectral resolution of 6-10 nm (FWHM) in the spectral range of 500-900 nm. Laboratory developed broadband illumination unit is based on the fiber optic ring light guide providing the uniform distribution of light intensity in the camera focal plane and 50W halogen lamp as a source. Diffuse reflectance of the skin was measured with the spectral step of 2 nm from the area of 5x5 cm (1010x1010 pixels).
To retrieve the skin parameters from the measured diffuse reflectance spectra, the nonlinear regression algorithm for two-dimensional mapping of skin chromophores based on the solution of steady-state diffusion equation for two-layered turbid media was developed. Special attention was paid on the calculation efficiency of the algorithm. The variations in the content of blood, melanin, blood oxygen, blood hematocrit and water within the skin layers, as well as the parameters of the measurement setup are taken into account.
The developed hyperspectral imaging platform was used to perform the trial measurements and the occlusion tests with healthy volunteers. Finally, the two-dimensional maps of blood volume fraction, blood oxygen saturation and melanin content of the skin were obtained.

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