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Segmentation of Leukocytes Diagnosis of Disease

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ABSTRACT

Automating the process of Leukocytes (also known as White Blood Cells) detection and classification in image processing techniques is the aim of this Paper. WBC recognition and its classification to Differential WBC are crucial for the laboratory and clinical tests for the diagnosis of various kind of disease present in our body. In traditional method, most of the case of analyzing the Differential cells was done by Hematologists under the microscope which leads to consumption of time and was very tedious process which only needs experts, knowledgeable and skilled person .While in some case, medical instruments are used which are very costly, does not need experts to handle, very quick in processing results but not available in most of the hospitals and clinic owing to its cost. The feature of Nucleus is very essential for identification of what type of cell it could be in most of the case. The image segmentation process which is very significant step for the clinician to handle more data than they normally could makes the inspection of blood smear faster and more easier to deal with. In this paper, our focus is to use SMMT (Selfdual Multiscale Morphological Toggle) operator along with the combination of image arithmetic and automatic thresholding for simplification of image and regularization of contour which in turn improves the accuracy of WBC segmentation. For separation of overlapped cells Watershed Transform is used and for nucleus segmentation, an efficient contour based Level Set technique is used. Cytoplasm is segmented by Mathematical Morphological operations. Finally features are extracted from the segmented cells for further classification. Classification to differential WBC is done using SVM classifier. The proposed scheme is found to be promising and can be applied to images with varying cell appearance and encourages future work.

KEYWORDS: *Image Processing, Recognition, Leukocytes, Detection, Matlab*

I. INTRODUCTION

Leukocytes (WBC) composition is very useful for the diagnosis of various kinds of disease present in our body. Automatic detection and classification of differential WBC plays a vital role in the field of diagnosis of cancer. This recognition is done by Haemotologists whenever there is suspection of malignancy. While dealing with such kind of malignancy using traditional method of manual diagnosis seems to be very difficult, slow and subjective. Therefore automation of the system is very essential for the improvement in haematological procedure and seems to be very fast in diagnosis.

There are 5 different types of Leukocytes in the human body namely Neutrophil, Eosinophil, Basophil, Lymphocyte, Monocytes. Because of this WBC is called Differential WBC when considering its types rather than the whole part. It is shown in Fig 1.

Neutrophil Eosinophil Basophil Monocyte Lymphocyte

Fig 1. Types of Immune cells

Neutrophil contain more than three nucleus interconnected to kill bacteria when gets injected. It is also called PolyMorphoNuclear (PMN) leukocytes since it contains multilobed nucleus. They kill 5-20 bacteria in their lifetime. It deals with bacteria andfungi most of the time. They live around 6 hours to few day after which they dies out. Eosinophil target includes parasites that are larger in size. They live around 8-12 days. They are inflammatory cells thus used in allergic reactions. Basophils also are used in allergic reactions which release more histamine and attract heparin which prevents clotting of blood in the infected areas. Their lifespan includes few hours to few days. Lymphocyte has single nucleus with 3 different types of cells namely B-cells, T-cells and Natural killer cells. It kills viruses and are helpful when becoming cancerous. Monocytes are larger in size with kidney shaped nucleus. Their lifespan is longer to present pathogens to T-cells so that they will be recognized and killed completely. They destroy old, damaged cells and gets changed to macrophages after 10-20 hours. These macrophages may live from months to years.

II. PROPOSED METHOD

Most important of all the diagnosis process is the segmentation of Leukocytes. A normal blood smear image has three types of objects namely background, Erythrocytes and Leukocytes. Our approach is to use scale space operator after the conversion of RGB image into grayscale. After which segmentation of WBC, its nucleus and cytoplasm is done. This method holds good even in case of complicated background and overlapped RBCs.

The first step involves image acquisition. We have acquired images of cells from medical library as our input. These images since are free from noise, these can be taken directly to the process of segmentation. In case of noisy image, it has to undergo some noise removal procedure after which it can be taken for further processing. Digital filters are used in most of the case to remove noise in the better manner. After this step the image is applied for scaling operation which is done by SMMT. This is a toggle operator which has two rules: primitive and decision rule. Here morphological operations like erosion and dilation is used as primitives and decision rule makes decision depending on the value of function f(x) and the primitive result. Formally

$$(f\, g_\sigma)^k(x) = \begin{cases} \psi^k{}_1(x) & \text{if } \psi^k{}_1(x) - f(x) < f(x) - \psi^k{}_2(x) \\ f(x) & \text{if } \psi^k{}_1(x) - f(x) = f(x) - \psi^k{}_2(x) \\ \psi^k{}_2(x) & \text{otherwise} \end{cases} \quad \text{------(1)}$$

where $\psi^k{}_1(x) = (f \oplus g_\sigma)^k(x)$ is the dilation of f(x).

Depending upon the applications it uses structuring element of larger in size. This operator has a strong monotonicity property with well controlled behavior which is used for preserving geometric features of the microscopic images. Here iteration of this operator regularizes the edge which in turn improves the quality of the gradient of cell images for the betterment of segmentation. Localization of the cells required can also be done through this toggle operator.

The next step is the separation of overlapping cells. This is done by applying watershed transformation. Sometimes it may leads to over-segmentation which could be avoided by path-cost function. This would take the characteristics of required microscopic images. Watershed transformation includes assigning internal seeds and external marker. It purely applies to the gradient images. Since WBC has nucleus part dark than the other parts, a simple thresholding like Otsu"s thresholding is done to retrieve sample of each leukocytes. Whenever inconsistency is retained, there occurs change in the contrast in-between the boundaries of cytoplasm and nucleus. Thus in that case watershed by Image Forest Transform which avoid leaking pixels is used. But these methods are avoided in our system by the usage of SMMT operator. Since SMMT provides simplified image and regularization in contour, direct implement of watershed after SMMT separates the touching cells. The original gradient of the image is weak which in turn is solved by the Scale Space operator than the usage of traditional operators like Laplacian operator and High-Boost operator etc. Toggle operator also has the function of filtering and preserving. Erosion is performed later, to avoid the small portion connected with nucleus and cytoplasm since nucleus has no sharp boundaries.

After the separation of overlapping cells, the leukocytes are segmented using Automatic

thresholding along with Contrast Stretching, Histogram Equalization, Image arithmetic like addition and subtraction , filtering.

The resultant image from watershed transformation is subjected to linear Contrast Stretching (C) and another copy of resultant image undergoes Histogram Equalization (H). The image from C and H get added together to form R. The equation is given by

$$R(i,j) = C(i,j) + H(i,j) \quad \text{----------(2)}$$

Now Subtraction is performed between H and R to get R1. By doing so, the borders of the nuclear image get highlighted.

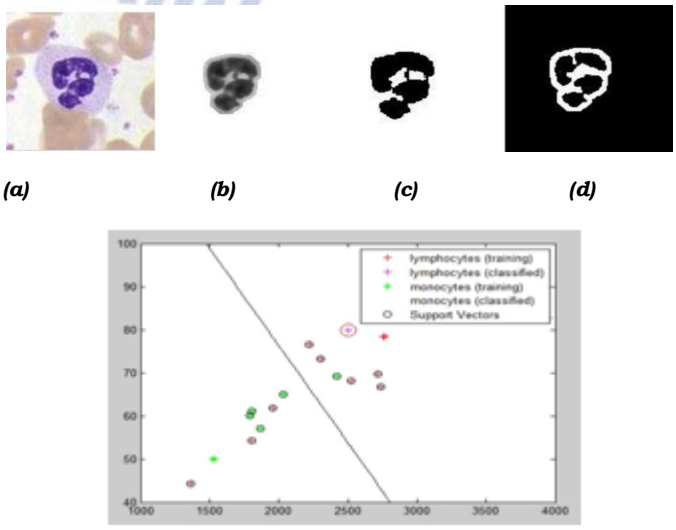
$$R1(i,j) = R(i,j) - H(i,j) \quad \text{----------(3)}$$

Now at last addition is performed between R and R1 to produce R2.

$$R2(i,j) = R(i,j) + R1(i,j) \quad \text{----------} \quad (4)$$

To avoid miss-segmentation, 3 By 3 minimum filter is used for enhancing the intensity value of nucleus to make it darker so that it can be detected well in case of automatic thresholding. Here, the 2D order statistics filtering replaces each element in input by the orderth element in the sorted set of neighbors specified by the nonzero elements in domain. From the segmented WBC, nucleus is extracted by Level Set method of Segmentation that are motivated by Active contour approach. It represents the image surface as the zero level interfaces. It fixes an internal marker of smaller size inside the image. The mask expands under it finds the edge of the image. In case it does not encloses the whole image, it expands and in case of marker moving out of the image, it contracts. Thus the mask is fixed on the nuclear boundary which is very useful for its segmentation. The leakage of the curve at the edge of the object is prevented by using the equation

Thus, gI(x, y) approaches to one when the mask is outside of the edges of the image and tends to zero nearer to the edge. It can also be said like marker unless it mark the interest region it revolves which can be identified by reduction of velocity of gI to zero. This method is used for images of higher dimensions which is advantageous. Sometime due to reinitialization the computation cost may be increased. Due to the usage of SMMT, this problem is solved. Thus nucleus is segmented from leukocytes by Level Set. After segmenting nucleus, our work is to segment cytoplasm which is done here by Mathematical Morphological Operations. Here a morphological operation like bottom-hat transform is used for highlighting the brighter regions. The nucleus part is eliminated from WBC by thresholding which is followed by Opening for connecting cytoplasm. Flood –fill operations followed by opening is done for elimination of smaller areas and for removal of associated RBC in the microscopic images. By doing so and by application of Xor operation on the resultant image, cytoplasm is segmented. Here the segmentation for Neutrophil, Lymphocyte and Eosinophil is done.



(a) *(b)* *(c)* *(d)*

(e)

Fig 2(a) RGB Neutrophil (b)Neutrophil segmented (c)Nucleus segmented (d)Cytoplasm segmented (e) SVM classification between lymphocytes and monocytes.

Features are extracted by transforming input data into sets of feature for reducing the amount of resources required for describing larger sets of data. Features extracted in our work include Area, Perimeter, Eccentricity, Centroid, Major Axis Length, Minor Axis Length, Convex Hull, Convex Image, Convex area, and Solidity. These features are used essentially for feature classification. Classification is done using SVM. SVM is a statistical learning method established on a structural chance minimization procedure that minimizes the upper attached generalization errors encompassing of the sum of training errors and an assurance interval. The aim across the training procedure is to find the separating hyperplane alongside the biggest margin in the obtained hyperspace. The transformation is used for a non-linear purpose whose form is determined by a little kernel. Thus here SVM is used to classify lymphocytes and monocytes. Likewise it can be used for differential immune cells.

III. CONCLUSION

In this paper, image segmentation and classification has been counseled. Here features have been extracted from the labeled component and database has been created. With the help of this database, Classification has been done. This counseled method is extra reliable and computationally less luxurious and yet yields a comparable classification rate.

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