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Abstract

Computer methods in the analysis and processing of medical images

Computer methods of digital image processing and analysis have been developed for several decades and, along with the development of computing power, they find increasingly wider practical applications, including the field of medical image analysis and processing. This dissertation focuses on describing the algorithms for digital processing and analysis of medical images proposed by the author and showing the possibility of combining classical algorithms with algorithms based on artificial neural networks. Due to the dynamic development of methods based on deep learning, the last chapter of the dissertation presents the author's own view of the development directions in the field of digital image processing and analysis in the context of these changes.

The dissertation is divided into theoretical and experimental parts. The theoretical part focuses on presenting in a condensed form the theoretical basis of the algorithms used in the experimental part. The experimental part contains a description of the solution to three problems in the field of digital image processing and analysis proposed by the author of the thesis. The chapter "A multi-stage approach to the segmentation of noisy images using the example of micro-tomography images" presents a description of the algorithm for segmenting porous structures (polymer foam) from images obtained using the micro-tomography method. These types of materials are used, for example, in regenerative medicine to fill bone defects. The chapter is a summary of the author's work documented by three publications of which the author of the dissertation is the first author.

Chapter six "Segmentation of erythrocytes from optical microscope images with calculation the ratio of their height to width" presents a description of the algorithm for segmenting erythrocytes found in images obtained using an optical microscope. These types of algorithms are used to determine the number of erythrocytes in a blood sample and to determine their shape (including axis ratio). The use of an algorithm that automatically

determines these parameters significantly speeds up the analysis of such images. The chapter contains a description of the algorithm previously published in a publication of which the author of the thesis is the first author.

The chapter "Processing of atomic force microscopy images to visualize the surface of erythrocytes" describes an algorithm that processes atomic force microscopy images to highlight the surface structure of titanium dioxide-treated erythrocytes contained in these images. The description of the algorithm has not been previously published by the author of the dissertation. By visualizing the erythrocyte surface using the described algorithm, titanium dioxide was observed entering the cell. This observation correlates with the trend of limiting the use of titanium dioxide in the food and medical industries due to concerns about its potential genotoxicity.

The dissertation contains a chapter summarizing the described results of the presented algorithms and detailing the original elements of the work. The last chapter of the dissertation, "Considerations on the future and directions of development of image analysis and processing algorithms, including medical images", presents the author's view on the prospects for the development of the field of digital image processing and analysis in the context of the development of methods based on artificial neural networks. This is currently the leading trend in the development of this field, resulting among others, from the need to create general methods for solving complex problems instead of narrowly specialized ones or those requiring adjustment of parameters to the task, and thus less universal classical algorithms. The direction of development of the field envisaged in this thesis is the development of algorithms based on artificial neural networks, resulting in the creation of a very general model in the future, with an intermediate stage in the form of using a combination of models and classical algorithms specialized in particular tasks.