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DETECTING WBC COUNT USING K-NEAREST NEIGHBOUR ALGORITHM

Sheethal N Gowda[*1], Huda Mirza Saifuddin[2], Sangamma Devpur[3] & Thejas[4]
[*1,3&4]Dept of CSE, RRCE, Bengaluru, India
[2]Assistant Professor, Dept of CSE, RRCE, Bengaluru, India

ABSTRACT

In relevance to the human body, blood is not only a body fluid required by the body but it also delivers necessary substances like nutrients and oxygen. These substances are consumed by the cells and transport the metabolic waste products away from those same cells. The main cells in the human body's blood are of 3 kinds i.e. Red Blood Cells (RBC), White Blood Cells (WBC) and Platelets. To categorize the condition of a well-being, we require blood count. Henceforth segmentation and identification of these blood cells particularly WBC, plays a vital role. In the era of modernization, many health centres even till today use the same old method of manually counting the blood cells. This is not only time consuming but also produces inaccurate results. On the other hand there are some costly machines like Haematology Analyser, which are very expensive for health centres to afford them. This paper presents an image processing technique that uses microscopic images to segment and count the blood cells, mainly the WBC and classifies the obtained count of WBC using K-Nearest Neighbour technique to detect infections.

Keywords: *blood components, image processing, knn classification.*

I. INTRODUCTION

One of the blood components is White Blood Cell (WBC), which is also known as leukocyte in medical field. These WBC are the cells that belong to the immune system. This immune system is mainly required to protect the human body against infectious diseases as well as foreign invaders or bodies. In order to obtain the count of the WBC, several steps are to be carried out. The microscopic images(Fig. 1) of patients' blood components are obtained. These images are used to calculate the Hue Saturation Value (HSV). The HSV is an alternate representation for the RGB (red green blue) colour model. After obtaining the HSV value, a thresholding method called HSV thresholding is done to perform image segmentation. After which a few pre-processing steps such as dilation and erosion are carried out to get the area of the WBC. Finally based on a method called Connected Component Labelling, the count of the WBC is obtained. This count is classified as infectious or normal count based on K-Nearest

Neighbour algorithm. Finally the count gives the result of the patient i.e. whether the patient is having infection or is prone to infection.

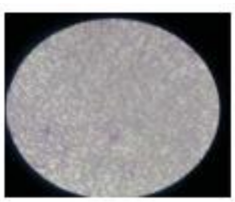

Fig. 1:- WBC microscopic image

II. RELATED WORKS

Many researchers investigated the detection of blood components using many segmentation methods on microscopic images. Thejaswini and M.C. Padma[1] used circular Hough transform to detect WBC count. Alomari, Y. M.[2] used an image processing technique called Hough Transform and thresholding techniques to detect and count number of RBC and WBC in the blood sample. This detection was carried out on three patients. K. A. ElDahshan[3] presented a comparison of the segmentation work on digital microscopic images using RGB and HSV colour spaces.

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He showed that HSV thresholding method is a better thresholding method than other methods. The entire segmentation process was carried out on both the colour spaces to obtain a comparative study on them. This was to get the blood count for leukaemia diagnosis. R. S. Ledley[4] gave the fundamentals of true colour image processing. This was because even though RGB colour system is used by TV, camera and monitors but the perceptions of human observers are better described by other colour systems which correspond directly to subjective human sensation of colour. He showed that HSV being the simplest colour space turned out to be more beneficial when compared to RGB colour space. Putta Madegowda. J[5] performed WBC segmentation by applying some filters, followed by fuzzy C means method and finally segmented the WBC using Snake algorithm. Desai Shubham Manikl, Lalit Mohan Saini and Nikhil Vadera [6] proposed a new framework to enhance the classification of WBC using Artificial Neural Network. Sachin Seth and Kanik Palodhi [7] used some modified hough transformed filters to detect the count of WBC. Anjali Gautam and Priyanka Singh [8], utilized Otsu thresholding to segment and detect WBC count. Anjali Gautam and Harvindra Bhadauria [9], used Otsu thresholding technique followed by applying some filters and histogram equalization.

This paper introduces a novel method to calculate the count of WBC. This approach is based on getting the count of WBC and classifying as infectious or normal count using KNN classifier to provide a good generalization performance.

III. METHODOLOGY

This paper provides a cost effective analysis of WBC blood component for rural areas where health centres in rural areas cannot afford expensive equipment. We train a classifier called K Nearest Neighbour, which is fed with some blood samples of patient having normal blood count. This data set is compared with the results obtained from image processing using Euclidean distance formula. Based on the outcome of above comparison we can predict whether the patient is having normal count, by which an infection is identified. In order to have a better visualization, Fig. 2 gives the block diagram for above mentioned methodology.

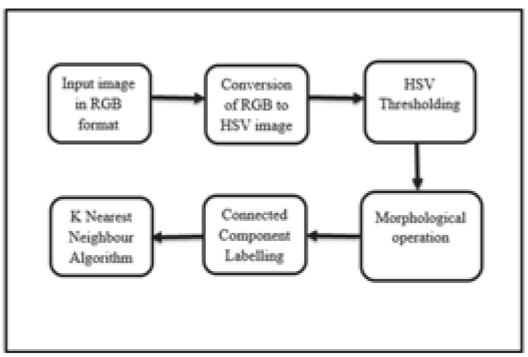

Fig. 2:- Proposed Methodology

The microscopic images utilized for this paperwork are live data taken from RajaRajeswari Medical College and Hospital (RRMCH) [10]. The dataset contains 20 microscopic images out of which 15 had a normal WBC count and remaining 5 had an Infectious prone WBC count.

The microscopic image is taken as the input image in RGB format (Fig. 3a). The image is just a blood smear which will be fed into the system to perform segmentation. The input image is converted from RGB to HSV image (Fig. 3b)in order to perform HSV thresholding (Fig. 3c). HSV is an alternative representation for RGB colour model. Hue channel refers to the colour type such as (red, yellow, green). Saturation value gives the purity of the colours while Value means the amount of light in the colour. Hue ranges from 0 degree to 360 degree while Saturation and Value ranges from 0 to 1 respectively. HSV Thresholding is one of the best segmentation methods used in image segmentation. In this paper we segment blood components using the Hue attribute. The image is then subjected to the morphological operations (Fig. 3d)i.e., opening and closing. Morphological operations basically involve 2

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special operations called as dilation and erosion. The synonym used for dilation is closing operation whereas for erosion it is opening operation. The synonyms for these are based on the operations they perform i.e. Dilation operation thickens objects to have a better visualization whereas Erosion thins the objects later to obtain the proper illusion of the object. After performing these morphological operations the resulting image is subjected to connected component labeling procedure. The resulting image comprises of regions which are connected to each other. These connected regions need to be labeled in order to get the count of WBC present in the microscopic image. Hence, connected component labeling procedure will be applied to these regions. This procedure takes the resulting image that is obtained from the morphological operations and starts connecting regions right from the first pixel in the image. As it starts the connection, it even starts labeling the components to form the respective connected regions.

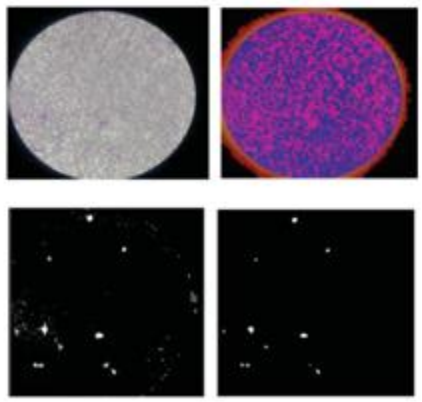

Fig. 3:- (a) Image in RGB format. (b) RGB to HSV image. (c) HSV Thresholding.(d) Morphological operations

This connected component labeling procedure gives the final count of the WBC present in the microscopic image. The next step is to classify this WBC count as either normal or infectious. For this, we make of the k-Nearest Neighbor classification(Fig. 4)method. This classification method is quite simple and straightforward due to its usage for studies which involve very less prior knowledge about the distribution of data. The working of this can be stated as; the classifier will be already fed with a normal range and infection prone range for WBC. This range will be then used to compare with the obtained WBC count for the given microscopic image. The comparison is carried out using the Euclidean distance [12] between the test data sample (p) and the already trained sample (q).

$$dist = \sqrt{\sum_{k=1}^{n}(p_k - q_k)^2}$$

Here *n* stands for the number of dimensions (attributes) and *pk* and *qk* are the kth attributes (components) of *p* and *q*. An example can be used to illustrate the kNN classification. In the Fig. 2 there are 4 nearest neighbours for the given test sample. The figure clearly shows that red is the most frequent class label, and henceforth the test sample is assigned to the red class.

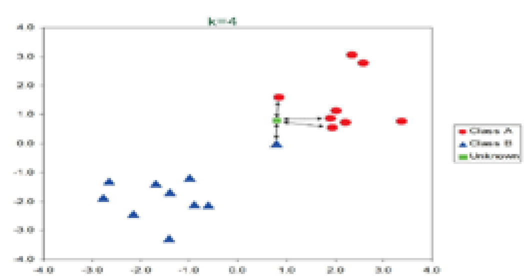

Fig. 4:- KNN classification

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IV. RESULTS AND DISCUSSION

The dataset of microscopic images were subjected to all the above mentioned steps and finally the WBC count for 20 patients were obtained. In which 15 patients had a normal range of WBC count, which led to the conclusion that the patients had no infections. The remaining 5 patients had a high WBC count when compared to the normal count which led to the conclusion that those 5 patients were prone to some infections. The results of 3 patients are shown in the Table 1 and the range of WBC count is given in Table 2. Any patient whose WBC count is higher than the normal range is prone to an infection. From the table 1 it is clear that patient 1 has normal WBC count and has no infection whereas patient 2 and 3 have a WBC count more than the range mentioned in Table2. Hence they are prone to have an infection. Our proposed work gave an accuracy of 95% (Fig. 5) in comparison with other segmentation methods.

Table 1:- WBC count of 3 patients from the dataset

Patient	WBC count
1	9.6 x 10^9/L
2	11.2 x 10^9/L
3	12.57x 10^9/L

Table 2:- WBC count range

PARAMETER	NORMAL RANGE
White blood cells	4.0 - 11.0 x 10^9/L

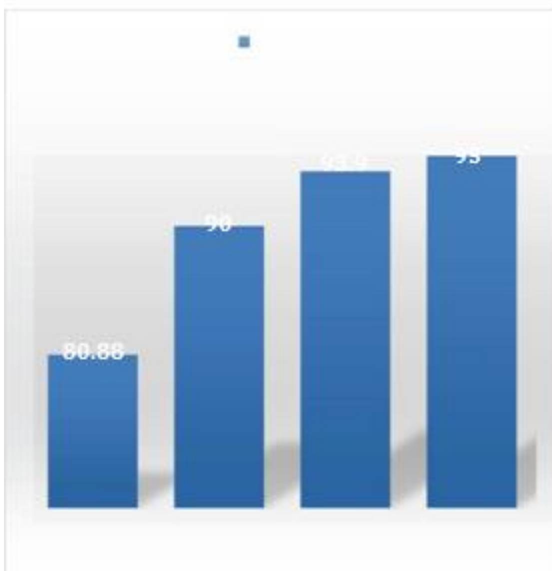

Fig. 5:- Comparison with other techniques.

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V. CONCLUSION

Blood components having a normal range can lead to a well-being of a human. If the range is slightly higher or higher than it leads to the conclusion that the patient has some infection. In the near future, we can expand this work to find out for what range of WBC what infection can be found out. For example, dengue, malaria etc. Thus, the above mentioned work has established a successful obtainment of WBC count for live data by producing an accuracy level of 95% and this methodology can help the residents of rural areas by not only saving time but also by giving a good performance at a low cost for detecting infections.

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