ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2015

WBC Segmentation Using Morphological Operation and SMMT Operator - A Review

Belekar S. J[1] , Dr. Chougule .S .R[2]

ME (E & TC) Student, Bharti Vydhyapeeth College of Engineering, Kolhapur, Maharashtra, India[1].

Bharti Vydhyapeeth College of Engineering, Kolhapur, Maharashtra, India[2].

ABSTRACT: This paper give idea regarding various methods for segmentation of nucleus and cytoplasm of white blood cells (WBC). This basic information is necessary for automatic differential counting, which give idea in diagnosis of different diseases. Self dual multiscale morphological toggle (SMMT) operator is used for segmentation and contour regularization. After preprocessing with SMMT nucleus can be segmented using watershed transform and level-set methods. Cytoplasm region can be identified using granulometric analysis and on morphological transformations

KEYWORDS: Segmentation Methods, SMMT Operator.

I. INTRODUCTION

White Blood Cells are the cells of immune system that are involved in defending the body against infections. White Blood Cell (WBC) are very important cells for human life. The count of these cells in bone marrow will give valuable information to doctor's, Depend on that doctor will get knowledge of different diseases and will give specific treatment. Automatic cell segmentation always challenging problem because in same image we can find different cells in various stages of maturation whose nucleus and cytoplasm will differ in shape, texture, color, granulites and density etc.

In this paper we have to use SMMT operator for WBC image enhancement and to detect and analyze nucleus we have to use segmentation algorithm such as watershed transform and level set transform and to detect and analyze cytoplasm we have to use granulometric analysis and mathematical morphological algorithm. Finally, we also have to perform classification of cells according to their maturation levels. This classification is based on shape based features which are extracted from segmented nucleus and cytoplasm component. In order to determination of the patient's health for different stages such as diagnosis', treatment and follow up.

White blood cell (WBC) counting plays a major role. By analyzing the white blood cell count which will gives idea about some diseases like Acquired Immune Deficiency Syndrome (AIDS), Leukemia, Cancers. In traditional method, an expert use microscope to select an specific area of interest in bone marrow, observe white blood cell, then classify these cells based on his knowledge and experience. To perform all these process manually it is very tedious and time consuming. In Indian medical field, many of pathologists use above mentioned manual methods for counting white blood cell. From few decades, Automation is very growing field in medical sector also. Since Automatic blood cell segmentation which is part of automation, Doctor's are very careful about patient's health so they still use manual method for precaution.

In order to improve result from automation, the direction of researcher's and engineers used various image processing algorithms such as image segmentation, mathematical morphology transformation, thresholding, histogram equalization etc. in which each technique will have some advantages and some disadvantages too. Due to low contrast between nucleus, cytoplasm and background, thresholding and histogram equalization will face leaking problem. This problem was solved by mathematical morphological and SMMT operator introduced in, "Semiautomatic White Blood Cell Segmentation Based on Multiscale Analysis" implemented by Leyza Baldo Dorini, Rodrigo Minetto, and

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2015

Neucimar Jerˆonimo Leite[1].In this direction the present theories and practices for WBC counting and currently researched methods are explained further.

II. RELATED WORK

Different types of automated techniques for counting and classifying WBC mentioned below:-
Nipon Theera, Umpon Sompong Dhompongsa[2], In this paper author say that, Segmentation of WBCs will be done in bone marrow with the help of different classifiers such as Baye's classifier and artificial neural network in which input given to classifier was nucleus based features such as area of nucleus and location of its pattern. Morphological operation can be used to estimate particle size distribution indirectly. The approach is simple in principle. With particles having regular shapes that are lighter than background; the method consists of opening with structuring element increasing in size. The basic idea is that opening operations of a particular size should have the most effect on region of the input image that contain particle of similar size. For each opening, the sum of the pixel values in the opening is computed. In this most of the classification occurs in adjacent cell.

W. Shitong and W. Min[3], This paper include, With the help of automatic recognition system white blood cells can be detected. Nearly complete white blood cells can be detected using NDA algorithm. In this case how to distinguish nucleus from cytoplasm effectively is a challenging problem. Another problem is how FCNN can be further improve so that NDA will have better performance.

B. Kumar and T. Sreenivas[4], In this paper, Teager energy operator (TEO) is used to segments leucocytes into nucleus and cytoplasm. Teager energy operator (TEO) has local mean weighted high pass filtering property which can be used to identify and distinguish the nucleus of white blood cells. Mathematical morphology is used to segment cytoplasm present in white blood cell. In this case segmentation will show better result even at low percentage of impulse noise.
Rosenberg, Azriel[5], In this paper, pixel and region based segmentation discussed. In this pixels classification were done independently. It is simpler process but it has drawback in area of local consistency. Splitting of image into distinct connected regions is main goal in region based segmentation.

Mosthefa Mohamed, Behrouz[6], This paper include, Segmentation were done by using thresholding. Due to computationally fast and cheap it is simplest segmentation process. When nucleus, cytoplasm and background each have various gray levels then thresholding will be use for segmentation. It has problem when brightness level changing image by image.

Fatin A. Dawood[7], In this paper author say that, Segmentation were done by using histogram equalization. Based on color concentration, detection of every element in the blood slide and cut out the WBC segmentation was carried out. If result of this method are compared with those of thresholding method it is conclude that this method give more appropriate than thresholding method.

Tenn francis chen[8], This paper include, Level-set method is used. This helps significantly statistical classification over conventional. Due to a lot of iteration Level-set methods suffers heavy computational burden. To overcome this fast Level-set framework based on watershed algorithm is used.

L.B. Dorini, R.Minetto, and N. J. Leite[9], In this paper author say that, Segmentation were carried out by using SMMT operator and mathematical morphology. Leaking is a common problem when dealing with cell images due to low contrast between nucleus, cytoplasm and background. To avoid this problem the authors used a scale-space toggle operator with simplification using SMMT operator that conduce to a contour regularization, after that cell nucleus was extracted using the watershed transform. Then, red blood cells segmented based on the size distributed information and the cytoplasm was segmented using thresholding and morphological opening.

By looking literature review we can observe that, Traditional segmentation methods are manual, And when thresholding is used for segmentation then leaking will become major problem. This leaking problem will be overcome by using SMMT operator[1].The drawbacks mentioned in above systems are recovered by using the methodology as per the block diagram shown in proposed work.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2015

III. PROPOSED ALGORITHM

a) Scope: -

Main block diagram consists of four blocks namely image acquisition block, WBC segmentation using programs written in MATLAB and report generation block and is as shown in figure 2.

Image acquisition: - In this step blood image can be acquired using the microscope with high resolution. By using MATLAB program we can create database for these blood images.

WBC segmentation algorithm: -In this step various algorithms are used to segment and analysis of WBC cells. This block can be elaborated in figure 2.

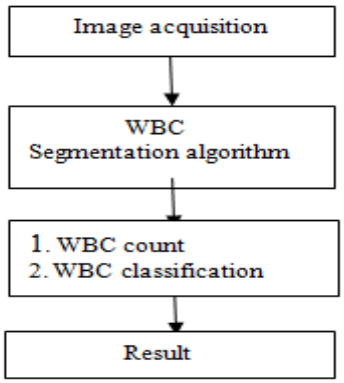

Fig. 1. Proposed system

WBC count and classification: -The input to this block is segmented WBC cells. Using this step we can obtain count of WBC cell in Whole blood cells and we can classify these WBC cells.

Result: -In this step we can obtain final result and we can generate final report that contains WBC count and WBC classification.

Block diagram of WBC Segmentation: -Block diagram of WBC segmentation contains various blocks like microscopic blood image data base, image simplification by SMMT operator block, nucleus segmentation, cytoplasm segmentation, WBC count and WBC classification, result comparison block and finally report generation block. Each block of WBC segmentation of Figure 2 is explained below.

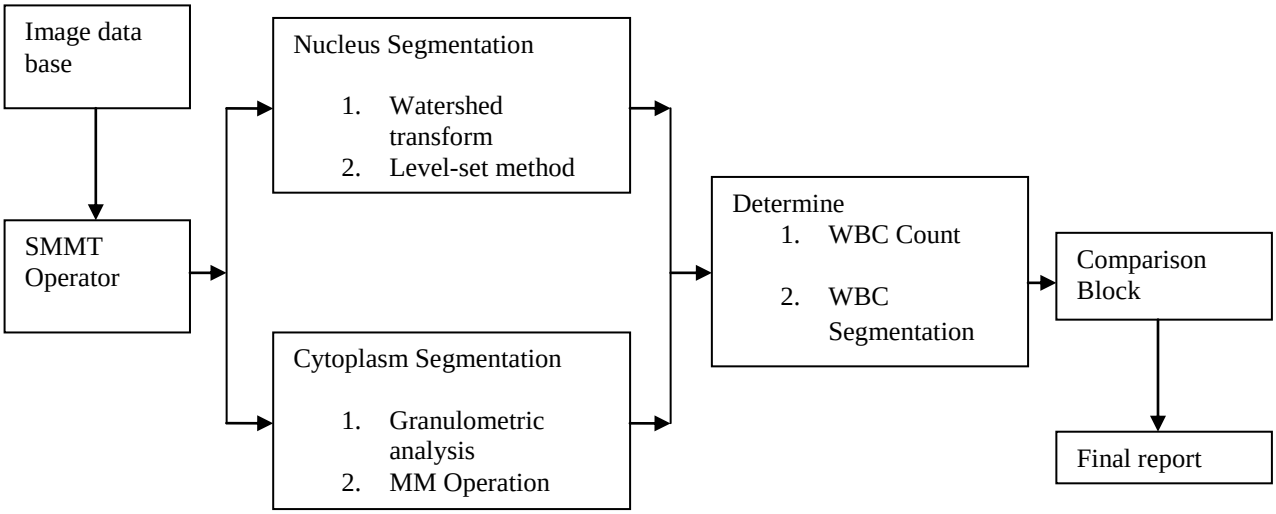

Fig. 2. Block Diagram for WBC Segmentation

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2015

Image database: - Input Blood image will be take from Image data base.
SMMT operation block: - This block is used as a pre-processing. In this operator SMMT operator is used for contour regularization. The output of this block is given to nucleus and cytoplasm segmentation block.

We call SMMT operator the following transformation

$$(f \oslash g_\sigma)^k(x) = \begin{cases} \emptyset_1^k(x) & \text{if} \emptyset_1^k(x) - f(x) < f(x) - \emptyset_2^k(x) \\ f(x) & \text{if} \emptyset_1^k(x) - f(x) = f(x) - \emptyset_2^k(x) \\ \emptyset_2^k(x) & \text{otherwise} \end{cases} \quad \ldots\ldots (1)$$

Where,

$$\emptyset_1^k(x) = (f \oplus g_\sigma)^k(x) \cdots\cdots\cdots \text{dilation} \quad \ldots\ldots (2)$$
$$\emptyset_2^k(x) = (f \ominus g_\sigma)^k(x) \cdots\cdots\cdots \text{erosion} \quad \ldots\ldots (3)$$

In order to improve quality of image used in segmentation algorithm, we have to use SMMT operator. Fig. 3. shows the improvement. By applying SMMT operator contour regularization result give better quality.

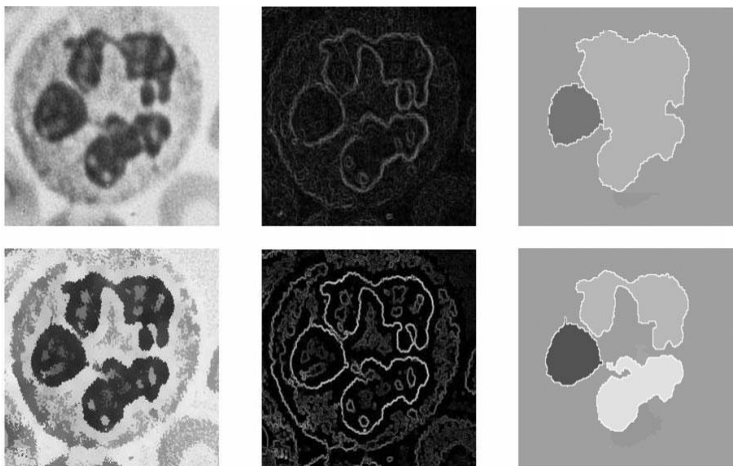

Fig. 3. Improvement in image after applying SMMT operator. (Left) Original images. (Middle) Weak and the well-definedcontours.(Right)Different segmentation results [1].

Nucleus segmentation: - Two different algorithms are considered to segment the nucleus, using watershed transform [10] and second Level set method [11].
i] Watershed transform: - Watershed transform is powerful segmentation method in which combination of region growing and edge detection used to partition a image into two different sets.
This algorithm is given as:-

1. Take an input image I;
2. Apply thresholding to obtain binary image Ib;
3. Apply SMMT operator on I to obtain simplified image Is;
4. Apply erosion on Is to discard small residues;
5. Apply watershed transform;
6. End

The result of this algorithm is shown in fig. 4.
ii] Level set transform: - Level set method are motivated by active contours approach[12].
This algorithm is given as:-

1. Take an input image I;
2. Apply thresholding to obtain binary image Ib;
3. Apply SMMT operator on I to obtain simplified image Is;

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2015

4. Set initial interface Ii, as the edges of Ib;
5. Evolve Ii in Ib;
6. End

The result of this algorithm is shown in fig. 5.

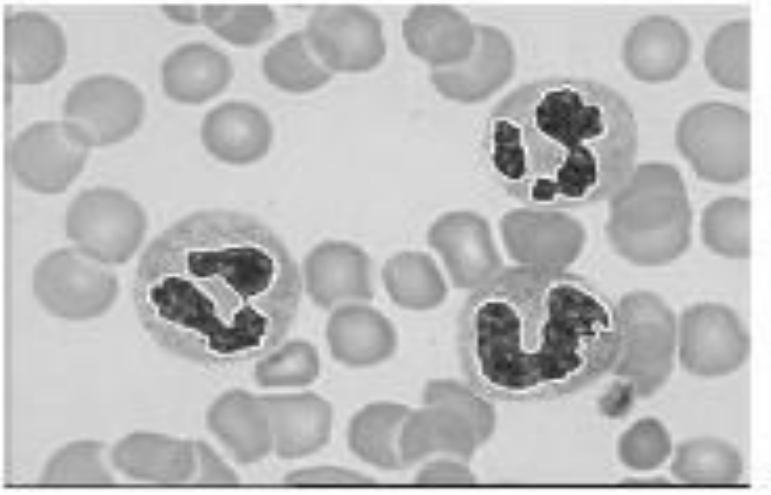

Fig. 4. Result Of Watershed Transform [1].

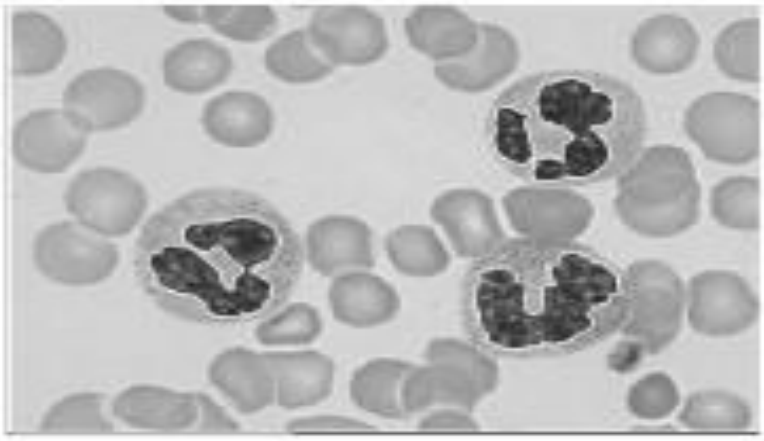

Fig. 5. Result Of Level-set method [1].

Cytoplasm segmentation: - Two different algorithm are considered to segment the cytoplasm, using granulometric analysis and mathematical Morphology (MM) operator operation and remove unwanted part from the image.

i] Granulometric analysis: - In this Granulometric function is used which will helps to achieve size distribution information. In this structuring element is used whose size is based on size of Red Blood Cells (RBC's). In this we consider distribution of granulometric function to determine mean size of the RBC.

This algorithm is given as:-

1. Take an input image I;
2. Compute the granulometric function to obtain the RBC size distribution Sd;
3. Apply thresholding to obtain binary image Ib;
4. Apply an opening on Ib with structuring element having size Sd ;
5. Discard components which do not intersect with a segmented nucleus;
6. End

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2015

The result of this algorithm is shown in fig. 6.

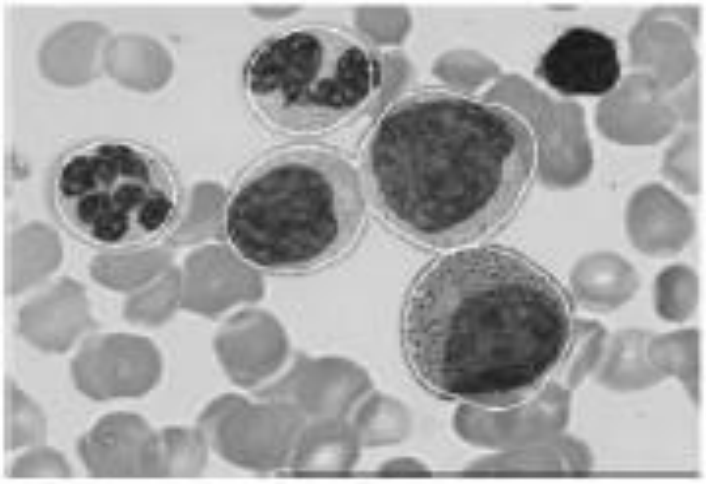

Fig. 6. Result Of granulometric analysis [1].

ii] Mathematical Morphology operation: - In this method Mathematical Morphology (MM) will be applied, so that with the help of size distribution information one can apply suitable morphological.
This algorithm is given as:-

1. Take an input image I;
2. Apply SMMT operator on I to obtain simplified image Is;
3. Apply bottom-hat transform on Is to obtain cytoplasm regions;
4. Apply thresholding to obtain binary image Ib;
5. Apply a flood-fill operation ;
6. Apply an area opening to eliminate small regions;
7. Add the previously segmented nucleus;
8. Apply the watershed transform;
9. End

The result of this algorithm is shown in fig. 7.

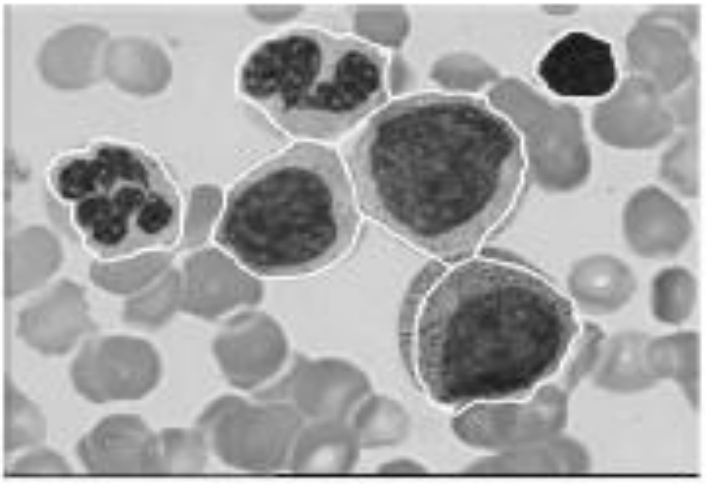

Fig. 7. Result Of Morphological operation [1].

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2015

WBC count and classification: - The Results obtained from nucleus segmentation and cytoplasm segmentation will be used to calculate WBC count using appropriate method and WBC classification will be achieved by Neural Network or any other classifier.
Comparison block: - At this stage result obtained from WBC analysis using various image processing algorithms will be compared with results obtained from laboratory by experts on the same samples.
Report generation block: - Finally report will be generated by considering comparison results. Report contains WBC count and WBC classification.

IV. SIMULATION RESULTS

By looking this entire algorithm we can obtain nucleus and cytoplasm from WBC. Watershed and Level-set transform will give very good result but Level-set transform will give very accurate result at the borders. Granulometric analysis and MM Operation give better representation of cytoplasm region in WBC image.

V. CONCLUSION AND FUTURE WORK

In this paper, we discuss various algorithms to segment WBC in two morphological components, nucleus and cytoplasm. Nucleus can be segmented by using Watershed transform and Level-set method. To segment Cytoplasm, we discuss granulometric analysis and MM Operation. Interest feature and image simplification can be obtain by using SMMT operator.Quantitative and qualitative analysis consider as future work.

REFERENCES

1. Leyza Baldo Dorini, Rodrigo Minetto, and Neucimar Jerˆonimo Leite "Semiautomatic White Blood Cell Segmentation Based on Multiscale Analysis" IEEE journal of biomedical and health informatics,vol. 17, No. 1, january 2013
2. N. Theera-Umpon and S. Dhompongsa, "Morphological granulometric features of nucleus in automatic bone marrow white blood cell classification," IEEE Trans Inf. Technol. Biomed., vol. 11, no. 3, pp. 353–359, May 2007.
3. W. Shitong andW. Min, "Anewdetection algorithm (NDA) based on fuzzy cellular neural networks for white blood cell detection," IEEE Trans. Inf. Technol. Biomed., vol. 10, no. 1, pp. 5–10, Jan. 2006.
4. B. Kumar and T. Sreenivas, "Teager energy based blood cell segmentation,"in Proc. Int.Conf.Digital Signal Process., 2002, vol. 2, pp. 619–622.
5. Rosenberg, Azriel, "Image Analysis, Problems, Progress and Prospects", Pattern Recognition, Vol 17, Number 1, 1984 pp3-12.
6. Mosthefa Mohamed, Behrouz Far "An enhanced threshold based technique for WBC nuclei Automatic Segmentation" IEEE 14th international conference on e-health networking, Application and Services, 2012.
7. Fatin A. Dawood "Unsupervised segmentation of microscopic white blood cells images using histogram equalization technique" Department of Computer Science, College of Science, University of Baghdad. Baghdad-Iraq.
8. Tenn Francis Chen "Medical Image Segmentation using Level Sets" Technical Report #CS-2008-12
9. L. B. Dorini, R. Minetto, and N. J. Leite, "White blood cell segmentation using morphological operators and scale-space analysis," in Proc. 20th Brazilian Symp. Comput. Graph. Image Process., 2007, pp. 100–107.
10. [10] P.Soille, Morphological image analysis: principles and applications. New York: Springer
11. Verlag-2003.
12. J. A. Sethian, Level-Set Methods and Fast Marching Methods. Cambridge,U.K.:Cambridge Univ, Press 1999.
13. M. Kass, A. Witkin, and D. Terzopoulos, "Snakes: Active contour models."Int. J.Comput. Vis., vol. 1, no. 4, pp. 321–331, 1987.
14. CellAtlas Dataset. (2007). [Online]. Available: http://h34.cellavision.se/start/

BIOGRAPHY

Sandip Jivaji Belekar is M.E Student in Bharti vydhyapeeth college of engineering kolhapur. He received Bachelor of Engineering degree in 2012 from DKTE, Ichalakaranji, Maharashtra, India.