Effective use of image processing techniques for the detection of sickle cell anemia and presence of Plasmodium parasites

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ABSTRACT

Various blood related diseases have been increasing over the years due to various internal and external factors affecting more than a million people causing long term illness and mortality. Two such diseases are anemia and malarial fever. Anemia is a condition which is determined by low count of red blood cells or abnormally shaped red blood cells. Anemia causes weariness, paleness and tiredness. There are several types of anemia like thalassaemia, fanconi anemia, haemolytic anaemia etc among which sickle cell anemia is the most common one. Sickle cells refer to abnormal crescent shaped red blood cells present in the blood, which may cause severe pain and permanent damage to brain, lungs, kidney and spleen. Malaria is a most common infectious disease that is caused by parasites in the saliva of the mosquitoes in human and other animals, which eventually affect the red blood cells causing a sharp rise in body temperature. Common symptoms of malaria include dry cough, headache, muscle pain and fatigue. The proposed paper focuses on the detection of blood anemia and malarial fever by examining the blood stain and detecting abnormal red blood cells such as sickle cells and presence of plasmodium parasites on the blood cells through an computer-based automated system which uses image processing techniques like Otsu segmentation for binary conversion and feature extraction using morphological operations than the most commonly followed traditional laboratory method where the pathologists are needed to examine the blood requiring more time and cost for diagnosis. The result are found to be 89% accurate which more efficient than existing methods.

Keyword : - *Sickle cell, Parasite detection, Otsu segmentation, Feature extraction, morphological operations*.

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1. INTRODUCTION

Sickle cell anemia also known as the sickle cell disease (SCD) or drepanocytosis are caused by sickling. The sickling occurs because of a mutation in the Beta 15 - haemoglobin gene. It follows when a person inherits two genes which are abnormal that cause their RBCs to change shape to crescent shaped cell pointed at one end and smaller than normal RBCs in size .They are stiff and sticky and tend to form lumps and obstruct the flow of blood in the blood vessels, thereby causing damage to vital organs resulting in extreme pain. Traditional diagnosis of sickle cell anemia is done by sickling tests haemoglobin electrophoresis.

Fig1: Sickle cells

Malarial fever is a serious disease which requires immediate medical assistance once diagnosed It affects between 250 and 500 million people and is the cause for more than 1 million deaths every year. The disease causes symptoms that include high rise in temperature, fever and headache, which in extreme cases can progress to coma or death. It is caused by the protozoan Plasmodium parasite and is transmitted through the bite of a female Anopheles mosquito. Inside the human body, the parasite goes through a complex life cycle in which it grows and reproduces. During this process, RBCs (red blood corpuscles) are taken as hosts and are destroyed at the end of the cycle.

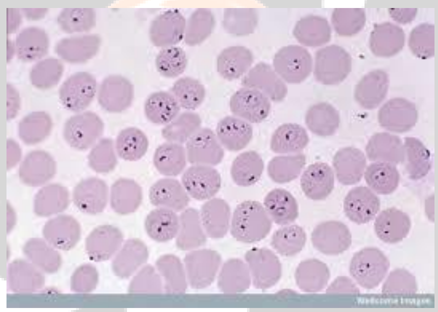

Fig2: Parasite infected cells

Usually, the time taken by pathologist is 3-8 days to diagnose and generate the reports. The reports are generated after various chemical treatments on blood samples which requires more time. It is also time consuming and costly as the instruments used for identification of the blood parameters are expensive. The patients suffer due to both these reasons physically as well as mentally. In detection process various methods are used for the segmentation of abnormal red blood cell from the rest .Using otsu segmentation and feature extraction with the help of MATLAB software where we can get the accuracy of up to 89%.

2. LITERATURE SURVEY

Tolba, Bikhet, Darwish, &Shaheen [1] presented segmentation algorithms that were able to detect and classify different categories of normal WBC based on morphological features of their outer contour and nuclei. The main advantage of the algorithm is that low computational complexity is needed. However, there were some problems in the area of overlapping and touching cells.Wijayarathna & Hirimutugoda[2]proposed fast and accurate automated diagnosis of red blood cell disorders. They described a method to detect plasmodium parasites and thalassemia in blood sample images. The paper discussed with image processing techniques with artificial neural network using the morphological features of red blood cells to automate the diagnosis of the blood disorders.Rakshitet [3] proposed the detection of abnormal cells using image processing. Here Pre - processing is done using Sobel Edge detection and Weiner filter method and estimate form factor using regionprop commands. Sreekumar [4], paper proposed a method to count the red blood cells and detect sickle cells using an image processingtechnique known as Hough transform. In this paper we a proposing the use of Otsu segmentation and feature extraction method to detect the abnormal cells.

3. PROPOSED METHODOLOGY

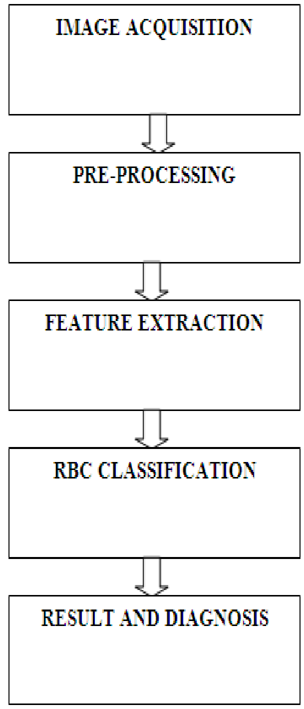

FIG -3: Block diagram

- Image acquisition
- Pre processing
- Feature Extraction
- RBC classification
- Results and diagnosis

3.1 Image acquisition:

The digital images serve as input images and are obtained using a high-end microscope and stored in system memory. The acquired image is assumed to be in RGB format.

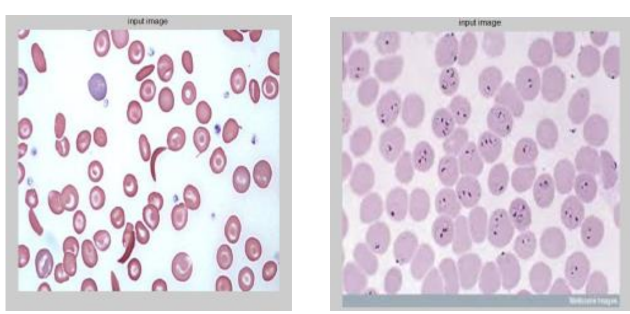

Fig4:Input images

3.2 Pre –Processing:

The main use of the pre-processing stage is to remove unwanted effects which include noise from the image, and transform or adjust the image as necessary for further processing. The resolution of the image is reduced by a factor of four to 512·384 to speed up performance of the system. Also, the test images will be subjected to selective median filtering and unsharp masking to isolate noise which may have been accumulated during image acquisition and due to excessive staining. This is followed by image segmentation. Segmentation is done for the extraction of desired objects from the background. Segmentation is more complex in nature and requires more processing time in compared to other process. Here Otsu segmentation is used for this process resulting in the formation of binary image.Otsu segmentation is based on a very simple idea i.e. to find the threshold that minimizes the weighted within-class variance value. This turns out to be the same as maximizing the between-class variance. It works directly on the grey level histogram.

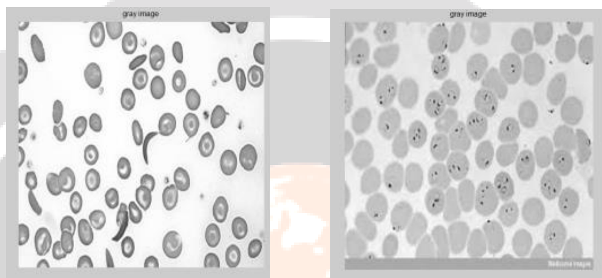

Fig5:Grayscale images

3.3 Feature extraction:

In image processing, feature extraction is a type of dimensionality reduction. When an input data is given to an algorithm is very large to be processed and is redundant, the input data will be transformed into a representation that is reduced with a set of features present in it. Transforming the input image data into the set of features is known as feature extraction in image processing. If the features extracted are chosen correctly the feature that is set will extract the needed information from the input data to perform the desired work using this reduced representation instead of using the full size input image data. Feature extraction involves the process of simplifying and reducing the amount of resources required to describe a large set of data accurately. While performing the analysis of complex data one of the major issue arises from the number of variables that are involved. Analysis using a large number of variables generally requires a large amount of computation power and memory and a classification algorithm which over fits the training samples and provides generalized results poorly to the new samples. Feature extraction is a generally a term that is used for methods of constructing the variable combinations to get around with the problems while still describing the data with sufficient accuracy efficiently. Here the various geometrical aspects are analyzed through the use morphological operation. Feature extraction is carried out by using region prop commands to extract the various features, taking into account the minor axis and major axis of the blood cells.

Major Axis length
maj_axis1 = majax(i).MajorAxisLengths;
Minor Axis length
min_axis1 = majax(i).MinorAxisLengths;.
The ratio between the major and minor axis is calculated which differentiates the normal cells from the abnormal ones.

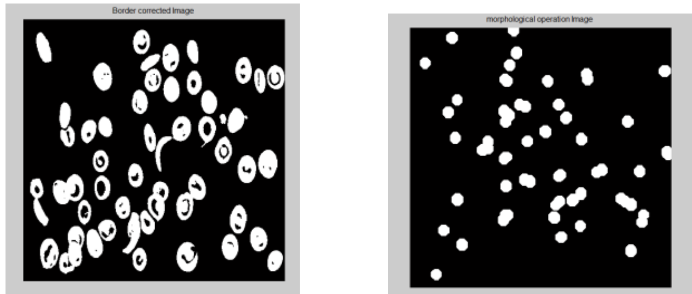

Fig 6: Feature extraction

3.4 RBC classification:

Sickel is 'S' shaped with crescent usually one end pointed, and it is varying in size but it is usually smaller than the normal RBC. The region is irregular in shape, and it has been tested by computing the distance between the center of bounding box and the center of the cell body region either on the x_axis or y_axis, if the distance is more, it is said to be a irregular shape but if the distance is too close so it is a regular shape. The color of the centre region is more than the number 10 of 255 for each RGB-layer and this makes analysis more accurate and be sure that no hole in the regions. Area is smaller than overall minimum area of normal RBCs and more than 0.1 of minimum area of the normal RBCs which makes it sure that region indicates true RBCs. Parasites are differentiated from the normal RBC and WBC through their size. . To measure the number of abnormal cells counting algorithm is applied. Components labelling is used for counting. In the case of sickle cells the total number of sickle cells is calculated and percentage of them in the total image is determined. Parasite affected cells the total number and percentage is determined.

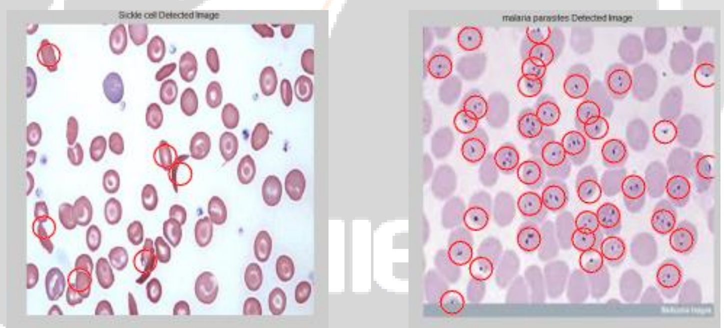

Fig 7: Sickle cell and parasites detection

3.5. RESULTS AND DIAGNOSIS:

Based on the percentage of sickle cells obtained the presence of anemia in a person is determined. Similarly the presence of plasmodium parasites indicates malarial fever .The results obtained from the system is 87% accurate and less time consuming compared to the traditional methods followed by pathologists and lab technicians.

4. CONCLUSION:

In this paper, we have developed a automated system that can be used for both the detection and diagnosis of anemia caused by sickle cell and plasmodium parasite affected cells that cause malaria. The Otsu algorithm that has been used and feature extraction has shown more efficiency in the detection and analysis of the blood image and overcomes most disadvantages that are encountered in previously proposed systems. This system would prove useful in the healthcare sector on providing immediate attention to anemia and malaria affected patients to provide attention and treatment at the earliest.

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