Advanced Approaches to Optical Imaging Data Processing

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ABSTRACT

The development of optical imaging methods is inextricably linked with the development of new image processing methods. Image analysis is a powerful tool in biology and medicine to collect qualitative and quantitative information in time and space. Because different optical imaging techniques can easily produce gigabytes of research data, accurate and automated analysis methods are the key to the successful interpretation of the information registered. Also, some methods, such as hyperspectral imaging (HSI), contain hundreds of spectral bands, and these data cannot be analysed by visual inspection, instead special algorithms must be developed to extract meaningful information from images. Other methods relate to the registration of dynamic processes, and time-frequency analysis of such signals can provide valuable additional information.

An artificial neural network (ANN) approach for analysing HSI data and continuous wavelet transform (CWT) for decomposing laser speckle contrast imaging (LSCI) signals will be presented here.

A compact, hand-held hyperspectral imaging system utilizing ANN-based processing for the reconstruction of 2D maps of blood volume fraction and skin blood oxygenation in the skin was developed [1]. For the training of ANN, the diffuse reflectance spectra of the skin for all possible combinations of the considered parameters were simulated by GPU-accelerated Monte Carlo technique. Examples of the system and algorithm capabilities are shown in Fig. 1. The developed approach was tested in clinical conditions and showed high sensitivity in detecting vascular complications of diabetes mellitus [2].

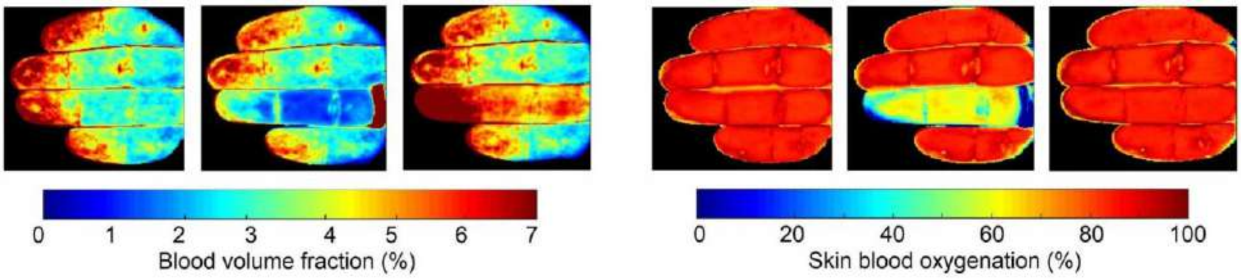

Figure 1: *Retrieved maps of blood volume fraction and skin blood oxygenation before, during, and 1 min after finger occlusion test.*

CWT expands the capabilities of the existing dynamic light scattering methods and can provide spatial mapping of blood flow oscillations (cardiac, respiratory, myogenic, etc.) [3]. Fig. 2 shows the application of LSCI for mapping the cerebral vessels of a laboratory animal, and presents the time-frequency processing of the registered signals. The proposed technology makes it possible not only to measure the relative cerebral blood flow of the cerebral cortex, but also to expand diagnostic capabilities for detailed analysis of the physiological mechanisms of changes in cerebral blood flow.

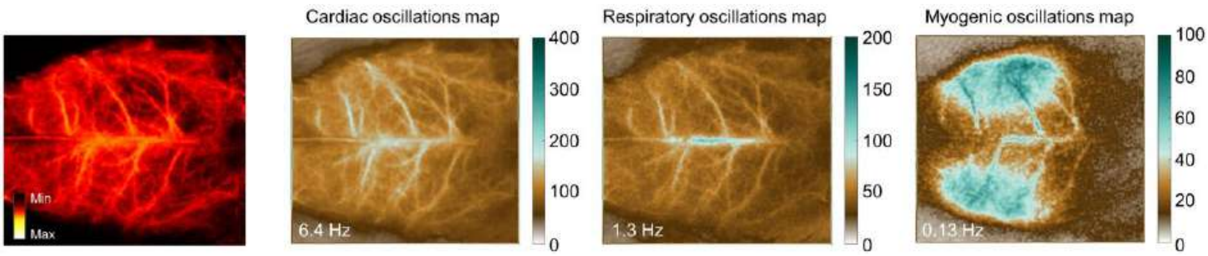

Figure 2: *LSCI image of the rat brain obtained transcranially and spatial variations in cardiac (6.4 Hz), respiratory (1.3 Hz), and myogenic (0.13 Hz) activity.*

REFERENCES

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