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ACCEPTED MANUSCRIPT

Automatic Segmentation, Counting, Size Determination and Classification of White Blood Cells

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Abstract

The counts, the so-called differential counts, and sizes of different types of white blood cells provide invaluable information to evaluate a wide range of important hematic pathologies from infections to leukemia. Today, the diagnosis of diseases can still be achieved mainly by manual techniques. However, this traditional method is very tedious and time-consuming. The accuracy of it depends on the operator's expertise. There are laser based cytometers used in laboratories. These advanced devices are costly and requires accurate hardware calibration. They also use actual blood samples. Thus there is always a need for a cost effective and robust automated system. The proposed system in this paper automatically counts the white blood cells, determine their sizes accurately and classifies them into five types such as basophil, lymphocyte, neutrophil, monocyte and eosinophil. The aim of the system is to help for diagnosing diseases. In our work, a new and completely automatic counting, segmentation and classification process is developed. The outputs of the system are the number of white blood cells, their sizes and types.

Keywords: White Blood Cells, Neural Network, Automatic Counting, Principal Component Analysis (PCA)

1. Introduction

The main purpose of this paper is to describe the development of a blood smear image based process to help for diagnosis of diseases. The diseases can be diagnosed by the number and morphological changes of white blood cells. The diagnosis can still be performed mainly by manual techniques. However, the accuracy of it depends on the operator's expertise. The situation of the operator may highly affect the analysis. Another method is to use automated cell counter systems such as laser based cytometers [1]. In that paper, authors describe a device that allows carrying out optical excitation of separate cells in a flow cytometer using the radiation of YAG-Ni pulsed laser. There are a lot of cytometers on the market today. They may provide automated cell counting but they have lack of capabilities necessary for automated diagnosis of ALL disease. They don't have the capability to separate abnormal cells such as lymphoblasts from normal cells. They don't allow classifying white blood cells according to their morphologies. They are costly devices and require accurate hardware calibration and they have to use actual blood samples. After analysis, the blood sample is totally destroyed. In recent days, image based cell counting approaches attract the interest of researchers. Image based approaches can give rise to cost effective, automated and remote systems to be implemented. Although difficulties on image processing techniques to determine automatic threshold and segmentation still exist and intelligent classification has some problems, several good attempts are available in the literature on these approaches [2]. In [3], Otsu proposed in his famous paper a method for standardized and automatic threshold selection which is characterized by its nonparametric and unsupervised nature and has the desirable advantages such as it is very simple, straightforward extension to multi-threshold problems not based on the differentiation, but integration of the histogram, quite general covering a wide scope of unsupervised decision procedure. In the research in [4], an automatic threshold is used based on the Otsu's method. In that work, as is often done, the image mathematical morphology is used as a final step to smooth the region of interest giving a result of 92% accuracy. Edge detection methods were also used widely [5,6] but this method

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