

An Overview: Segmentation Method for Blood Cell Disorders

M.F. Miswan¹, J.M. Sharif¹, M.A. Ngadi¹, D. Mohamad¹, and M.M. Abdul Jamil²

¹ Faculty of Computer Science and Information Systems, Universiti Teknologi Malaysia, Skudai, Johor

² Modeling and Simulation Research Laboratory, Electronic Engineering Department, Faculty of Electrical & Electronic Engineering, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor

Abstract— Blood make up of 45% blood cells and 55% plasma. Blood cells consist of red blood cell (RBC), white blood cell (WBC) and platelet (thrombocytes). Each of the cells has the role to carry oxygen and carbon dioxide in the blood, work as an antibody and function for clot mechanism. Complete blood count (CBC) is done to measure all of the blood cells and including hematocrit and hemoglobin. Any abnormal reading which beyond the normal reading is considered blood cell disorder like leukimia, aplastic anemia, and others. Many analyzing methods has been developed to give a precise and reliable reading for CBC such as flow cythometric immunophenotyping, manual blood reading, blood smear, segmentation and others. Segmentation is among the best way for analyzing in term of cost effective and time consuming compared to other methods. A continuous improvement for 3D image segmentation will lead to a better result in the future.

Keywords— blood cell, complete blood count, blood disorder, segmentation, 3 dimensional.

I. INTRODUCTION

To understand how the blood cell can be analyzed, firstly we must have basic understanding about the anatomy and physiology about the blood itself. The field of study of hematology covers the study of blood and the tissues that form, store or circulate blood cells. The transport of nutrients, oxygen, and hormones to cell throughout the body is the function of circulatory system. Circulatory system removes metabolic wastes (carbon dioxide, nitrogenous wastes, and heat) and regulates the body temperature, fluid pH, and water content of cells. Protection of the body against foreign microbes and toxins plays by the white blood cells. Platelet helps in the clotting mechanisms which protect the body from blood loss after injuries.

The formation of blood element (hematopoiesis) takes place in the red bone marrow in the long bones epiphyses, flat bones, vertebrae, and the pelvis. Red bone marrow is the place where all the development stages including stem cells are present, which are stimulated to many types of blood cells to be developed. Mitosis is the most blood cell formation and various blast cells are produced. Each of them divides and differentiates into red blood cells (RBCs), white blood cells (WBCs), and platelets. Blood consists of

cells and cell fragments (*erythrocytes*, *leukocytes*, *thrombocytes*) and water with dissolved molecules (*plasma*). Cells make up approximately 45% of blood and 55% is plasma.

Erythrocytes or red blood cells (RBCs) transport oxygen (O₂) and carbon dioxide (CO₂) in the blood and have protein hemoglobin to attach with. As mentioned earlier, *Leukocytes*, or white blood cells (WBCs), have function to protect the body from foreign microbes and toxins. It can be classified into two groups based upon the presence or absence of granules in the cytoplasm and the shape of the nucleus which is *granulocytes* and *agranulocytes*. *Granulocytes* contain numerous granules in the cytoplasm and have nucleus that is irregular in shape with lobes and compared to *agranulocytes* which do not have visible granules in the cytoplasm and the nucleus is not lobbed. There are three types of granulocytes called *neutrophils*, *eosinophils*, and *basophils*. *Neutrophils* are contributed to the formation of pus with other dead tissue when it destroyed during engulfing bacteria by phagocytosis. It is the first to arrive at a site of infection. *Eosinophils* increase in numbers during parasitic infection and allergic reactions. The action of antibodies on antigens (foreign substances) actively phagocytizes complexes formed. *Basophils* release histamine (inflammatory response) in response to damaged tissue and pathogen invasion.

There are two types of leukocytes; lymphocytes and monocytes. *Lymphocytes* play a role in the immune response to regulate the immune system response to produce T lymphocytes and B lymphocytes. *Monocytes* engulf microbes and cellular debris when it enlarge and become macrophages. *Platelets* (thrombocytes) are fragments of huge cells called megakaryocytes. Platelets activate hemostasis (the stoppage of bleeding) after adhere to damaged blood vessel walls and release the enzymes. Approximately 10 days of average life in circulation.

Next, to diagnose and manage a disease, the blood tests must be performed by a physician. In addition to examining blood cells, important information about the functioning of bodily systems can be yield by the composition of chemical in the blood. It includes cholesterol, thyroid hormone, potassium, and numerous others which are dissolved in the

plasma and circulated in the blood. For a chemical blood test, blood is drawn from a patient’s vein and placed in an empty tube and usually allowed to clot; the fluid portion of the blood after clotting, called serum is then used for the various chemical analyses.

A. Complete Blood Count (CBC)

A complete blood count or CBC is referring to the examination of all three blood cell types. It is also tests hemoglobin and hematocrit. Some refer to the results as a hemogram. Hemoglobin is a protein used by red blood cells to distribute oxygen to other tissues and cells in the body. Hematocrit refers to the amount of the blood that is occupied by red cells.

Blood counts show a normal reading in a periodic health examination, like other features of the examination. It is a sensitive barometer of many illnesses and the measurement is an important part of a standard periodic health examination. The reading can shows a result of some infections, diseases and other illness. For example, the white cell count may be elevated if a bacterial infection is present. The red cell count may be decreased as a result of a specific vitamin deficiency. A decreased platelet count is called thrombocytopenia [1].

As mention above, the measurement of blood cells can contribute to the diagnosis of many disorders. So, if someone has a blood cell disorder, it can be an important index of the response of the disease to treatment. It is also important to learn the effects of drug treatment or radiation therapy. The physician can determine the effectiveness of a drug that is been given to the paient from the blood cell count [1].

In this paper it reviews some of the method used to examine blood cells quantity and how the method use CBC to get all the data in the blood cell. Each of them is compared and the segmentation method is proposed in the research for a several reasons.

II. BLOOD CELL DISORDERS

Normal blood counts fall within the range that has been established by testing healthy men and women of all ages. The cell counts are compared to those of healthy individuals of similar age and sex. If a cell count is higher or lower than normal, the physician will try to determine the explanation for the abnormal results. The approximate normal ranges of blood cell counts for healthy adults are as follows.

Table 1 Normal blood count for men and women

Blood cell types	Men	Women
RBC	4.5 - 6.0	4.0 to 5.0
	million/microliter	million/microliter
WBC	4.5 - 11 thousand/ microliter	4.5 to 11 thousand/ microliter
Platelet	150 - 450 thousand/ microliter	150 - 450 thousand/ microliter
Hematocrit	42% to 50%	36% to 45%
Hemoglobin	14 - 17 grams/100 milliliters	12 - 15 grams/100 milliliters

Differential count, sometimes referred to as a “diff,” is a breakdown of the different types of white blood cells, also called leukocytes. The observer can also tell if the white cells in the blood are normal in appearance. The five types of white cells that are counted are neutrophils (60%), lymphocytes (30%), monocytes (5%), eosinophils (4%), and basophils (below 1%).

These are several blood cell disorders listed below when the blood count shows an abnormal reading:

A. Leukemia

White blood cells or leukocytes diseases may refer to have Leukemia. The different types of leukemia affect give a different blood count. Person with acute leukemia may have a low or normal or high white blood cell count. It may show an abnormal average count which many times higher than 7,000 white cells per microliter of blood. In short, the leukemic white blood cells in acute leukemia patients do not function normally. However, normally patients with chronic leukemia always have an increase in white blood cells [2].

B. Aplastic Anaemia (AA)

The disease refers to a very rare condition for all three types of blood cells that it normally produced by stem cells in bone marrow. It shows a low blood cell counts in all three types of cells which are red cells, white cells and platelets. The bone marrow is examined and usually found to be hypoplastic (low growth of blood-forming stem cells) or aplastic (no growth of blood-forming stem cells) [3].

III. ANALYZING METHODS

There are several tools or application used to perform the blood test or CBC. One of it is light transmission in a pressure-driven slit flow system with a vibrational mechanism is used in analyzing red blood cell (RBC) aggregation. RBC aggregation helps in determine blood viscosity which can

detect diseases like diabetes, thrombosis, myocardial infarction, vascular diseases and hematological pathology from the increased of RBC aggregation. It is begin with vibration generator which effect in disaggregation of RBC aggregates stored in the slit. Shear stress decreased exponentially and causing instantaneous pressure and transmitted light intensity measured over time. A rapid elongation of RBCs is occur from the applying of an abrupt shearing flow after disaggregation and becoming loss with the decreasing of shear stress. Then, RBCs start to re-aggregate and transmission intensity increase which giving aggregation indices detected by curve fitting program [4].

Next, one research is done in comparing the analysis method of white blood cell (WBC). It is involving the use of double-hydrodynamic sequential system (DHSS) in PENTRA 80 Automated Blood Cell Analyzer to compare with manual microscopy counts, multiangle polarized side-scatter technology instrument and flow cytometric immunophenotyping. The research shows a good correlation for the reading of neutrophil and lymphocytes with $R^2 \geq 0.92$ and $R^2 \geq 0.88$ respectively [5]. For the reading of eosinophil and monocytes, it shows lower correlation especially for conventional microscopy.

In other research, it shows that flow cytometry concept can perform red cell count in 10 seconds with ± 2.1 percent (5000 cells counted in 10 seconds for a 5 Millions counts) [6]. This facts is supported from an experiment in using of Agilent 2100 bioanalyzer which use the concept of flow cytometric immunophenotyping, antibody staining and cell fluorescence assays without a washing step to identify peripheral whole blood cells. The very small volumes of samples and reagents, the analysis which uses low number of cells (only 30000 cells per sample) as well as the easy use of the Agilent 2100 Bioanalyzer are the specific advantages of this microfluidic chip-based technology compared to a flow-cytometry-based reference [7].

Research by applying segmentation method, automated image detection in blood smears and cytometry segmentation is applied. It is automatically detects and then segments nucleated cells in Wright's giemsa-stained blood smears. The method involves acquisition of spectral images and preprocessing the acquired Images. This is to obtain high-quality images, remove random noise and correct aberration and shading effects. Then it detects the single and touching cells in the scene to segment the nucleated cells from the rest of the scene. Using the initial cell masks, nucleated cells which are just touching are detected and separated. Simple features are then extracted and conditions applied such that single nucleated cells are finally selected. Next, segments the cells into nuclear and cytoplasmic regions. The success rate in segmenting the nucleated cells is between 81 and 93%. The major errors in segmentation of

the nucleus and the cytoplasm in the recognized nucleated cells are 3.5% and 2.2%. Lastly, post processing of the segmented regions. The advantages of the algorithms used are simple which covers touching and no touching cell, segmentation and detect nucleated cells employing conventionally prepared smears [8].

Another segmentation method, Lohitha is software that can be used for recognizing and analyzing blood cells and produce blood count reports. Lohitha is capable of performing standard counts which comprises of RBC counts, WBC counts, PLT counts and differential counts. The operation of Lohitha is purely based on image processing and computer vision technologies. The input is an image of the already prepared slide containing a film of blood, taken from a special camera attached to an ordinary microscope. The software would not consider about the preparation of the slides to be viewed through a microscope. They are required to prepare the slides as they normally do. The main objective of Lohitha is to provide a software solution which is cost effective as well as efficient for countries like Sri Lanka to be widely utilized in the healthcare industry. The software is designed to be extensible, tiered and a highly efficient with great consideration on ease of use for the end user [9].

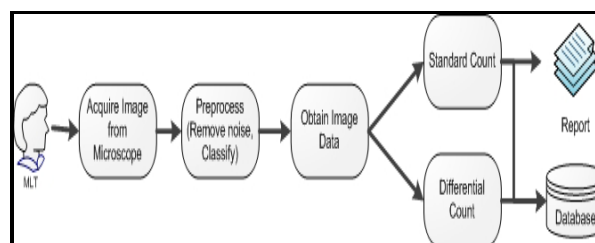


Fig. 1 Overall flow of processing Lohitha software

In [10], it shows that the blood-cell image classification system to be able to analyze and distinguish blood cells in the peripheral blood image. To distinguish their abnormalities, we segment red and white-blood cell in an image acquired from microscope with CCD camera and then, apply the various feature extraction algorithms to classify them. In addition to, it use neural network model to reduce multi-variate feature number based on PCA (Principal Component Analysis) to make classifier more efficient. Finally it shows that the system has a good experimental result and can be applied to build an aiding system for pathologist. In special, we classified the abnormality of red blood cells in two steps, using the inner and outer edge information and classify normal white blood cell using various kinds of features about nucleus and cytoplasm. The experiment of results show that the complexity of neural networks can be reduced and can

construct more efficient system, providing that principal component analysis is applied to the extracted features from cells [10].

In [11], this is a work for image segmentation and counting based on PCNN and autowave for blood cell images. Our research work, will work out on automatic counting method for any microbiological cell but for at the beginning we will focus on blood cell images. At the end, we hope this tool can be an initiated tool for any biological cell images [11].

In [12], this is other work done for blood smear segmentation which involves the process of extraction of blood cell into background, nucleus, cytoplasm and erythrocytes. It is done step by step in hierarchy which first extract nucleus, second is the background and lastly cytoplasm to get erythrocytes. This also can help as a mixing method which helps in the process of segmentation [12].

In [13], this is a work in obtaining the 3D image from 2D image from the process of enhancement and edge detection to form 2D edge image. From that, binary image is created after the process of enhancement which makes to reduce noise. Next, zero-order interpolation is applied as part of surface representation algorithm and then 3 surfaces are created through 3D plot surface to form 3D visualization. We also hope this technique can be initiated tool to create 3D image [13].

IV. CONCLUSION

Segmentation is the best analyzing method that can be used to analyze disease and perform CBC in term of cost effective and efficiency. The use of flow cythometric is also good in term of efficiency and precise reading. Plus, it can handle many samples in one time. However, it creates high cost to develop such technology. Segmentation is just a simple software component which can help the pathologist, biological lab officer or any users in the field of biomedical to use it in a simplest way. It can be used to analyze a specific sample in a short time with precise reading. Thus, the development must be done to improve the segmentation technique so that it capable to excel as the main analyzing tool for CBC.

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