International Journal of Biological and Medical Science (IJBiMeS)
Vol. 1-No.1 (2016) pp. 13-15
http://ulakbim.dergipark.gov.tr/ijbimes

Research Article

Research of cells segmentation methods#

Bakhtiyar ISSIN[1*], Kazizat ISKAKOV[1] and Valery STAROVOITOV[2]

[1]L.N. Gumilyov Eurasian national university, Department of computer engineering, Astana-kazakhstan
[2]United Institute of Informatics Problems, National Academy of Sciences, Surganov str. 6, Minsk,
[2]University of Bialystok, Faculty of Economics and Informatics in Vilnius, Kalvariju str. 135, Vilnius, Lithuania

* Corresponding Author : issinbakhtiyar@gmail.com

Presented in "2nd International Conference on Computational and Experimental Science and Engineering (ICCESEN-2015)"

Keywords
segmentation,
medical images,
cells, object,
color,
algorithm,
interpretation,

Abstract: The research work deals with the development of methods of cells segmentation. Its purpose is the development of the algorithms permitting to allocate histologic objects on the image of a preparation, having kept geometrical and optical properties of the object. There is given the explanation of the need of classifying the objects for definition of the algorithm of segmentation, developing on the basis of methods the mathematical morphology of algorithms of segmentation of cellular structures at low and high optical magnification. There is presented the orientation of carrying out studies by methods of areas buildup, as well as the development of algorithms of cells definition on the binary image obtained as a result of threshold segmentation.

1. INTRODUCTION

Segmentation of visual information is a preliminary stage of any system of processing images. Segmentation should be considered as the initial stage of developing a formal description of a scene which quality of performance in many respects defines the success of solving the problem of recognition of images, interpretation and identification of visually observed objects.

Various methods and algorithms are developed for solving the problem of segmentation of images. The use of computer facilities and mathematical methods in this branch permits not only to accelerate the material processing, but also to increase the accuracy of the research results.

Automation of the analysis of histologic structures accelerates the diagnosis of a disease, permits to expand the borders of scientific searches in medicine. Automatic measurement of histologic objects parameters gives an opportunity to specify treatment and management of therapeutic processes. So, the most prospective method of early diagnosis of tumor diseases is automation of the cytophotometric analysis of specially prepared and painted histologic preparations and their division according to the norm – pathology principle. The majority of objects on histologic preparations are presented by faint images and are characterized by great variability of geometrical and optical characteristics, in this connection in the analysis of similar images there are certain difficulties. Therefore for selecting effective methods of segmentation there is needed an additional classification of these objects.

An important characteristic of cells in cross section is their topological structure therefore it is necessary to develop an algorithm of cells definition among the binary images obtained by the threshold segmentation. Probably such an algorithm will permit to modify the result having removed the objects which do not belong to cells.

The algorithm of cells segmentation by the method of areas buildup is focused on the processing of images with a complex background in which there change the brightness characteristics and there is a texture consisting of false objects and artifacts. The method of areas buildup is significantly slower than morphological segmentation but it permits to define objects even when the differences of the objects brightness levels are the same as in the background surrounding them. For performing segmentation of

histologic objects on color images there appears a need of developing the system of coordinates of describing the color for performing the operations of mathematical morphology on color images.

The purpose of the planned study is to develop algorithms of segmentation for definition of histologic objects on faint color and gray-scale images for solving the problems of diagnosis of diseases, treatment and management of therapeutic procedures.

The studies will be carried out in the field of images segmentation. Histologic objects on color and gray-scale images of preparations of optical microscopy will be the object of the studies.

As theoretical methods of the studies there will be used the methods of digital processing of signals and images, the mathematical analysis and mathematical modeling. For program realization of the developed algorithms there is a need of using the methods of developing program systems, methods of optimization of program complexes, programming in high-level languages.

The system of coordinates of describing the color specialized on the performance of operations of mathematical morphology on color images should be developed for improving the quality of the obtained results and increasing the speed of processing.

When using the algorithms of images segmentation of cellular structures the overall performance of the researcher shall increase and there will appear a possibility of obtaining better and more accurate results of measuring the characteristics of histologic objects. The use of the algorithms and program complexes in scientific and diagnostic processes will be economically efficient and will be introduced and used in educational, scientific and diagnostic processes.

2. TASKS AND METHODS

Histological images have two types of objects: membrane and nuclei. In addition two types of histological color markers are presented in such images. The one basic task of histological sample analysis is detection nuclei and membrane on image.

One of the most important characteristics of nuclear patterns in histological images is color. We realize a color modification of the normally brown diaminobenzidine (DAB) reaction. The colors ranged from purplish blue, dark blue/bluish black, to grayish-blue. Also extraction of brown component are realized: 1) it yields a distinct dark blue color that is easily distinguishable from brown DAB; 2) the blue reaction product is very stable

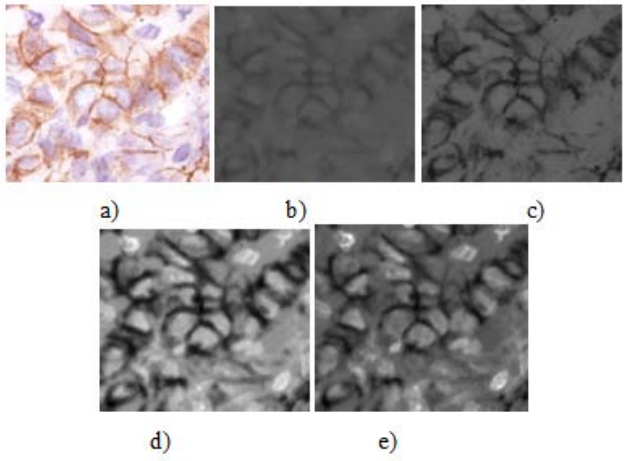

Figure.1 *Histological sample: a) normal color: b) DAB-Blue component; c) DAB-Brown Component; d) DAB-Color contrast; e) DAB-CD component.*

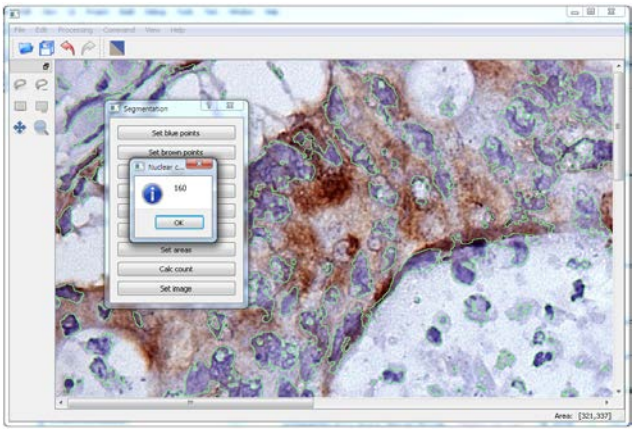

Figure. 2 *Screenshot of nuclear analysis module.*

throughout the entire staining procedure; and 3) background staining is minimal (see Fig.1).

There are many algorithms for extraction of nuclei by shape analysis. We realized a new algorithm that takes into account specifics of histological images after coloring processing and includes the shape correction by mathematical morphology. The result of merging binary patterns of cells and nucleus is multiphase images with pattern of structure that constructed from nuclei.

In many cases extraction of separate nuclei is very complex task. But tissue pattern collect many information about nuclei. In result, segmentation module and a module counting nuclei has been developed for complex histological images. Working with modules is semi-interactive. To separate the blue and brown components should indicate the appropriate area on the image with the mouse.

After that, the blue and brown components are circled by contours.

To count the number of cores should indicate the typical size of a nucleus to get rid of the noise effects, as well as to examine the case of agglomerated nuclei. After doing this work can be seen the result of segmentation, as well as the number of cores (Fig. 2).

The basic characteristic of objects in histological images is the colour of cells and nuclear membranes. The membrane is not just a passive skin. It is actually a fluid bilayer of lipids with hydrophilic ends on the outside. This membrane is thus active and is being penetrated by protein complexes that determine what substances are allowed in and what is allowed out. Also, the outer layer is occupied by glycoproteins that have attached sugars, and these act as a kind of finger-print of the cell, allowing it to be recognised by other cells and important compounds like hormones. Therefore, membranes pay an important role for controlling physiological process in tissue. Analysis of this structure is very important for pathology diagnoses.

The membrane pattern in a histology image is characterized by color, elongated shape and inhomogeneity body. For medical diagnosis, some analysis of physiological features of tissues and properties of membranes may be useful. There are some algorithms for membrane pattern extraction. Most simple membrane segmentation techniques are combinations of brightness segmentation and thinning. The task of the membrane pattern extraction from a color histological image is very important. Threshold-based approaches with the application of mathematical morphology allows a satisfactory result for the separation of homogeneous structure. The main drawback of these methods is the processing of a whole object, but not its boundary. We propose to use an image described in the new PHS color space where each pixel of the image has two main features: length of the color vector P and color value as an angle H. Both components of the color image may be investigated as a gray-scale image, and we can apply an algorithm of the gray-scale thinning for the P component of our color image description. Membrane is an elongated object. In our opinion the Zhang-Suen algorithm is optimal for thinning of elongated objects with small width. Different colored lines are defined as a single one complex line of a connected object with variable brightness. Our proposed new algorithm allows us to take best result. The developed algorithm has been applied for detection membrane pattern from a histological image. Practical verification has demonstrated that the algorithm allows one to obtain a high-quality skeleton in color image of the cell membrane. However, employment of the harmonic functions decelerates the process of the preparation of the image for processing. Therefore, subsequent refinement of the algorithm through the optimization of the coordinate transformation is possible.

3 CONCLUSIONS

In the theses there is considered the problem of developing methods of images segmentation of cellular structures. Its purpose is a scientific search for the algorithms permitting to allocate histologic objects on the image of a preparation having kept the necessary properties (geometrical and optical) of the object.

There is shown the need of developing algorithms of cells segmentation at low and high optical magnification, algorithms of images segmentation of cellular structures by methods of mathematical morphology and areas builup, as well as algorithms of definition of cells on the binary image obtained as a result of threshold segmentation.

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