Paper ID: VESCOMM01

A REVIEW ON WATERSHED SEGMENTATION FOR AUTOMATIC BLOOD CELL COUNTING FOR HUMAN

Mr. Konade Basavraj Pundlik. ME (Electronics),
bkonade@gmail.com
Bharat Ratna Indira Gandhi College of Engineering, Kegaon, Solapur (MH), India.
Affiliated to Solapur university, Solapur (MH), India.

Abstract—**The number of red blood cell is very important to detect as well as to follow the treatment of many diseases like anaemia, leukemia etc. In clinical laboratory is to produce a precise result for every test especially in the area of Red Blood Cell (RBC) count. Red blood cell count gives the vital information that help diagnosis many of the patient's sickness. The old conventional method of RBC counting under microscope gives an unreliable and inaccurate result depends on clinical laboratory technician skill. This method puts a lot of strain on the technician. Another method for RBC counting uses the automatic hematology analyzer, this machine is very costlier. So it is not possible all the hospital's clinical laboratory implement such an expensive machine to count the blood cell in their laboratory. This introduces an efficient and cost effective computer vision system for automatic red blood cell counting.**

Keywords— **Blood Cell count, Morphological operations, Hough Transform, MATLAB.**

I. INTRODUCTION

In image indexing and retrieval has been an important research area in computer science for the last few decades. Many digital images are being captured and stored such as medical images, architectural, advertising, design and fashion images, etc. As a result large image databases are being created and being used in many applications. In this work, the focus of our study is on medical images. A large number of medical images in digital format are generated by hospitals and medical institutions every day. Consequently, how to make use of this huge amount of images effectively becomes a challenging problem [1]. In the field of biomedicine, because of cell's complex nature, it still remains a challenging task to segment cells from its background and count them automatically [2-5].Among all of the body's tissues, blood is unique due to its existence as the only fluid tissue. A blood cell can be any type of cell normally found in blood which falls into four categories which are red blood cell (RBC), white blood cell (WBC), platelet and plasma [6]. The differences between these groups lie on the texture, color, size and morphology of nucleus and cytoplasm. In blood smear, number of red cells is many more than white blood cells. For example an image may contain up to 100 red cells and only 1 to 3 white cells. Platelets are small particles and are not clinically important [7]. Blood cells form in the bone marrow, the soft material in the center of most bones. Leukocytes or WBC are cells involved in defending the body against infective organisms and foreign substances. Leukocytes cells containing granules are called granulocytes (composed by neutrophils, basophil, and eosiphil).
Cells without granules are called a granulocytes (lymphocyte and monocyte) [6].These cells provide major defense against infections in organisms and their specific concentrations can help specialists to discriminate the presence or the absence of very important families of pathologies [8]. When infection occurs, the production of WBCs increases [6]. Abnormal high or low counts may indicate the presence of many form of disease, since blood counts are amongst the most commonly performed blood test in medicine.
A new technique for binary images based on the fundamentals of RCD has been proposed and used for counting RBCs and WBCs. Therefore, the original image is separated into two images; the first image contains RBCs only and the second image contains WBCs; this step has been done using thresholding. We study the histogram for 20 sample gray scale images, and we find out the best thresholding values to extract WBCs and RBCs; values were 64 and 140, respectively. After cells separation, each image is preprocessed using morphology operators to obtain the edge image using Canny operator.

a. Iterative Structured Circle Detection Algorithm-

1. Preprocessing-The proposed method for cell segmentation works with edge images. Microscopy images of blood smears are colored images, and several steps are required to prepare the image before extraction of the edge image. In our proposed method, the cells were separated by type and distinct preprocessing steps were developed for WBCs and RBCs separately.

2. Preprocessing for WBCs- At this stage, white blood cells are extracted as a separate image, and the red blood cells have varying intensities; therefore, it is preferable to develop separate preprocessing steps for each cell type. To remove RBCs from the image, the RGB image was converted into grayscale image by eliminating the Hue and saturation information while retaining its luminance and then converted the image to binary using thresholding using a threshold value visualize the WBC. Some undesired holes appeared in the cells, and the morphology operator, fill holes were used to remove them. The complementary images before the holes were filled. This image eroded to reduce the number of overlapping cells. Because the

boundary of the cells is required, the holes were filled to improve the edge detection. image after the holes filled. The Canny operator was used to visualize the cell edges, After edge detection, some undesired pixels appeared that affect the segmentation process. These pixels were removed using an open morphology operator

b. software-based method - The main problem with the method of counting manually under the microscope is accuracy, this method needs a real experienced laboratory technician who is trained enough to produce an accurate cell counting report, and even if the laboratory technician if well trained and experienced still we one cant neglect the chance of error in the report due to error caused by apparatus, personal errors, statistical errors etc.

While on the other hand latest haematology analyzer somehow error free and fast but it is widely unavailable and very expensive machine and the countries like Pakistan are resource less to provide it in every hospital laboratory in country. So as a result of the problem this research based project proposed a new method of cell counting which is easy to use, don't need fully experienced men to handle, much more accurate then the manually counting method and is very economical way of cell counting.

c. Topological gradient algorithm-

– Initialization : $c = c0$.
– Calculation of $u0$ and $v0$ the solutions of the direct equation and adjoin equation
– Computation of the 2×2 matrix M and its lowest Eigen value lmin at each point of the domain W.
– Set

$$c1 = \begin{cases} e & \text{if } x \in W, \mathrm{l}min < a < 0, e > 0 \\ & c0,\ elsewhere, c \end{cases}$$

– Compute $u1$, the solution of Eq. 2 with $c = c1$.
We refer the reader to Jaafar Belaid *et al.* (2008), for some theoretical and numerical comparisons with conventional restoration methods.

d. The watershed transformation

One aim of this work is to show how the use of Mathematical morphology operators can be very useful in image segmentation. Particularly, we show how the watershed transformation contributes to improve the numerical results for image segmentation problems. We describe briefly in this section the basic notions and operators we use.

Let $u(x,y)$ with $(x,y) \in$ R2, be a scalar function describing an image I. The morphological gradient of I is defined in Beucher *et al.* (1993) by

$$dDu = (u \oplus D) - (u \ominus D) \ldots\ldots \quad (1)$$

where
$(u \oplus D)$ and $(u \ominus D)$ are respectively the elementary dilation and erosion of u by the structuring element D. The morphological Laplacian is given by

$$DDu = (u \oplus D) - 2u + (u \ominus D)\ ) \ldots\ldots$$

(a) Morphological dilation and area closing on higher pixel value image.

We note here that this morphological Laplacian allows us to distinguish influence zones of minima and suprema: regions with $DDu < 0$ are considered as influence zones of suprema, while regions with $DDu > 0$ are influence zones of minima. Then $DDu = 0$ allows us to interpret edge locations, and will represent an essential property for the construction of morphological filters. The basic idea is to apply either a dilation or an erosion to the image I, depending on whether the pixel is located within the influence zone of a minimum or a maximum.

The Catchment basin $C(M)$ associated to a minimum M is the set of pixels p of W such that a water drop falling at p flows down along the relief, following a certain descending path, and eventually reaches M. The catchment basins of an image I correspond then to the influence zones of its minima, and the watershed will be defined by the lines that separate adjacent catchment basins. Several algorithms have been proposed for the computation of watersheds and the most commonly used are based on an immersion process analogy.

Let us express this immersion process more formally according to Soille (1992): we consider $hmin$ and $hmax$ the smallest and the largest values taken by u.

Let $Th = \{p \in W, u(p) \leq h\}$ be the threshold set of u at level h. We define a recursion with the gray level

Table 1: Normal Blood Count Differentiate by Gender

Blood Cell Types	Gender	
	Men	**Women**
RBC	5.4-6.0 Million/micro liter	4.0-5.0 Million/micro liter
WBC	4.5-11 Thousand/micro liter	4.5-11 Thousand/micro liter
Platelet	150-450 Thousand/micro liter	15.0-45 Thousand/micro liter
Hematocrit	42%-50%	36%-45%
Hemoglobin	14-17 Grams/100 milli liters	12-15 Grams/100 milli liters

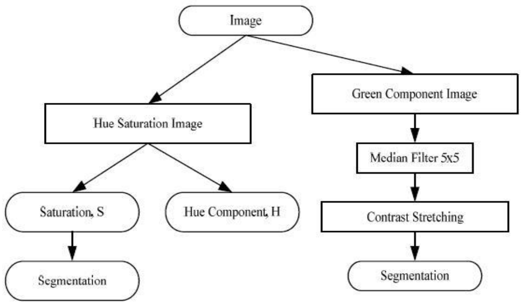

Figure 1: Image Enhancement

It is an implementation of automated counting for blood cell which manually done by hematocytometer by using counting chamber. Blood counting is synonym with the complete blood count or CBC which refers to compilation test of red blood cell (RBC), white blood cell (WBC), platelet, hemoglobin and hematocrit. Each of them has their role in the body system and the counting result is important to determine the capability or deficiency of the body system. In short, any abnormal reading of CBC can give a sign of infection or disease. For example, the present of bacterial infection is diagnosed from increasing WBC count. Plus, specific low vitamin may come from a decreased RBC and thrombocytopenia is referring to low platelet count. The result can influence physician to make the best response and monitor the drug effectiveness from the blood count [13]. CBC consists of several counting of the main component in the blood cell. Each of them has a standard quantity range as a reference for a healthy women and man. Any counting value out of the range is considered abnormal and physician will interpret the result for further action. In addition, differential count also include in the measurement of CBC as a division of WBC count for five different types of WBC. They are neutrophils, lymphocytes, monocyte, eosinophils and basophils. The standard count for them is 60%, 30%, 5%, 4% and below 1% respectively from the total WBC counts. Table 1 shows the standard CBC for the healthy person divided by gender Object counting using image processing has huge applications where automation is to be introduced and time of counting is to be reduced. Some of the main applications of object counting in industrial systems are packaging, quality control, and so on. It is helpful in the research areas where objects are of very small size. Object counting algorithm can be also used to track and identify objects. The present methods can be extended to have counting system based on user selected attributes. This system includes an effective and efficient method in recognizing and counting blood cells as a practical alternative to the manual blood cell counting.

II. EXPERIMENTAL RESULTS

In this section, we present experimental result to demonstrate the performance of the watershed technique. The performance of the method under the presence of intense noise is also analysed, and the results are compared with other segmentation methods. The results of cellular images and their corresponding watershed images are shown in Fig.4 (a)–(d), respectively. From the segmentation results, the continuous and thin closed contours can be clearly identified by the given watershed algorithm.

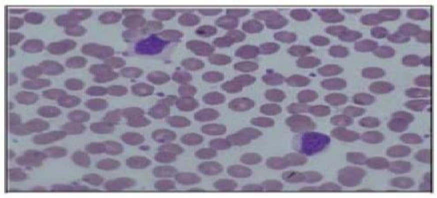

Figure 2: Original Image of Blood for 40X object

When the operation of masking is applied, the masked image has diminished the WBC nucleus morphological view. After morphological operation involving binary erosion and filling holes, the RBC can be viewed accordingly. In this study, masking has been used to remove WBC and platelet is subtracted by morphological operators. The left one will be RBC which represent the RBC segmentation. Figure 5 shows the result of the RBC segmentation from the elimination of WBC nucleus and small particles including platelets.

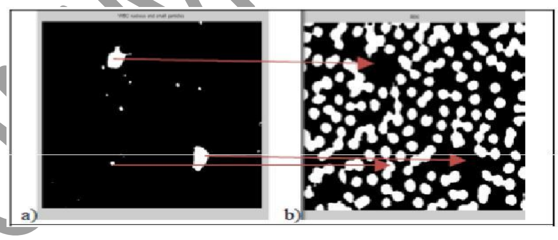

Figure 3: a) Segmented WBC nucleus b) RBC segmentation from the elimination of WBC nucleus and small particles.

III. CONCLUSION

As a conclusion, this successfully uses various image processing techniques for Red Blood Cell Estimation. Image processing techniques are helpful for object counting and reduce the time of counting effectively. Proper recognition of the object is important for object counting. The accuracy of the algorithm depends on camera resolution used, size of objects, whether or not objects touching and illumination conditions. The system can be further improvised for detecting various diseases related to different blood cell morphologies.

REFERENCES

[1] Lehmann T.M., Wein B., Dahmen J., Bredno J., Vogelsang F. & Kohnen M. : Content based image retrieval in medical applications : a novel multi step approach. International Society for Optical Engineering (SPIE), 3972, pp.312-320.(2000)

[2] Dwi Anoragaingrum : Cell segmentation with median filter and mathematical morphology operation, proceeding of the IEEE 10th International Conference on Image Analysis and Processing (ICIAP), pp. 1043-1046 (1999).

[1] Keng Wu et al.: Live cell image segmentation, IEEE Trans on Biomedical Engineering, 42(1), pp.1-12.(1995).

[2] H Elaine N. Marieb (2006): Essentials of Human Anatomy & Physiology, 8th ed. Pearson Benjamin Cummings.

[3] Choi H, Baraniuk R., Multiscale : Image segmentation using wavelet-domain hidden Markov models, IEEE Transaction on image processing, 10(9), pp.1309-1321 (2001).

[4] Fatemeh Zamani, Reza Safabakhhsh: "An Unsupervised GVF Snake

Approach for White Blood Cell Segmentation Based on Nucleus", Signal Processing, The 8th International Conference on Volume 2, 2006.

[5] Vincenzo Piuri, Fabio Scotti: "Morphology Classification of Blood Leucocytes by Microscope Images", IEEE International Conference on Computitional Intelligence for Measurement Systems and Applications, Boston, MA, USA, 14-16 July 2004.

[6] Ramin Soltanzadeh. "Classification of Three Types of Red Blood Cells in Peripheral Blood Smear Based on Morphology. Proceedings of ICSP, 2010.

[7] Heidi Berge, Dale Taylor, Sriram Krishnan, and Tania S. Douglas. Improved Red Blood Cell Counting in thin Blood Smears. Proceedings of ISBI, 2011. pp.204-207.

[8] Zack G.W., Rogers W.E. and Latt S.A. "Automatic-measurement of sister chromatid exchange frequency." Journal of Histochemistry & Cytochemistry 25, 1977, 741-753.

[9] Guitao Cao, Cai Zhong,Ling Li and Jun Dong. "Detection of Red Blood Cell in Urine Micrograph". The 3rd International Conference on Bioinformatics and Biomedical Engineering (ICBBE). 2009.

[10] Roy A. Dimayuga, Gerwin T. Ong, Rainier Carlo S. Perez, Gefferson O. Siy, Saman C. Sohrabi Langroudi and Miguel O.Gutierrez. "Leukemia Detection Using Digital Image Processing in Matlab". ECE Student Forum, De La Salle University, Manila. March 26, 2010.

[11] Miswan, M. F., et al. "An Overview: Segmentation Method for Blood Cell Disorders" 5th Kuala Lumpur International Conference on Biomedical Engineering 2011 Springer Berlin Heidelberg, 2011

[12] Mahmood, Nasrul Humaimi, and Muhammad Asraf Mansor. "Red blood cells estimation using Hough transform technique." Signal & Image Processing: An International Journal (SIPIJ) 3.2 (2012)

[13] Haider Adnan Khan and Golam Morshed Maruf, "Counting Clustered Cells using Distance Mapping," 2013 International Conference on Informatics, Electronics and Vision (ICIEV), May 2013. pp. 1-6.

[14] Watcharin Tangsuksant, Chuchart Pintavirooj, Somchart Taertulakarn, Somsri Daochai, "Development Algorithm to Count Blood Cells in Urine Sediment using ANN and Hough Transform," The 2013 Biomedical Engineering International conference, Oct. 2013.

[15] Sharif, J. MISWAN, et al. "Red blood cell segmentation using masking and watershed algorithm: A preliminary study." Biomedical Engineering (ICoBE), 2012 International Conference on. IEEE, 2012.