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Review on Blood Cell Image Segmentation and Counting

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ABSTRACT

Investigating blood cells through images have attracted researchers recently, because of reduced complication in medical diagnosis process. Numerous image processing algorithms and methods and have been developed to segment Red Blood Cells (RBC) and White Blood Cells (WBC) and counting. Generally, blood cell segmentation and counting methods include image acquisition, pre-processing to enhance image quality and to exclude noisy information and further to segment and count the number of various blood cells present in the image. Among these various tasks, blood cell segmentation is a major challenge ahead. Numerous blood cell segmentation methods have been presented in the literature. This paper reviews few popular techniques and summarizes them in a systematic common evaluation bench. The techniques under review perform blood cell segmentation and counting on images acquired through both microscope and camera.

Keywords:- review, blood cell, segmentation, counting, WBC, RBC

1. INTRODUCTION

The hematological report has lot of importance in medical science. The report results display the details of main test parameters i.e. blood components like RBC count, WBC count, platelet count etc and also the analogy of these components. Investigating the blood components helps in diagnosing diseases like anemia, malaria and many more. However, pathologists confess lags in speed and accuracy, when they attempt to handle huge number of blood samples. So, the necessity to have software based solution has arisen. This paper presents the overview of previous techniques used for processing blood cell images using various image processing techniques along with a review summary on a systematic common evaluation bench. Despite none of the algorithms is compatible with real time image acquisition process, they provide some insight into the feasibility of image processing techniques [7]. The paper is organized as follows. Section 2 briefs the components of blood. Section 3 provides review of various blood cell segmentation techniques. Section 4 summarizes the review platform and Section 5 concludes the paper.

2. COMPONENTS OF BLOOD

One micro liter of blood contains:

- 4.7 - 6.1 million (male), 4.2 - 5.4 million (female) erythrocytes
- 4,000–11,000 leukocytes
- 200,000–500,000 thrombocytes

2.1 Erythrocytes (RBC)

RBCs contain the blood's hemoglobin and distributed oxygen. Mature RBCs of mammals do not have nucleus and organelles. RBCs (together with endothelial vessel cells and other cells) are also marked by glycoprotein’s that define different blood types. The proportion of blood occupied by red blood cells is referred to as hematocrit, and is normally about 45%. The combined surface area of all red blood cells of the human body would be roughly 2,000 times as great as the body's exterior surface [14].

2.2 Leukocytes (WBC)

White blood cells are part of the body's immune system. They destroy and remove old or aberrant cells and cellular debris, as well as attack infectious agents (pathogens) and foreign substances. The cancer of leukocytes is called leukemia [14].

2.3 Thrombocytes (Plateletes)

Thrombocytes or plateletes are responsible for blood clotting (coagulation). They change fibrinogen into fibrin. This fibrin creates a mesh onto which red blood cells collect and clot, which then stops more blood from leaving the body and also helps to prevent bacteria from entering the body [14].

3. BLOOD CELL SEGMENTATION AND COUNTING TECHNIQUES

3.1Image Segmentation: A General Review

In computer vision, image segmentation is a process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or to represent the image in a more meaningful and easier manner to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share similar visual characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (see edge detection). Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s) [1]. Hualiang Zhuang proposed a pulse-coupled neural network (PCNN) with multichannel (MPCNN) linking and feeding fields for color image segmentation. The performance of the proposed MPCNN is comparable to those of other popular image segmentation algorithms for the segmentation of noisy images while its parallel neural circuits improve the speed of processing drastically as compared with the sequential-code-based counterparts [2].

3.2Morphological Methods

Leyza Baldo Dorini *et. al.* have simplified image and regularized contour based on self – dual multiscale morphological toggle (SMMT). They have segmented nucleus after SMMT based pre-processing and hence better segmentation efficiency has been accomplished. Further, they have determined cytoplasm using morphological transformations. Wid number of images have been considered for experimentation and the performance have been investigated. The classification results have been observed and analysis has been made based on the outcome [3]. J. Poomcokrak and C. Neatpisarnvanit have worked on extracting and counting red blood cells. In their process, they have exploited morphological operations in a significant way. They have used three renowned morphological operations such as image dilation, image filling and image erosion. Image dilation provides the information about the border of the blood cell, but the cell interior has holes still. Image filling process fills the holes and provides the biggest area of the image. Erosion can be seen as a post processing method, because it makes the segmented objects in a more sensible visualization [5]. Nasrul Humaimi Mahmood and Muhammad Asraf Mansor have used Hough transformation for RBC segmentation and counting. They have categorized image pixels into lower and higher pixels and have applied two morphological operations. The two morphological operations are morphological closing and dilation. Morphological closing is applied to lower pixel value image and morphological dilation on higher pixel value image. Finally, they have applied morphological xor operation to segment RBC [8]. Yi-De Ma *et. al.* have proposed a simple blood cell segmentation and counting method based on logical and morphological information of blood cells. They have mainly exploited the morphological erosion and labeling operations to perform the tasks [13].

3.3 Granulometric Methods

Leyza Baldo Dorini *et. al.* have used granulometric function to determine the distribution of RBC size. The granulometric analysis have been performed based on six feature extracted from the image such as area, eccentricity, area of convex part, perimeter and ration between nucleus and cytoplasm. Nucleus segmentation has been carried out using two renowned algorithms such as level set method and watershed segmentation. Wide experimental investigation has demonstrated the performance of the algorithm under various scenarios [3] J.B. Nemane and V. A. Chakkarwar have presented a segmentation algorithm in which granulometry, mask function and pre-processing have been considered. They have first removed the noised and then performed watershed segmentation [4].

3.4 Supervised Methods

J. Poomcokrak and C. Neatpisarnvanit have used multilayer perceptron neural network for blood cell counting. They have provided adequate training to the network using a training library with RBC characteristics, sickle cells, etc. Given unknown segmented cells, the network has provided the category of the cell and hence the number of cells have been counted. [5] Joost Vromen and Brendan McCane have presented a simple Bayesian model accompanying with polynomial model. The model have ensured smooth boundaries and hence for better cell segmentation and counting. Prior, they have presented a model based contour tracing approach to the problem of automatically segmenting a Scanning Electron Microscope image of red blood cells [6]. Navin D. Jambhekar have used artificial neural network to classify RBC by distinguishing its shape from other cells. Firstly, we have used edge detection and segmentation techniques to segment blood cells from microscope image. Further, trained neural network has been used to classify the cells. They have also presented the way of classifying different RBC structures based on various methods of image processing [7].

3.5 Supplementary Methods

Sanaullah Khan have developed a methodology for blood cell segmentation and counting in which various phases have been included. They have included contrast enhancement prior to gray scale conversion and further processing steps.

They have applied histogram equalization and thresholding schemes to perform segmentation in an efficient manner. The thresholding method has paved the way for supplying noiseless image for segmentation process in which filtering process is performed. The work has recommended iterative thresholding method to obtain quality blood cell segmentation outcome [12]. Ruihu Wang has worked on scanned electronic microscope (SEM) images to categorize blood cells. They have mapped intensity level image into a 3-D depth through Shape from Shading (SFS) to obtain the vertical alignment of every pixel, followed by extracting the top level of each cell using region growing method. The region growing method has been developed based on boundary contour tracing that has been used for feature extraction and statistics computation [15].

4. REVIEW SUMMARY

Despite numerous methods have been reported in the literature at diverse intents, it is essential to review them in a common platform. We provide such a summarized review through Table 1 in which feature based review is tabulated.

Table 1: Review summary based on various features and performance measures

Methods		**Features**									**WBC segmentation and counting accuracy (In %)**	**RBC segmentation and counting accuracy (In %)**	**Sideline methods**
		Area	**Solidity**	**Eccentricity**	**Area of convex part**	**perimeter**	**Nucleus to cytoplasm ration**	**Centroid**	**First order minima & maxima**	**curvature**			
Granulometric analysis [3]	I			*		*					68.57	-	
	II			*	*	*					69.43	-	Watershed and level set method
	III			*	*	*	*				71.43	-	
	IV	*	*	*	*	*	*				54.29	-	
Morphological operations [3]	I			*		*					68.57	-	Watershed and level set method
	II			*	*	*					69.43	-	
	III			*	*	*	*				78.51	-	
	IV	*	*	*	*	*	*				59.57	-	
Granulometric analysis [4]		*										-	watershed
Neural network [5]								*				74	Morphological processing
Bayesian model [6]				*								82.5	Gradient tracing and kalman filtering
Neural network [7]									*		81		Gradient and Laplacian methods
Morphological methods [8]		*				*						96	Hough transform
Histogram Thresholding [12]		*									95		
Region growing [15]										*	-	-	

5. CONCLUSION AND FUTURE SCOPE

The aim of segmenting the blood cell is to identify the exact components of blood from background and to count. The paper gives the different methods of segmentation and counting of blood cells from blood smear. But we cannot perfectly talk about any single method that gives the absolute results, because each method has its own drawbacks. So we need to find out a solution which gives us maximum accuracy. Hence, the scope is wide in developing such a robust methodology to segment and count blood cells without compromising performance rate.

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