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Efficient Approach to Detect Hypochromic and Normochromic Anemia through Image Processing

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ABSTRACT

Hypochromic and Normochromic anemia have taken prodigious possession in the research field. In this paper, we have proposed a process that will feasibly detect the Hypochromic and Normochromic anemia. The task that goes elementarily in image processing is the reduction of the noise from image. Therefor, Harr Wavelet (level-2) has been applied as a tool to contrive the process of noise reduction from image. Extraction of significant information from the image is the vital job. For this purpose, segmentation is used. Here, Watershed transform has been applied. Significance has been provided in the calculation of the number of true pixels of blood cells and filled (whereas the blood cells filled with truth value (1) using imfill()) blood cells. Hereafter, their ratio will have been employed for the detection of the Hypochromic and Normochromic anemia. The outcome of the proposed process exhibits the accuracy of 96.7% whither manually processed result is lower.

Keywords

Hypochromic, Normochromic, Harr Wavelet, Watershed Transform, Hemoglobin

1. INTRODUCTION

Blood is the aggregation of plasma and cells which provides three fundamental functions: transportation, protection and regulation. Composition of blood includes red blood cells (erythrocytes), white blood cells (leukocytes) and platelets (thrombocytes). Fig.1 shows the three elements. RBC is appointed to the transportation of oxygen from lung to body cells and carbon dioxide from body cells to lung. WBC primarily serves in protecting human body against infection, bacteria, viruses, pathogen and microbes. Platelets accomplish the job of regulation. They are responsible for the impediment of bleeding from wound in human body. They coagulate the blood cells.

There lies a strong relationship between RBC and hemoglobin. Hemoglobin is a protein that delivers the red essence of blood. Deficiencies of it make the blood cell white from its center. If hemoglobin decreases the amount of white dots increases gradually and vice versa. When the amount of white dots is less than 1/3 of taken blood cell, then the cell represents Normochromic contrariwise white dots greater than 1/3 of taken blood cell is representative of Hypochromic. Any human exhibits this circumstance is regarded as anemic patient [1]. Fig.2 shows Hypochromic and Normochromic blood cell.

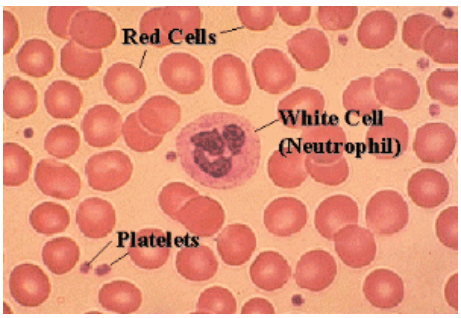
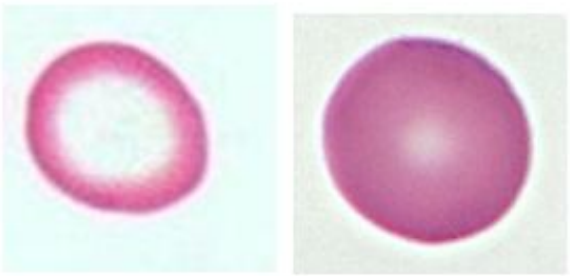


Fig. 1. Blood Cell.

In conformity with the National Cancer Society, grading assessment of anemia can be narrated as follows: Grade0) hemoglobin 12.0-16.0 g/dl (male), 14.0-18.0 g/dl (female) suggests normal state. Grade1) hemoglobin ranges in 10.0 g/dl to normal limits suggest mild severity. Grade2) hemoglobin 8.0-10.0 g/dl suggests moderate severity. Grade3) hemoglobin .5-7.9 g/dl suggests the severe state. Grade4) hemoglobin less than 6.5 g/dl suggests the life threatening state [2].

Anemia is a ubiquitous problem excruciating 1.62 billion people both in developed and developing countries. It is cankering billions of dollars annually from human capital [3]. None are free from the attack of anemia. However, pregnant women are vulnerable to this disease. Lack of iron is the main cause of anemia in the circumstance of pregnancy. Almost 80% of the pregnant folks are affected by this [4]. In developing countries, children whose age is under 5 years, about 39% of them suffer from anemia. Besides, children whose age is between 5-14 years, about 48% of them suffer from anemia [5]. Common symptoms of anemia are weakness, fatigue, headache, tiredness, sleeping problem, chest pain, irregular heartbeat, rapid heartbeat, cold skin and shortage of breath after exercise etc.



(a) (b)

Fig. 2. Red Blood Cell: (a) Hypochromic RBC (b) Normochromic RBC.

2. LITERATURE REVIEW

For many years of expedition, extensive exploration on blood cells to detect several diseases has been done. S. Chandrasiri and P. Samarasinghe in their paper Automatic Anemia Identification through Morphological Image Processing, have identified Elliptocytes, Microcytes, Macrocytes and Spherocytes anemia [6]. They applied watershed transform as a segmentation technique. Jameela Ali, AbdulRahim Ahmad, Loay E. George, Chen Soong Der, Sherna Aziz have recognized anemia in Red Blood Cell Recognition using Geometrical Features [7]. They have applied Fourier descriptors, aspect ratio and moments as Geometrical Features. Besides, City Block Distance has been applied as classifier.
Mojtaba Taherisadr, Mona Nasirzonouzi, Behzad Baradaran, Alireza Mehdizade in their paper New Approch to Red Blood Cell Classification Using Morphological Image Processing has classified blood cells in 12 categories [9]. For classification of blood cells shape, circularity, internal central pallor and elongation of blood cells are extracted with the help of decision logic. Sumeet Chourasiya and G Usha Rani have implemented a process to count red blood cells using watershed transform in paper Automatic Red Blood Cell Counting using Watershed Segmentation [10].

3. METHODOLOGY

Here, a method has been introduced to detect Hypochromic and Normochromic anemia in human blood cells. Implementing this process required images disaggregating we procured 60 images amongst them 30 are Hypochromic and rest are Normochromic. Images are generated from imagebank.hematolohy.org and https://openi.nlm.nih.gov. Whole process is implemented in MATLAB 2014. Fig.3 shows the methodology of this paper which is expanded in the next sections.

3.1 Preprocessing

Obligatory specimen of image based application directs to preprocessing. First step is to reduce the noise and this momentous task is done through Harr wavelet (level-2). This tool perpetrate better than other noise reduction techniques. The performance of noise reduction technique is measured by peak SNR. The more the peak SNR is, better the performance is. Harr Wavelet has more peak SNR value. So this technique is chosen. For Fig.4 peak SNR value using Harr Wavelet is 38.8863 where peak SNR value is 18.1416 when we used imfilter function.

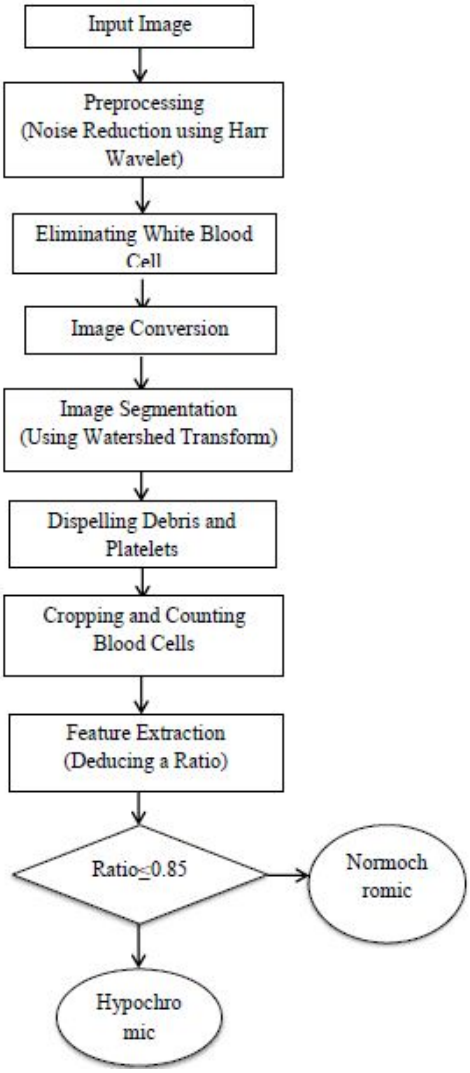


Fig. 3. Flowchart of implemented work.

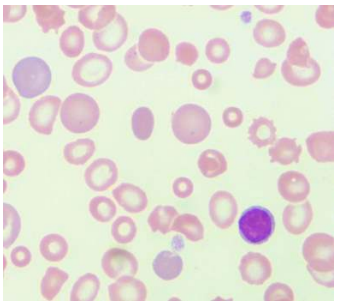
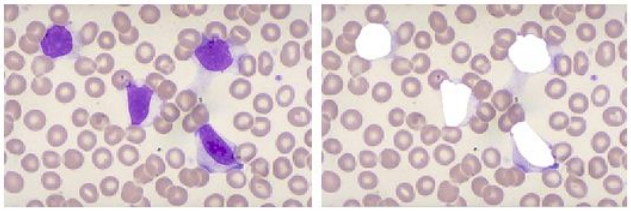


Fig. 4. An image of blood cells.

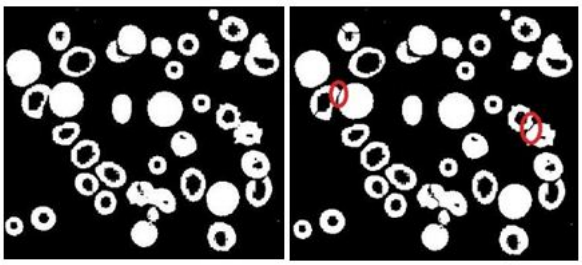
3.2 Eliminating White Blood Cells

The proposed method are asserted only RBC for the purpose. In the procurement of these images, WBC and platelets are persist in image. WBC and platelets must be eradicated to complete our task.



(a) (b)

Fig. 5. White blood cell removing process : (a) Original image (b) Image after removing WBC.



(a) (b)

Fig. 6. Image segmentation process : (a) Image before segmentation (b) Segmented image.

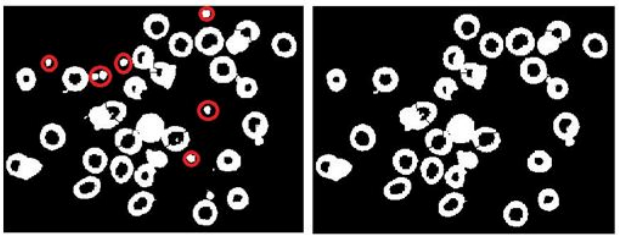
In this purpose, RGB image is converted into HSV and saturation component is observed. A saturation of 0.4 is set. Objects containing pixels less than 300 are removed from the saturated image. The remaining cells contain holes which have been removed. Dilation operation is performed on mask to make sure that the rest of purple surroundings are eliminated from the image. Using this mask and masking original image, a final image is produced having no white blood cells. The inverted mask is multiplied with original image and fills in the missing information with white. The procedure of removing platelets is described in subsection 3.5.

3.3 Image Conversion

Images are converted into gray scale from RGB and then applying imadjust function contrast of converted image (gray scale) is increased. Thereafter, gray scale image is converted into binary image using Auto Thresholding. There is a threshold value T. If the value of pixel is greater than or equal to T then pixel is labeled to 1 otherwise 0.
For the purpose of highlighting the blood cells and extracting features from them, binary image is inverted. Blood cells adjacent to border are removed to ignore incomplete blood cells.

3.4 Image Segmentation

Egregious question in image processing of blood cells introduces us to the term of overlapping of blood cells. Conquering this phenomenon is a challenge and that is polishedly done through segmentation technique. As segmentation technique watershed is used. Fig.6 shows the separation of blood cells which were connected previously. Say for example, red circles in Fig.6(b) indicate the separation area of two connected blood cells.



(a) (b)

Fig. 7. Dispelling debris and platelets : (a) Before clearing (b) After clearing.

3.5 Dispelling Debris and Platelets

During the exploration of blood cells quidam obstacles peered us named debris and platelets (small purple dots). Images applied in our work are microscopy image. Before collecting microscopy images they are spread on slide. Because of environmental exposure, there may have existence of debris on a slide. These debris and platelets must be removed from image to get complete blood cells. For the purpose of removing debris and platelets from the image, objects having number of pixels less than 300 have been eliminated from image. Fig.7 shows the process of clearing debris and platelets. Say for example, red circles in Fig.7(a) indicate the debris and platelets.

3.6 Cropping and Counting Blood Cells

Abolishing of debris and platelets from image retains only complete blood cells in the image. Counting blood cells in medical science is considered as a major term because of detecting several disease in human body such as anemia, leukemia etc. Conventional methods to count blood cells are not efficient and they are prone to errors. Watershed transforms segmentation technique has been appointed to dispel debris and platelets thus only complete red blood cells are apprehended in the image. Using ”imcrop” function each blood cell is cropped and then counted those cropped blood cells.

3.7 Feature Extraction

3.7.1 Sphere shaped blood cells identification. The color of blood cells is red because presence of hemoglobin. For lack of hemoglobin, in center of blood cells pallor exists. Blood cells containing pallor are called sphere shaped cells. At first number of true pixels (NofTP) of each blood cell is counted. Either pallor exists or not exists in blood cell imfill function is used to fill up blood cell. Then number of true pixels of filled blood cell (NoTPF) is counted. For a blood cell, if the difference between NofTP and NofTPF is greater than 40 then blood cell is considered as sphere shaped blood cell. An image containing no sphere shaped blood cell is regarded as Normochromic (See Image No 12 in Table 2).

3.7.2 Deducing a Ratio. A ratio is calculated to detect Hypochromic and Normochromic image.

$$Ratio = \frac{\sum NofTP}{\sum NofTPF}, \tag{1}$$

If the value of ratio is less than or equal to 0.85 then the image is said to be Hypochromic otherwise the image is Normochromic.

Table 1. Results of hypochromic images.

Image No	Ratio	Decision
Image 1	0.6560	Hypochromic
Image 2	0.7428	Hypochromic
Image 3	0.7665	Hypochromic
Image 4	0.7993	Hypochromic
Image 5	0.8024	Hypochromic
Image 6	0.8123	Hypochromic
Image 7	0.8107	Hypochromic
Image 8	0.8470	Hypochromic
Image 9	0.7578	Hypochromic
Image 10	0.7905	Hypochromic
Image 11	0.7185	Hypochromic
Image 12	0.8001	Hypochromic
Image 13	0.7906	Hypochromic
Image 14	0.8091	Hypochromic
Image 15	0.7595	Hypochromic
Image 16	0.6989	Hypochromic
Image 17	0.8112	Hypochromic
Image 18	0.7816	Hypochromic
Image 19	0.8068	Hypochromic
Image 20	0.8492	Hypochromic
Image 21	0.8418	Hypochromic
Image 22	0.8416	Hypochromic
Image 23	0.8496	Hypochromic
Image 24	0.7073	Hypochromic
Image 25	0.7914	Hypochromic
Image 26	0.8394	Hypochromic
Image 27	0.6953	Hypochromic
Image 28	0.7911	Hypochromic
Image 29	0.8664	Normochromic
Image 30	0.6449	Hypochromic

Table 2. Results of normochromic images.

Image No	Ratio	Decision
Image 1	0.8971	Normochromic
Image 2	0.9031	Normochromic
Image 3	0.9072	Normochromic
Image 4	0.9031	Normochromic
Image 5	0.9381	Normochromic
Image 6	0.9172	Normochromic
Image 7	0.9677	Normochromic
Image 8	0.8963	Normochromic
Image 9	0.9468	Normochromic
Image 10	0.9736	Normochromic
Image 11	0.9079	Normochromic
Image 12	1	Normochromic
Image 13	0.9137	Normochromic
Image 14	0.9172	Normochromic
Image 15	0.9853	Normochromic
Image 16	0.9661	Normochromic
Image 17	0.9468	Normochromic
Image 18	0.9248	Normochromic
Image 19	0.9563	Normochromic
Image 20	0.9039	Normochromic
Image 21	0.8877	Normochromic
Image 22	0.9019	Normochromic
Image 23	0.8835	Normochromic
Image 24	0.8398	Hypochromic
Image 25	0.9286	Normochromic
Image 26	0.9500	Normochromic
Image 27	0.9011	Normochromic
Image 28	0.9185	Normochromic
Image 29	0.9216	Normochromic
Image 30	0.9099	Normochromic

4. RESULT ANALYSIS

Herein this section analysis of the result of the proposed method is discussed. The accuracy level of proposed method is about 96.7%. In Table 1, result of 30 Hypochromic image is shown with Ratio where Ratio is calculated using equation (1). Similarly, the result of 30 Normochromic image is shown in Table 2 with Ratio.

5. CONCLUSION AND FUTURE WORKS

Here, a method have been manifested to track out Hypochromic and Normochromic anemia by exploring blood cells. In the first instance, WBC have been dispelled from image. While working with blood cells, a problem arose named overlapping of blood cells that has been separated using watershed transform as a segmentation technique. The developed method is more efficacious and cost friendly to detect anemia than manually detection of anemia. Most importantly, the proposed method has an accuracy level of 96.7%.

Anemia can be classified into four grades (Grade 0, Grade 1, Grade 2, Grade 3) based on amount of hemoglobin in blood. In future, our task will be identifying these four grades through image processing.

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