MEASUREMENT OF INTERCELLULAR RELATIONS IN PERIPHERAL BLOOD ON THE BASIS OF HYBRID ALGORITHM

Tomakova R.A., Filist S.A., Rudakova E.V.

Sout-West State University, Kursk;
Kursk Institute of Social Education (Affiliate of Russian State Social University), Kursk, e-mail: e-mail: tomakova@rambler.ru

Segmentation of badly structured images is a complex task for different models of artificial intelligence systems. The given work presents algorithmic solutions for intercellular relations measurement in peripheral blood. There has been proposed hybrid algorithm, allowing to distinguish three classes of formed elements: «erythrocyte», «leukocyte» and «not erythrocyte and not leukocyte». Analysis of geometric attributes of image segments and their color characteristics is the basis of the algorithm. Different images, being got by use of morphologic operators «erosion» and «dilatation» to the initial image, are analysis in this article. The process of segmentation is carried out on black-and-white image by gradient method. Information technologies may be used in automated systems of haemotologic analysis.

Keywords: segmentation of images, neuronic nets, RGB-codes of pixels, morphologic operators «erosion», «dilatation»

General clinical analysis of blood forms the basis of all diagnostic methods. This analysis reflects organism response to the influence of different physiological and pathological factors. However, detection and classification of a great number of cells manually make this analysis long and laborious. That is why, the task of automation for carrying out general clinical blood analysis is topical.

In practice, while detecting formed blood elements one may be faced with the main obstacle – great variance of images. That is why, methods, based on both aspects of images segments geometric attributes and aspects of their color characteristics, are used to increase accuracy for determination of intercellular relations in smears of peripheral blood [1].

Hybrid algorithm for measurement of intercellular relations in peripheral blood, given in Figure, is proposed in this work. The algorithm has been realized according to two-level scheme and takes into account both color and geometric characteristics of formed elements.

The algorithm distinguishes three classes of formed elements: «erythrocyte», «leucocyte» and «not erythrocyte and not leucocyte».

Different images obtained by using morphological operators – «erosion» and «dilatation» – regarding original image are analysed at each algorithm level [2]. As a result of these two images segmentation we get two images hereinafter called as «image 1» and «image 2».

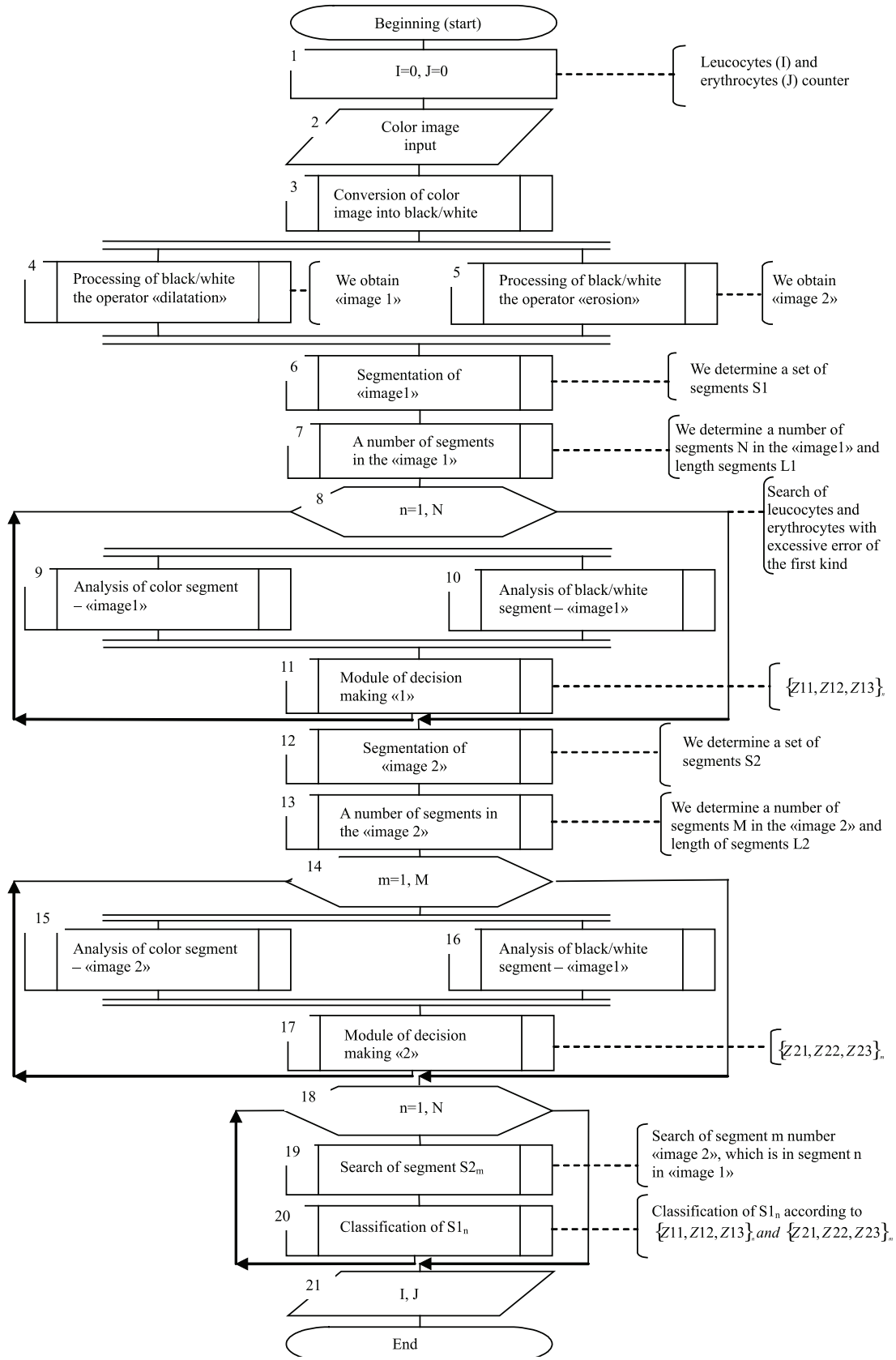
Three numbers $Z11$, $Z12$, $Z13$, being in the range 0…1 and characterizing belonging degree of the segment to one of the three distinguished classes, are set in conformity with each segment S_n of «image 1» at the first stage of image processing – blocs 4…11.

Analysis moduli of «image 1» of the first level – (blocs 9 and 10) – use two groups of decisive rules on the basis of which decision on belonging to classes «leucocyte», «not leucocyte», «erythrocyte», «not erythrocyte» is made here. The first group of decisive rules is based on the analysis of image color characteristics – (bloc 9). The second group of decisive rules realizes analysis of geometric structure of the formed element contour – (bloc 9). Two sets of four numbers corresponding to two groups of informative features: $\{X11, X12, X13, X14\}_n$ and $\{X21, X22, X23, X24\}_n$ determine belonging degree to these four classes of segment S_n.

Segments sets of input images are the object of analysis at the first and second algorithm levels. The process of segmentation is carried out on black-and-white image by gradient method. Then, distinguished segments are analyzed by two moduli at the first – (blocs 9…11) and second level – (blocs 14…17). As original image is structured, badly distinct boundaries between formed elements are absent. That is why, whyle using operators «erosion» and «dilatation» we get «image 1» and «image 2», correspondingly, regarding to original image; segment structure of obtained images will be different. In the first case, the number of errors of the first kind increases, besides a part of autorosettes «dissolves» in classes «erythrocytes» and «leucocytes». In the second case, a number of errors of the second kind increases, besides artificial union of formed blood elements is being carried out and a number of autorosettes increases at the expense of leucocytes and erythrocytes.

Such two-level analysis allows to avoid errors of the second kind connected with sintering (sticking together) of erythrocytes.

Images, in which at the expense of artificial sticking of erythrocytes between each other and erythrocytes and leucocytes we get false autorosettes, are analyzed at the second stage. This reduces a number of errors of the first kind while solving the problem of choice between «not leucocyte and not erythrocyte» class (autorosette) and «leucocyte» class.



Pattern of the algorithm for intercellular relations measurement in peripheral blood

Outputs of decision making units of each of analyses are variables *X*1...*X*4 and *Y*1... *Y*4, respectively, which are considered as elements of illegible sets, corresponding to therms of divided classes. Units of decision making are constructed according to the principle of macrolayers allowing to unite moduli of neuro-network models. Decisive moduli have two outputs wlich correspond to two divided classes: «leucocyte», – «not leucocyte» or «erythrocyte» – «not erythrocyte». At their outputs there are numbers in the range frome 0 to 1 being interpreted as certainty coefficient in belonging of the segment being analyzed to above-mentioned classes.

Analysis of outputs of decision making units of the both analysis stages is carried out according to the rules of illegible products:

If X1 = «leucocyte» and X4= «not erythrocyte», then Z1= «leucocyte»;

If X2 = «not leucocyte» and X3= «erythrocyte», then Z1= «erythrocyte»;

If X3 = «not leucocyte» and X4 = «not erythrocyte»,

then Z1 = «not leucocyte» and «not erythrocyte». (1)

Illegible neuronic net of direct spreading is used for realization of illegible products system (1). Neuronic net has three outputs corresponding to classes into which formed elements are divided. Choice of corresponding class is carried out according to maximal value of the output. If there given illegible sets corresponding to classes at the output of illegible net, then there is possibility to use method of diffusification, for example, according to mean centre [3].

Thus, there has been developed algorithm of intercellular relations measurement in peripheral blood, using hybrid technologies for analysis of complex structured images. The algorithm provides for two-level processing of the image. The image («image 1»), obtained as a result of segmentation of input black-and-white image after processing by morphological operator – «erosion», is being processed at the first stage. The image («image 2»), obtained after processing of input black-and-white image by means of morphological operator «dilatation», is being processed at the second stage. At each stage decision is made on the basis of aggregation of two values obtained as a result of analysis of segment color and geometric attributes. Final decision is made on the basis of decision comparing, accepted at the first and second stages of processing.

The article has been prepared according to the results of search scientific work in the direction of «Biomedical and veterinary technologies for life support and protection of a man and animals», being carried out within realization of Federal Special-purpose Programme «Scientific and scientific – pedagogical personnel of innovation Russia» for 2009-2013.

References

1. Filist S.A., Tomakova R.A., Gorbatenko S.A. and others. Analysis of histologic images by means of morphological operators, synthesized on the basis of Fourier transform and neuronetwork simulation // Biotechnosphere. – 2010. – №3 (10). – P. 54-60.

2. Gonsales R., Wuds R., Eddins S. Digital processing of images in the media MATLAB. M.: Technjsphere, 2006. – P. 616.

3. Osovsky S. Neuronic networks for information processing. Translation from Polish by I.D. Rudinskiy. – M.: Finance and statistic, 2002. – P. 344.