Soynikova E.S., Batishchev D.S., Mikhelev V.M.
A hematological blood test system based on Price-Jones curve

*FSAEI HE NRU «BelGU»
(Russia, Belgorod)*

doi 10.18411/gq-30-11-2017-04

idsp 000001:gq-30-11-2017-04

Abstract

Blood test nowadays on of the main test for determining human health. On of that type of analysis is Price-Johns curve which is based on erythrocytes diameters distribution. This article describes the preliminary blood cells image processing for quality improvement and further building cells diameter distribution chart. As a conclusion we propose to build a cloud service so everyone can upload an image of erythrocytes and get his results.

Keywords: medical image processing, blood cells, Price-Johns curve, computer vision

Currently, there are quite a lot of intensively developing intelligent systems. They designed for the automatic processing of medical images. Automated processing and analysis of medical images is a universal tool for medical diagnostics [1]. And modern systems of hematological analysis make it possible to perform a provisional classification of blood cells. For example, such systems can effectively sort leukocytes (8-10% of errors) and provide more detailed information on blood tests [2].

The classification of blood cells on a microscopic image is the task of object recognition (in terms of computer vision). The standard approach to this task consists of following two phases:

- segmentation of the image into ROI with objects and background;
- object classification, which includes features detection and object classification based on detected features.

Lots of different computer vision methods were developed during last few decades [3]. Thus the researcher faces a difficult problem of choosing the most suitable methods for a particular problem.

The specificity of the problem affects most the formation of feature vectors, the choice of the segmentation method and classifier.

So when choosing a strategy for solving this problem, special attention should be paid to studying the experience of using various methods of segmentation of microscopic images and the characteristic features used for the classification of blood cells.

The main result of segmentation of a microscopic image of a blood probe is the consolidation of objects of interest (blood cells) for the purpose of their further classification. The quality of segmentation is a key factor for obtaining adequate characteristic values for the features of an object for its correct classification. For example, an article [4] had noted that more than half of the leukocyte classification errors were due to incorrect segmentation.

The main causes leading to errors in the segmentation of microscopic images:

- the overlapping cells;
- the strong variation of cells in shape and size;
- the impact of various factors on the appearance of the cell;
- the poor contrast of images with additional problems caused by noise.

Another complicating factor is the variability in the colorization of blood products: often after colorization, the contrast of contours of cells structural elements exceeds the contrast of the boundaries of the cell itself.

The method of preliminary image processing proposed by us [5] includes the following steps:

- Removing the background in the images: in some places there are light spots and dark spots, due to which there is an incorrect contouring of the cell;
- Sharpening: in order for the contours of the cells to be more clearly displayed;
- Binarization: the background becomes 0, and cells 1;
- Determination of the cell center: obtaining a map of blood cell centers;
- Classification of areas: the pixels that correspond to the class number are painted in the corresponding color.

The source image of the blood probe is shown in Figure 1.

Figure 1. The source blood probe image

As a result of processing the original image according to the above method, we get the image shown in Figure 2.

Figure 2. Blood probe image after the preliminary processing

After preliminary processing of the image, it becomes possible to determine the area of blood cells. Using the area of the blood cells, calculate the diameter of each cell and build the Price-Jones curve, which is shown in Figure 3.

The Price-Jones curve can be represented as a histogram (Fig. 4) for the distribution of cell diameters, where the value of the erythrocyte diameter (in μm) is plotted along the X axis and the percentage of white blood cells corresponding to the value along the Y axis.

Figure 3. Price-Jones curve

Figure 4. Erythrocytes diameters distribution chart

The Price-Jones curve of healthy people has a regular triangular shape with a high apex and a narrow base. At the same time, erythrocytes with a diameter of 6-8 μm predominate, which constitute 70-75% of all erythrocytes. The part of microcytics (cells less than 6 microns in diameter) and macro-cells (diameter more than 8 microns) takes for approximately the same amount of 12-15%, the width of the curve reflects the degree of anisocytosis, and the maximum position is the mean erythrocyte diameter.

In microcytosis (characteristic, for example, for iron deficiency anemia), the erythrocytometric curve shifts to the left, the curve becomes asymmetric, its width increases.

With macrocytosis (for example, folic deficiency anemia), the Price-Jones curve shifts to the right, flattening, its base widens.

The construction of the Price-Jones curve by hand is an extremely time-consuming procedure. Thus the developed system of hematological analysis allows us to construct the

Price-Jones curve in an automatic mode quickly with high accuracy, which makes it possible to see the percentage ratio of all types of red blood cells. This allows you to quickly identify the anisocytosis in the patient and choose the appropriate methods for its treatment. In the future, it is proposed to implement a hematological analysis system in the form of cloud service [6] for storing and analyzing personal medicine data.

1. Tomakova RA, Filist SA, Zhilin VV, Borisovsky SA. The software of the intellectual classification system of blood elements // Fundamental research. - 2013. - P. 303-307.
2. Belyakov VK, Sukhenko EP, Zakharov AV, Koltsov PP, Kotovich NV, Kravchenko AA, Kutsaev AS, Osipov A.S., Kuznetsov A.B. About one method of classification of blood cells and its software implementation // Software products and systems. - 2014. - P. 46-56.
3. Gribkov IV, Zakharov AV, Koltsov PP, Kotovich NV, Kravchenko AA, Kutsaev AS, Osipov AS Comparative study of methods of image analysis. Moscow: NIISI RAN, 2005.
4. Sokolinsky BZ, Demyanov VL, Medny VS, Parpara AA, Pyatnitsky AM Automatic sorting of white blood cell leukocytes using methods of trained neural networks and watershed // In: Methods of microscopic analysis. M.: Medical computer systems, 2009. P. 128-132.
5. Soynikova ES, Ryabykh MS, Batishchev DS, Sinyuk VG, Mikhelev VM High-performance method for detecting boundaries on medical images. Scientific Result. Information Technology. 2016. T.1. P. 4-9.
6. Batishchev DS, Mikhelev VM Infrastructure of a high-performance computer system for the implementation of cloud storage and analysis services for personal medical data. Scientific bulletins of the Belgorod State University. Series: The Economy. Computer science. 2016. Pp. 88-92.