DETECTION OF ANEMIA: A REVIEW

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ABSTRACT

Anemia is the most common hematological disorder affecting about one-fourth of the world population. It can be defined as the decrease in the amount of hemoglobin in blood or can be described as the lowered ability of the blood to carry oxygen. The manual identification, counting and detection of red blood cells to identify presence of anemia is a tedious and also an error generating procedure. So many detection processes using image processing based techniques has been proposed by different researches using different methods .Various transform methods and segmentation procedures are among those methods to detect and finally making a count on it using counting algorithms to identify the presence of anemia. This makes detection process an efficient and also an accurate one. The objective of this paper is to produce a review on an image processing based system which is able to automatically detect and count the number of RBCs in the blood sample image and finally to detect anemia.

Keyword - *Anemia detection, Image processing, Segmentation, Transform methods.*

1. INTRODUCTION

For overall health evaluation and diagnosis of many blood disorders including anemia complete blood count is required. The human blood consists of 3 main types of blood cells such as red blood cell (RBC), white blood cell (WBC) and platelets . A person's full body health is determined using complete blood count. Blood cell segmentation and identification is important as blood being an important health indicator. Abnormal increase or decrease in cell count indicates that person has underlying medical conditional issues.

Red blood cells which is also known as erythrocytes are the most important and numerous blood cells in human body. Main function of RBC's is to carry oxygen and deliver it to the cells in body .They are minute disc or round shaped. They does not contain nucleus at their center but a protein called hemoglobin. Both inner and outer layers of cells are made up of protein that gives red color to blood . Hemoglobin actually does the work of taking and carrying of oxygen from different body tissues. Usually level of hemoglobin can be tested in blood test. Decrease in their level may cause severe diseases including anemia, blood loss, leukemia and malnutrition and other type of blood disorders.

A life span of RBC is found to be around 120 days for normal individual. A normal RBC count for an adult male is in range between 4.6x1012 and 6.2x1012 per liter of blood. Typical red blood cell count (RBC) levels in blood are:

- For women, 4.2 to 5.4 million cells per micro liter
- For children, 2.6 to 4.8 million cells per micro liter
- For men, 4.5 to 6.2 million cells per micro liter of blood

In diagnosis of several diseases, one of the major step is automated detection and counting of red blood cells. In the conventional procedure, haematologist manually counts and classifies the red blood cells with the help of a microscope. The task is to measure the red blood cells and finding out the size and shape of red blood cells. But this procedure is time consuming, complex and tedious one. Also, the accuracy of recognition is affected by some factors like experience and fatigue due to human tiredness conditions. As a solution to this problem, to provide automated, cost-effective and efficient alternative to detection and counting of RBCs, different image processing techniques are used.

2. RESEARCH WORK ON ANEMIA DETECTION

In this paper, a review is done on some of the methods of RBC detection and counting and finally anemia detection based on the results obtained.

The conventional method which is used to count blood cells involves counting by Hemocytometer. This device is specially designed for the complete blood count mainly red blood cells. Hemocytometer was invented by Louis-Charles Malassez. It consists of a chamber of special dimensions. This chamber is created by a rectangular thick glass microscopic slide. This chamber has grid of perpendicular lines etched on it. For counting purpose, person have to view Hemocytometer through a microscope and count red blood cells using hand tally counter. The depth of this chamber and area bounded by perpendicular lines is known. Therefore it is possible to count the number of red blood cells present in a specific volume of fluid, and thereby calculate the concentration of cells in the fluid overall.

In a manual counting method of RBC, 10 µl of blood is mixed with 2000µl of dilution solution. i.e. dilution ratio is 1:200. Then counting chamber is immediately filled with well mixed dilution solution and blood sample. After 3-4 minutes, the RBC's will be settled, and the counting of RBC's begins. This counting is done in 80 small minute squares.

Formula for RBC count: RBC (in count/µl) = Number of RBCs counted× dilution factor

or

Number of squares×volume above a small square

Drawbacks of the manual method:

a). It is time-consuming and laborious task.

b).Counting overlapping blood cells is a major problem.

c). It is a difficult task to get accurate results from visual inspection.

In image processing approach, there are 6 major steps involved in blood cells estimation.

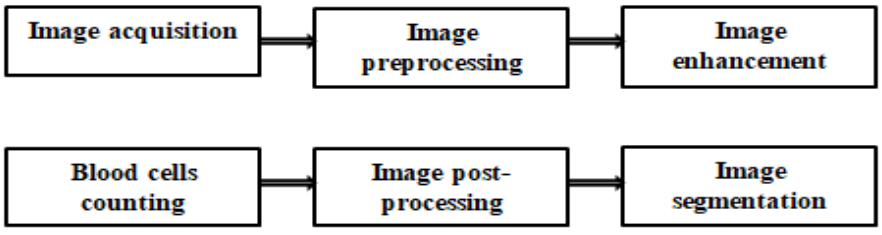

Fig -1:Flow chart

The first step in this process is image acquisition that is, to acquire a digital image of blood sample. Usually it can be obtained from online medical library or hospital blood sample images. These images are in the RGB color format. The Image pre-processing technique adjust images suitable for the next step of computational process. It is done in such a way that image quality is improved for the success of the other processes. Pre-processing techniques usually include enhancing contrast, removing noise, isolating regions and use of different color models like Gray scale image, hsv image etc... Original blood cells images are in RGB color format. To ease the process of ratio determination, the original images are converted into gray scale color format. Gray scale represents the image intensity. Acquired images have low contrast as all blood elements colors are in close to background color format. Noise is also included due to presence of clustered white blood cells. To overcome or reduce such effects image contrast enhancement is done. After pre-processing, image enhancement is done.

The next stage deals with the image segmentation. Segmentation partitions an input image into the foreground and background region. There are various approaches for segmentation method i.e. segmentation by using histogram and thresholding, Otsu adaptive thresholding and watershed transform, Hough transform technique as well as segmentation by Means of k-clustering method. The objective of segmentation is extraction of the desired objects from the background. Segmentation is a more complex step and requires more processing time in comparison with the other methods. However it is one of the most important and challenging step because the feature extraction and counting depends on the correct segmentation of RBC. Feature extraction involves morphological operations. It extracts features that contain quantitative information about objects of interest. Shape features are areas of cell and nucleus, cell perimeter, ratio of nucleus to overall cell area, boundary of the nucleus, metric value, aspect ratio and circularity factor. Texture features include contrast, homogeneity and entropy derived from the gray-level co-occurrence matrix obtained after enhancement process. Feature extraction techniques include classifiers like Artificial Neural network (ANN) support vector machine (SVM) and other classifier techniques.

To measure number of RBC's counting algorithm approach is applied. Connected components labeling method, is the most popular method used for counting. Besides that circular Hough transform, circlet transform is also used to get the RBC count and finally detection of anemia.

2.1 Transform Based Methods

Omid Sarrafzadeh and Alireza Mehri Dehnavi indroduced a novel method for RBCs segmentation and counting them from microscopic blood sample images using Circlet Transform[1]. It operates directly on gray scale image and does not need further binary segmentation. First, mask of RBCs is obtained and after that circlet transform is applied on gray-scale image. Then, minimum and maximum number of RBCs are estimated. Finally, RBCs are detected and counted by using an iterative soft-thresholding method and removed conflict RBCs. CT is able to segment RBCs even at very low gradient where CHT-based method failed to do this. This proposed method outperforms other methods in terms of accuracy.

Venkatalakshmi. B et al. proposed a method for automatic red blood cell counting using Hough transform technique[2]. This algorithm for estimating the red blood cells consists of five major steps: input image acquisition, pre-processing, segmentation, feature extraction and counting. In pre-processing step, original human blood smear is converted into a HSV image format. As the Saturation image clearly shows the bright components, it is further used for analysis procedure. First step of segmentation is to find out lower and upper threshold from histogram enhancement based information. Then Saturation image is divided into two binary images based on this information. For lower pixel value image, morphological area closing is applied and morphological dilation and area closing is applied to higher pixel value image. For two binary images, morphological XOR operation is applied and circular Hough transform is applied to extract RBCs.

Mazalan and Humaimi Mahmood introduced a method to count a total number of RBC in peripheral blood smear image by using circular Hough transform (CHT) method[3]. This process includes preprocessing and segmentation a single cell image of RBC after cropping process it to get the minimum and maximum radius of the same. Then based on the range radius of cells CHT method is applied to detect and count the number of RBC. Based on the result of RBC counted using the CHT technique the accuracy is measured and compared to the manual counting.

2.2.Thresholding Based Method

Saima chy and rahaman introduced a method by using the gray thresholding algorithm[4].The first step of proposed method is RGB to gray scale conversion. To remove noise in the background median filtering is done. Otsu's method is used for binarization of image. Holes presented in the binary image are filled for proper segmentation of blood cells. Less information are only present in the cells near border and are removed to reduce the complexity. To count the connected objects, Labeling algorithm is applied and form factor calculation is done and we get the total RBC count.

2.3 Watershed Transform Based Method

Algilani introduced a work to suppress over segmentation problem which is a major drawback of the watershed algorithm[5]. The experimental results shows that, watershed is most effective method when done on filtered image using non local means denoising method. The effectiveness of this proposed method is validated by analyzing the image segmentation quality measures. The proposed method provides higher performance in term of accuracy, sensitivity and specificity factors.

Viswas sharma introduced a method involving marker controlled watershed segmentation[6]. It involves acquisition of the thin blood smear microscopic images, pre-processing by applying median filter, segmentation of overlapping erythrocytes using marker-controlled watershed segmentation, applying morphological operations to enhance the image, extraction of features such as metric value, aspect ratio, radial signature and its variance, and finally training the K-nearest neighbor classifier to test the images. This algorithm processes the infected cells increasing the speed, accuracy and the effectiveness and efficiency of training and testing. The K-Nearest Neighbor classifier is trained with 100 images to detect three different types of distorted erythrocytes namely sickle cells, dacrocytes and elliptocytes responsible for sickle cell anemia and thalassemia.

Hemant Tulsani et al. proposed a method for counting of blood cells [7]. This involves image processing techniques used for counting are spatial filtering, morphological operations and segmentation using watershed transformation. In the preprocessing step, smoothening of image is done using average filtering approach. Then RGB image is converted to YCbCr image and Cb component is extracted to get nucleus and platelets from the image. Blood smear image is binarized and morphological opening is done to get the mask of WBCs and platelets which represents noise in the image. Then gray scale image of blood smear is applied to opening by reconstruction and closing by reconstruction. Finally, the binary base image containing all the cells is obtained and mask is subtracted from it to get RBC binary image and it is further segmented using Watershed transform.

2.4 Combination method

Albaryak introduced a work which shortens the diagnostic period of the disease and to minimizes error probability of this diagnosis by extracting healthy cells and just having sickle cells on the blood tissue using Image Processing Algorithms[8]. For diagnosis of Sickle Cell Anemia, red blood cells are examined and sickle cell detection is performed by using Image Processing Algorithms which are Thresholding Method to have gray scale image from RGB and binary image from gray scale image, Hough Transform Method to detect circular erythrocyte and taking the blood cells' outside of the sickle into the circle, Noise Reduction Filters and Morphological Filters are used to enhance images and count the remain cells in the image respectively.

2.5.Cell Structure and Intensity Based Method

S. Kareem et al. introduced angular ring ratio method for counting of RBCs in thin blood films [9]. The method consists of conversion of RGB image to gray scale. Dilation and Erosion of the image are done respectively on the image using a disk shaped structuring element. Next conversion of the closed image to a ratio transformed image has been done by calculating the ratio of average intensities of the annular concentric ring structuring element to disk shaped structuring element which masked over the image. After that peak intensity values of that enhanced ratio transformed image are calculated. Next step is to map each of the peaks on to correspondind coordinates ,ie the centre of each RBC cell is done.

2.6.Comparative Method

A Comparative analysis of both Hough Transform and k-Means clustering algorithm for extraction of RBCs and thereby it's detection was done by Monika Mogra et al [10]. K-means clustering algorithm consists of mainly six major steps: image acquisition, Clustering image, Histogram equalization, Image segmentation, Blood cell extraction and Counting of cells. On the other hand, Hough transform algorithm consists of following steps: Input image acquisition, Hough transforms edge linking, Image segmentation, Snake body detection, Output image and finally Counting of cells.

3. PERFORMANCE ANALYSIS

Performance of these proposed anemia detection methods are compared with each other models. The method proposed by Omid in [1] uses circlet transform method which is much more find to be advanced than other methods since it helps us to identify the cells even at the low gradient level at the image. Venkatalakshmi at [2] and Mazalan at [3] proposed methods for anemia detection based on circular hough transform technique which is based on the assumption that RBCs are in circular shape which distinct it from the truth that they are in biconcave shape. Saima chy at [4] which is based on the method of threshold based segmentation helps in reducing the complexity of data and simplifies the process of recognition and classification. However once throw out information is difficult to recover again. Algilani on [5], Viswas Sharma at [6] and Tulsani at [7] proposed the method on the basis of water shed segmentation which helps in separation of overlapping cells and to get an accurate result. The process is improved by means of a non-local means of filtering method. Albaryak at [8] used a combination method of both threshold segmentation and Hough transform technique was a much more better procedure to separate out RBCs and thereby final counting of it for anemia detection. Kareem at [9] which proposed on the basis of angular ring ratio for counting of RBCs and Monika Morgan at [10] which used both hough transform technique and K means clustering method were provided significant improvement over other methods used in the literature.

4. CONCLUSIONS

Analysis of blood cell image and thereby the detection of RBC'S to identify and detect anemia by the image processing technique is an efficient and accurate methods in terms of cost and time. Research work is going on increasing in the field of RBC counting methods. Different researches proposed different methods and techniques based on image processing to get more accurate result and thereby less time consuming task. Finally making this RBC counting algorithm procedure and thereby detection of anemia making a better working procedure in medical field and finding various applications in bio medical field. It mainly works on medical diagnosis and blood cell counting provided that standardization of blood smear is done properly to obtain blood cell image by various image processing techniques.

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