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A Proposal on Automatic Segmentation and Detection of Malignant Leucocytes in Microscopic Blood Smear

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Abstract—*This paper covers an investigation on the various segmentation techniques employed for the statistical estimation of Leukocytes from microscopic blood samples. Detection and analysis of Leukocytes plays a very significant role in the early identification of Leukocyte cancer. Generally blood images are investigated by pathologists to identify whether the cell is cancerous or not. But this manual method has few drawbacks such as time consuming and accuracy depends up on the operator's skills. This investigation is error prone. So, the fast and effective imaging techniques were developed for diagnosis of patients where they extract information from the microscopic images. This paper mainly concentrates on the detection and segmentation of Leukocytes using various segmentation techniques.*

Keywords— *Leukemia CLAHE, Otsu Thresholding, K-means Segmentation, ACO, Cuckoo Search (CSO), SIFT.*

1. Introduction

The images of blood cells can allow the evaluation and detection of various ailments such as anemia, leukemia etc.. Leukemia is a most dangerous cancerous disease usually affected on Leucocytes (White Blood Cells) .The operation of detection is performed by analyzing WBCs which is considered as the area of research interest in this paper.

This Leukemia is dangerous if it is not diagnosed in the early stages because it spreads quickly into the essential organs and whole body parts by damaging each and every part slowly without giving any symptoms most of the times. Based on the behavioral characteristics and expansion stages of leukemia, it is classified in to two types they are acute leukemia and chronic leukemia. AL (Acute leukemia) is again divided in to two subtypes such as ALL (Acute Lymphoblastic Leukemia) and AML (Acute Myeloid Leukemia).All these ailments commonly affect the lymphocytes of children and adults which are above 50 years old. To save the lives of cancer effected person early detection of Leukemia is very important [1]. Detection of ALL (Acute Lymphoblastic Leukemia) depends on morphological recognition of leucocytes by stream cytometry and microscopy. The preliminary characteristics of various diseases can be identified by pathologists (professionals) with diagnostic procedures [2]

General check up of patient is manifold, continuous and time taking process. All these conditions might degrade the precision of diseases. Since it depends on specialists skills and this disadvantage limits the

identification accuracy of cancerous cells. So numerous methods are available for the automatic detection of malignant cells from blood images. In this proposal metaheuristic optimization algorithm i.e Cuckoo search optimization is proposed to identify cancerous cells in microscopic images.

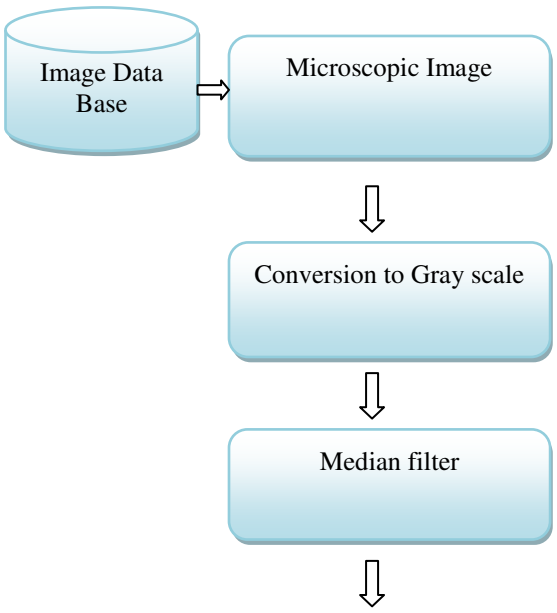
2. Proposed Methodology for Leukocyte Detection

There are three processing stages are used in proposed system. They are referred as Preprocessing, Segmentation and Feature Extraction. In Image pre-processing filtering techniques are used for noise removal and for image enhancement [3]. Most of the times the acquired images undergo various inbuilt problems such as noise and induction of disturbances which distort the quality of the images, hence filtering is indispensable in the beginning of all the Image processing problems to achieve optimum results. In segmentation, cancerous White Blood Cells are extracted from the blood images. The segmented image can be mapped in to numerical values in feature extraction stage. The automated approach for the leukocyte segmentation is shown in the Figure.1 .The steps of proposed model are explained below.

1. Input Image: The input Electron microscopic image is acquired from the public database.
2. Preprocessing: Noise is always present in digital images. Image acquisition and transmission are the two major sources of noise. Noise removal is one of the most important in the field of computer vision and image processing. To suppress the noise many filtering techniques are available. In Pre-Processing input image quality and SNR (signal to noise ratio) can be improved .The resultant image will be helpful in further processing. In this paper pre-processing stage involves image Enhancement that improves the image quality [5].

- Gray scale conversion
- Noise removal by filtering technique.
- Contrast Enhancement

A. Conversion to Gray Scale: A grayscale image is supposed to comprise only 'Gray' shade where the red, green and blue shade aspects are stated to have identical intensity values. Processing becomes simple when we assign a single intensity value for each pixel. Generally microscopic images are in RGB format and they have to convert in to gar scale.



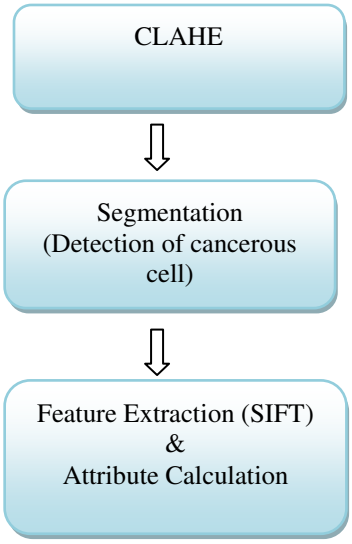


Fig1. Block diagram of proposed model

B.MEDIAN FILTER: Median Filter is a one type of spatial filter which is used to remove noise from an image. Median filter is a nonlinear spatial filter. To improve the outcome of lateral process noise reduction is important in image pre processing. This is the easiest approach which is used to get rid of noise from the image. whereas other smoothing filters only eliminates noise from the image however they are now not in a position to maintain edges of the Image but median filter is the exclusive smoothing filter which offers better result by noise elimination from the photograph along with the preservation of the edges [4].

C.CLAHE (Contrast Limited Adaptive Histogram Equalization): It is exclusive from Histogram equalization In its contrast limiting. In this approach enhancement function is applied over all neighborhood pixels and transformation feature is derived [5]. The difficulty with the adaptive histogram equalization is over amplification of noise this limitation can overcome by means of Contrast Limited Adaptive histogram equalization [6].

3. Segmentation: It divides an image in to its constituent parts or objects. Image analysis is most important in computer vision. The success of image analysis depends on accuracy of segmentation and accurate segmentation is the challenging problem in image processing.

4. Feature Extraction: In this, extracting the points between specific objects based totally on specialists knowledge. In this features are extracted primarily based on some features of segmented image.

In this proposal MATLAB tool along with Image acquisition Toolbox, Image Processing Toolbox and optimization toolboxes are used to generate the simulation interface in order to extract the features which assist in detecting the cancerous blood cells in acquired Electron microscopic images from Open source medical image database.

Processing steps in order to detect Cancer Cells:
Step 1: Microscopic image is considered as Input image
Step 2: Convert the RGB image to gray
Step 3: Noise can be removed by Median filter
Step 3: Apply CLAHE method for image Enhancement.

Step 4: Segmentation algorithm is used to identify blast cells from white blood cells.

Step 5: color and texture features are extracted from transform segmented image using SIFT (Scale Invariant Feature is used for Feature).

3. Segmentation Methods

In digital image processing and computer vision applications segmentation plays a key role for partitioning and analysis. Most of the applications need algorithms to process the image which are fast and immensely accurate. Based on the accuracy and reliability of the processing algorithms the corresponding application can achieve better results. In this paper the various existing segmentation methods such as Otsu segmentation, K-means clustering and Ant colony optimization algorithm are reviewed and analyzed. Moreover, the proposed algorithm Cuckoo search optimization algorithm is also reviewed and analyzed.

3.1 Existing Segmentation Methods

A. Otsu Thresholding:

In 1979 an effective threshold determination method is by proposed Otsu. This method has been the gold standard for so many years in the field of Image Segmentation to find threshold values in various Imaging applications. To set up an optimum threshold, this method maximizes the weighted sum of forefront and backdrop pixels in between class variances [7].In this technique total image is divided in to two groups (or) classes. Let f_1 and f_2 are the two classes at a threshold T.

f_1= (0, 1, 2, 3.....T) ..... (1)

f_2 = (T+1,T+2.....L-1) ..... (2)

where L represents total number of gray levels.

Let P_{f1} and P_{f2} are probabilities of f_1 and f_2

$$p_{f1} = \sum_{k=0}^{T} p_k \quad \text{..... (3)}$$

$$p_{f2} = 1 - p_{f1} \quad \text{..... (4)}$$

Mean of f_1 and f_2 are

$$\mu_{f1} = \sum_{k=0}^{T} \frac{k * p_k}{p_{f1}} \quad \text{..... (5)}$$

$$\mu_{f2} = \sum_{k=T+1}^{L-1} \frac{k * p_k}{p_{f2}} \quad \text{..... (6)}$$

The optimum threshold

$$T^* = Arg \max_{0 < T < L-1} \sigma^2(T) \quad \text{..... (7)}$$

Otsu method is a simple method and widely used for image segmentation [8]. The performance of the Otsu's method is relatively good if histogram is bimodal distribution. If the background area is large compared to

object area the histogram no longer exhibits bimodality and it causes incorrect threshold and having segmentation error [9].

B. K-means Segmentation:

It is an unsupervised learning algorithm that deciphers fine clustering problems. The chief principle idea behind this algorithm is to specify k centers for cluster one for each. All the centers should be positioned in a slyness way since different locality causes different consequences. So, the best alternative thing is to position the centers far away with each other to a greater extent [10]. However, each point related to data sets must be taken and connected it to the center which is nearest. When all the points are assessed indicates that the initial step is finished and premature cluster age is completed [11]. At this particular instance k new centroids are recalculated from preceding step as barycenter of the clusters. After obtained all the k new centroids, a fresh binding has to be made between associated data set points and the adjacent new center such that a loop is generated. Consequently, with this generated loop the location of K centers changes step by step [12]. At last, this algorithm minimizes an objective function which is known as squared error function and is given by:

$$J = \sum_{j-1}^{k} \sum_{i-1|}^{n} \|x_i^{(j)} - c_j\|^2 \quad \text{.....(8)}$$

where, '$||x_i - v_j||$' is the Euclidean distance between x_i and v_j.
'c_i' is the number of data points in i^{th} cluster.

'c' is the number of cluster centers.

The benefits of K-means algorithm is fast robust and easier to understand. The drawbacks are it fails data set which is non-linear and not capable to manage noisy data.

C. Ant Colony Optimization Algorithm:

It is an undeniably algorithm which acquire expeditious journey from source to food on the keystone of the organic behavior of the true fleas (Ants). It makes use of the efficiency of the true fleas (Ants) while piercing for the food. Usually fleas leave a level of pheromone on pathway while go on an excursion from home to foods and vice versa. So fleas estimate the small journey at a faster rate. However, this optimization technique could utilize in advanced electronic devices for redirecting the problems to obtain expeditious path. On the process of redirecting operation a few artificial fleas (packets) are imitative from source to the food (destination) [13]. The advance fleas will create an additional arbitrarily node exceptionally for finding the knowledge from eating desk to place where the bugs were leave pheromone at last visited. This optimization increases the measurability and working interval. It also exploits ease and strong mobility to attain extreme alarm nodes.

3.2 Proposed Segmentation Method

A. **Cuckoo Search Algorithm:**

There are numerous optimization methods available in Literature, however based on the suitability and its inherent properties Cuckoo Search algorithm has been chosen for experimental investigation in this research work. It is enthused by the bird called cuckoo. The cuckoo birds were offspring parasites and not at all build nest for their own and usually put down their eggs in another host bird nest [14]. Some of the birds (host) can pursue straightway with the intrusive cuckoo. The host bird throw the eggs from the nest if it finds that eggs are not their

own. Each egg related to cuckoo in a nest corresponds to a good and new solution [15]. The obtained good and new solution is a modified version of the existing solution. If nest contains one cuckoo egg it represents a single good solution similarly if nest contains several eggs it represents a set of good solutions. Mainly this CS algorithm is used to decipher the optimization and scheduling problems in global optimization and job scheduling respectively [16]. Because of idealized breeding behavior, this algorithm is used to solve the numerous problems related to optimization.

1. Cuckoo bird perch single egg and abandon it in an arbitrarily selected nest at a time.
2. The drey with the high excellence of eggs is known to be best nests which will take to the next generations.
3. If cuckoo eggs are found by host bird with the probability of pa=0,1 then it throw or abandons the eggs and a new nest is build.

4. Conclusion

The proposed method aims to identify the malignant cells in the blood from blood images .This Proposal comprises of various image processing techniques for the statistical estimation of human blood properties like WBCs .The leukocyte segmentation and detection system along with various segmentation methods adopted are discussed. The technique for shape and texture feature extraction are also involved in this paper. The Scale Invariant Feature transform is used to extract the features such as shape, color texture from segmented image. Proposed methodology provides the detection of cancer and provides detailed analysis to the pathologist.

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