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Research paper

Detection of Cancer Cells Using Microscopic Images of Blood Sample

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Abstract

Identification of Blood disorders is practiced by visualization of the blood sample through a microscope by the naked eye of a human. In this project a computerized technique has been developed to help the doctor in identifying different types of Leukemia. Initially the RGB image is converted to L*a*b colour space and is segmented using K-Mean clustering. To this clustered image the features are extracted and is classified into different types of leukemia. The required code is developed using MATLAB. A graphical user interface has been developed for better understanding of the procedure. This technique is used to identify the diseases and diagnose them at an early stage. Images are used as inputs, as they are cheap and do not need any kind of expensive testing nor lab equipment's. The project will be using features in the microscopic images and examine any kind of changes on color, texture, geometry and statistical analysis of the images. The changes that are found in these features will be used as our classifier input.

Keywords:

1. Introduction

1.1 IMAGE

An image is a two-dimensional picture, which has a similar appearance to some subject usually a physical object or a person.
Image is 2D, such as a simple photograph or a display on screen, and as well as 3D, such as a statue etc. These 3D objects can be captured by various devices that are available.
The word "image" is also used in any 2D figures such as a pie chart, a map, an abstract painting, or a graph. Images can also be developed manually on a paper, such as a painting, by carving, drawing, or printing [1].
So, here in this paper we interested about the microscopic images of the blood samples. We simply capture a microscopic image using a digital microscope and use it. An example for such image is given below in Fig 1.1.

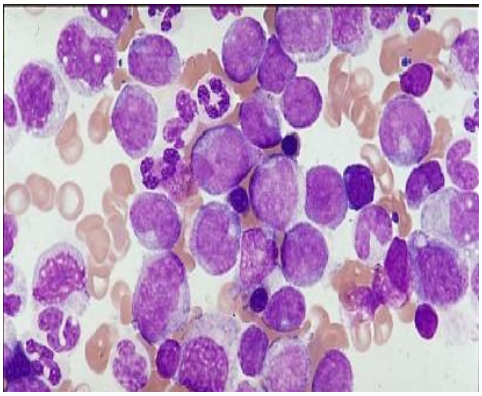
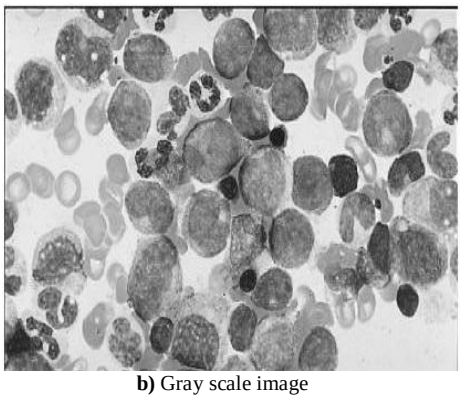


Fig 1.1: a) Colour image



b) Gray scale image

An image is nothing but a rectangular grid of pixels. It has a got some fixed values which counted in pixels. Each pixel has a fixed size which is represented as a square. However images in different computers might use different pixel sizes. Each pixel in a particular gird consists of numbers which represent the magnitudes of colour and brightness [1].
Each pixel has a colour, colour is a 32-bit integer. These 32-bits are divided into four parts which represent the transparency, redness, greenness and the blueness of the colour image [2].

1.3 White Blood Cells

White blood cells (WBCs), which are also called as leukocytes in medical terminology are the cells which are in the immune system. These cells are responsible for the protection of the body against foreign invaders and infectious disease. WBCs are produced from the amultipotent cells in the bone marrow which are known as ahematopoietic stem cell. [3] [4]

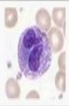
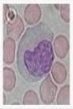
Type	Microscopic appearance	Diagram	Approx. % in adults	Diameter (μm)	Nucleus	Granules	Lifetime
Neutrophil			62%	10–12	Multilobed	Fine, faintly pink (H&E stain)	6 hours–few days (days in spleen and other tissue)
Eosinophil			2.3%	10–12	Bi-lobed	Full of pink-orange (H&E stain)	8–12 days (circulate for 4–5 hours)
Basophil			0.4%	12–15	Bi-lobed ortri-lobed	Large blue	A few hours to a few days
Lymphocyte			30%	7–8 & 12–15	Deeply staining, eccentric	NK-cells and cytotoxic (CD8+) T-cells	Years for memory cells, weeks for all else.
Monocyte			5.3%	15–30	Kidney shaped	None	Hours to days

Fig 1.2: Types of WBC's

2. Literature Survey

2.1 Blood Cell Image Segmentation

In general Image processing hierarchy involves five basic steps which are Image Acquisition, Preprocessing, Segmentation, Post Processing, and Analysis.

The toughest task in executing any image processing technique comes in the segmentation part of the image. The segmentation methods in modern day medical imaging have many application in the classification of various varieties biomedical-image. Basically, segmentation of an image is nothing but the image is divided into some specific regions or parts which are called as region of interests. This process of segmentation is said to be difficult or critical as the segmented image should retain the maximum useful information of the original image so as to reconstruct it.

There are many algorithms and techniques that are presently used for the image segmentation part. But, there is no general solution to the approach of image segmentation problem, generally the common techniques are combined with some applied domain knowledge which helps to effectively solve the image segmentation problem. [5]

2.2 Leukemia Cells

A person whose suffers with the leukocyte disease leukemia, the abnormal and unshaped white cells blood cells which are produced in the bone-marrow are called the leukemia cells.

Leukemia cells don't die easily they attack the normal blood cells which consists of (WBC's, RBC's and platelets. This disturbance created by the leukemia cells makes it difficult for all other normal blood cells to do their function properly.

2.2.1 Types of Leukemia

The type of Leukemia is generally based on the development of the disease which varies person to person. Broadly speaking there are two types of leukemia: chronic leukemia and acute leukemia.

1. Chronic leukemia: Chronic leukemia is one such kind which affect the human body very slowly, there will be no symptoms seen in the initial stage. As they grow very slowly leukemia cells capture maximum area of human blood and then the patient starts getting the symptoms of the disease.

2. Acute leukemia: Acute leukemia cells doesn't affect the white blood cells in the blood but in acute leukemia the number of leukemia cells increases rapidly and very quickly reaches the last stage. Medical science and doctors cannot help the patient to fight this type of leukemia [6].

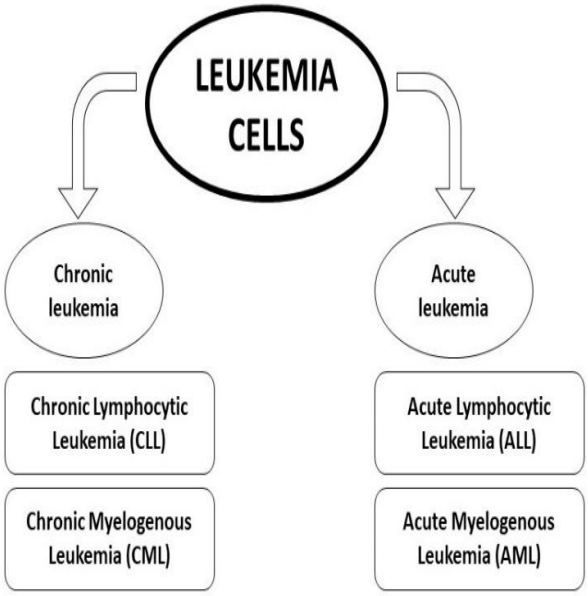


Fig 2.1: Leukemia cells

3. Methodology

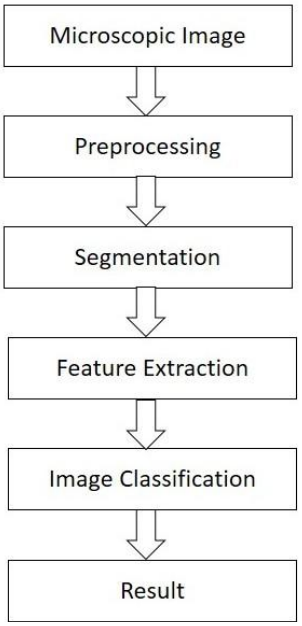


Fig 3.1: Flow chart of working methodology

The images from a database which are pre-defined are taken. The image taken is 8bit RGB image. These pre-defined images are used to train the system and form a particular range for a particular type of leukemia.

In the preprocessing step the input RGB image is converted into L*a*b colour space domain which helps in better segmentation of the image. [7]

The colour image segmentation is performed by using K-Means algorithm. The image in this step will be clustered into three clusters. The ROI is identified and is formed as one cluster.

This cluster is passed through various calculations and the few features are extracted out. Based on the values of these extracted features we decide the range of the values which fall under a particular type of leukemia. Once the system is trained and the range has been decided it will be saved in the system.
These range of values will be dumped in a classifier. This classifier is nothing but a comparator. When a new unknown image is given as input all the above mentioned steps are performed and the features of that image are extracted and recorded. The classifier will compare these features with the existing three categorized features and define the type of the leukemia. [7]

3.1 K- Mean Clustering

In this paper we are using k-means clustering technique that is applied for the segmentation of our microscopic images. Clustering is the method which is used to separate groups of objects. K-means is one of the simplest algorithm that gives us good results to solve the clustering problem that we come across. The aim of this clustering is to decide the partitioning of the images based on some user-defined clusters that is updated after each iteration or cycle, this clustering is convergent. K –means clustering is a cyclic procedure that is used for dividing the given image into k number of clusters.
The basic procedure is as follows:
1. Initially we select k cluster centers.
2. Assign every pixel value in the image that is closest to the cluster centers selected i.e., the distance between the pixel and the cluster center should be as minimum as possible.
3. Average all of the selected pixels in cluster and recompute it.
4. The above steps 2 and 3 should be repeated until the convergence is attained.

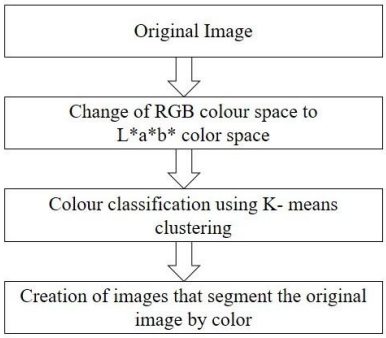


Fig 3.2: Flow Diagram of K- Mean Clustering.

A prefect estimation of color space is important for segmentation of color images which is an essential key technique for image processing. For our research work, we have decided to go with the L*a*b * color space system. The ease of this system is that the differences between any of the two pixels in this is same as a person senses it with his naked eye and this color space will allow people to differentiate the visual differences. [7]

3.3 Features Extracted

The features that were extracted are listed below. These are the mathematical (Probability and Statistics) standards which are used in image processing to differentiate images based on various factors [9].
a) Mean
b) Entropy
c) Standard Deviation
d) Smoothness
e) Skewness
f) Contrast
g) Kurtosis
h) Homogeneity
i) Correlation
j) Variance

These features can be easily found in the matlab's toolbox.

4. Results

The images have been classified into three different categories of Leukemia which are mentioned below. Further to this, these categories have been defined with a range of the features that have been extracted.
- Acute Leukemia (AL)
- Chronic Lymphocytic Leukemia (CLL)
- Chronic Myelogenous Leukemia (CML)

4.1 Acute Leukemia

In order to decide the range for the images which have to be categorized as acute leukemia, the input image is given which is pre-defined as acute leukemia. Fig 4.1 shows the input image.

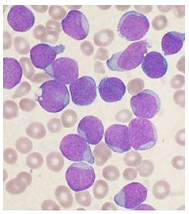


Fig 4.1: Acute Leukemia

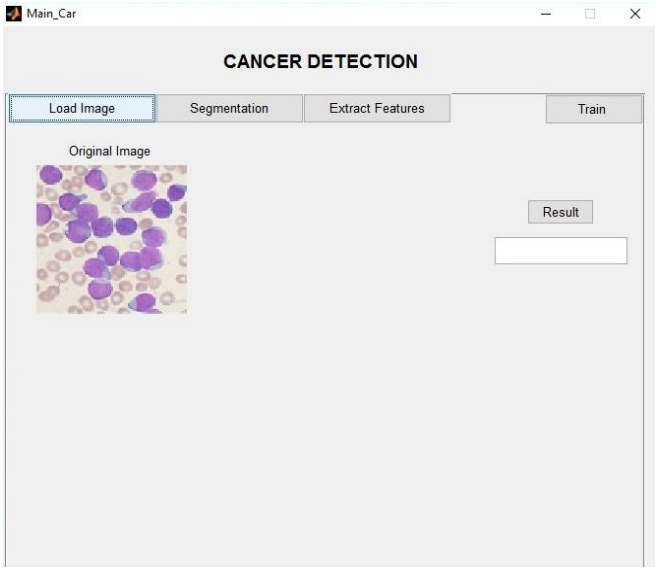
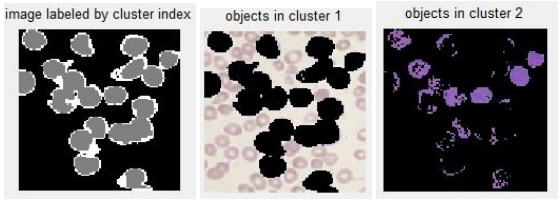


Fig 4.2: GUI representation after loading image of AL.

This input image was segmented with k-mean. The three cluster which were drawn out are shown below in fig 4.3 (a, b &c). The segmented clusters are shown in GUI in Fig 4.4.



(a) **(b)** **(c)**

Fig 4.3: Three segmented clusters using k-mean for AL

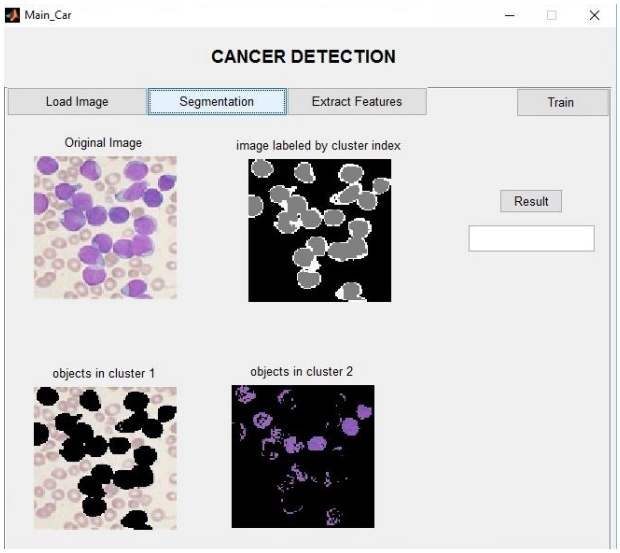


Fig 4.4: GUI representation after segmentation of AL.

After the image is segmented, features are extracted out of the segmented image as discussed earlier.

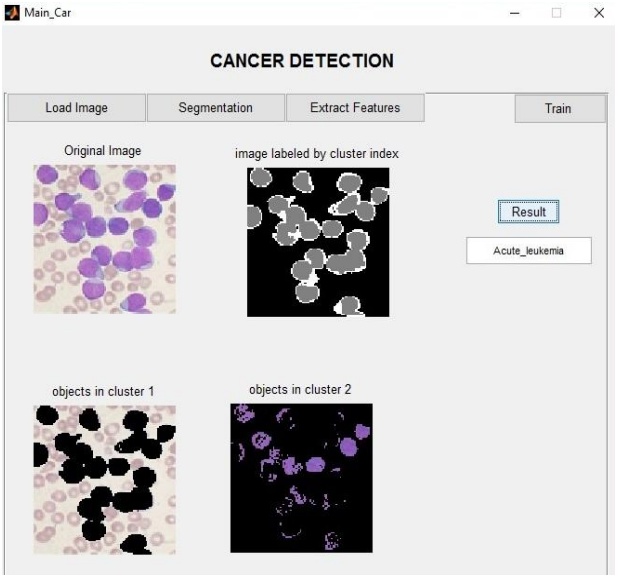


Fig 4.5: GUI representation of the final result of AL.

4.2 Chronic Lymphocytic Leukemia

Similar to that of the previous section, the procedure is the same. The first step is loading of the image.

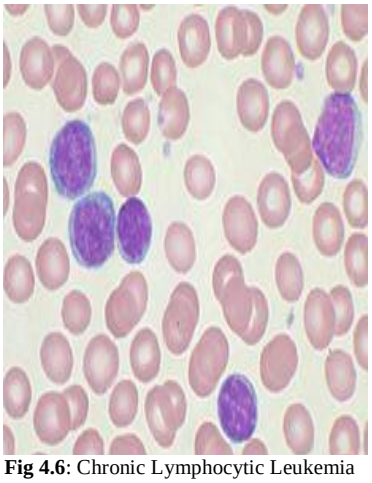


Fig 4.6: Chronic Lymphocytic Leukemia

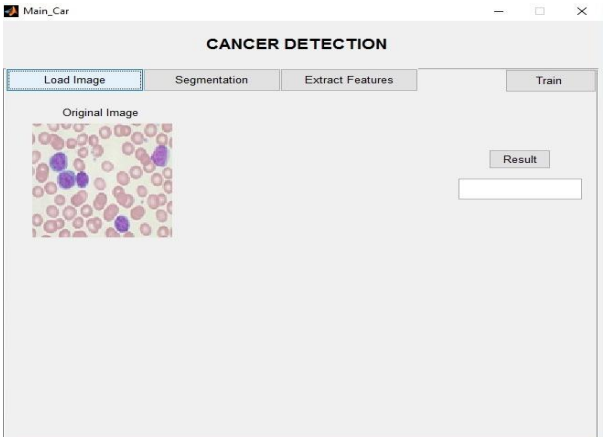
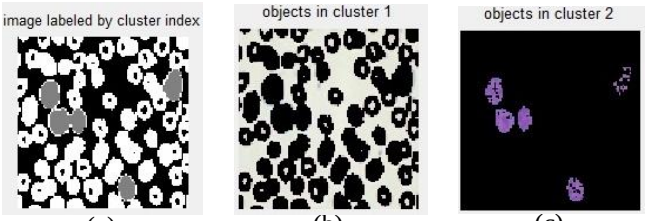


Fig 4.7: GUI representation after loading image of CLL.

The second step in the procedure is segmentation of the image. Three clusters are formed using k-means algorithm for image segmentation.



(a) (b) (c)

Fig 4.8: Three segmented clusters using k-mean for CLL.

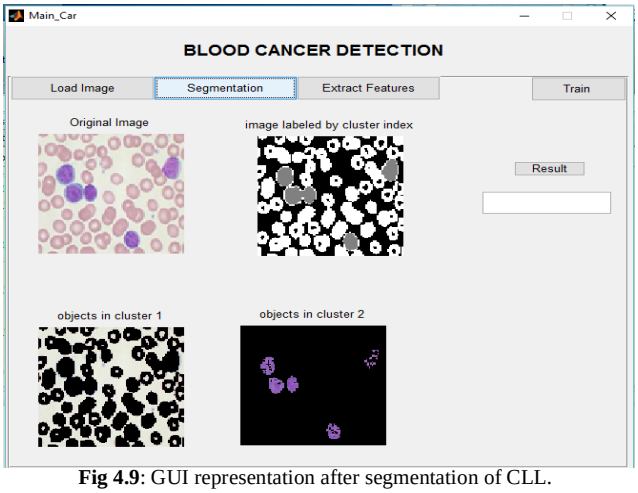


Fig 4.9: GUI representation after segmentation of CLL.

After the segmentation has been done, the feature will be extracted. According to the values that have been extracted the image is classified and the result is displayed.

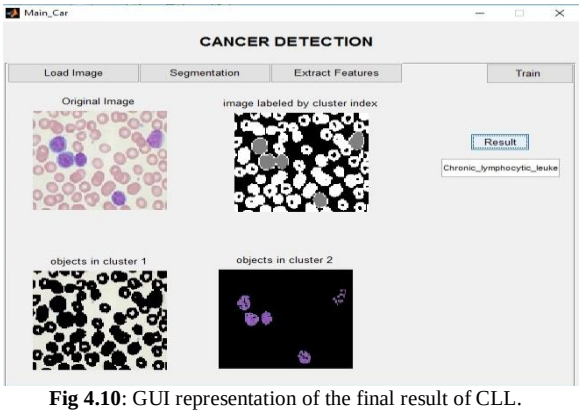


Fig 4.10: GUI representation of the final result of CLL.

4.3 Chronic Myelogenous Leukemia

Similar to that of the previous section, the procedure is the same. The first step is loading of the image.

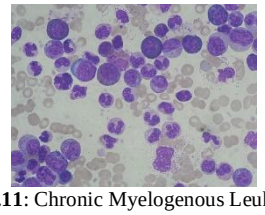


Fig 4.11: Chronic Myelogenous Leukemia

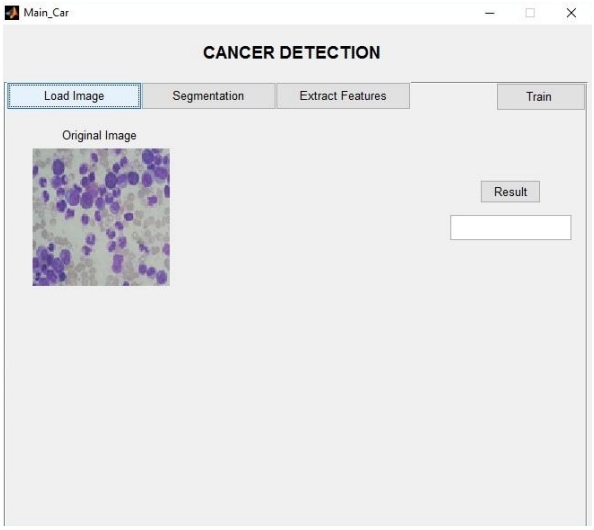
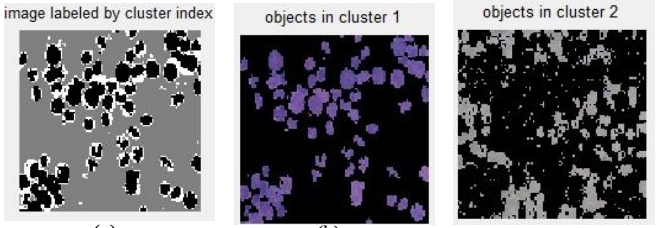


Fig 4.12: GUI representation after loading image of CML.

The second step in the procedure is segmentation of the image. Three clusters are formed using k-means algorithm for image segmentation.



(a) (b) (c)

Fig 4.13: Three segmented clusters using k-mean for CML.

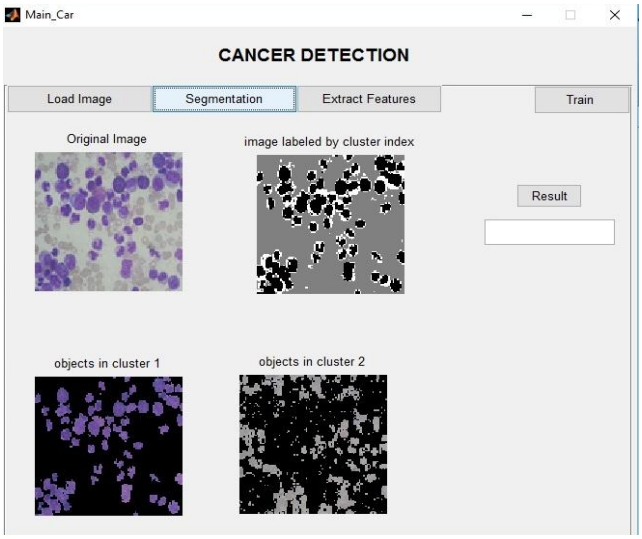


Fig 4.14: GUI representation after segmentation of CML.

After the segmentation has been done, the feature will be extracted. According to the values that have been extracted the image is classified and the result is displayed.

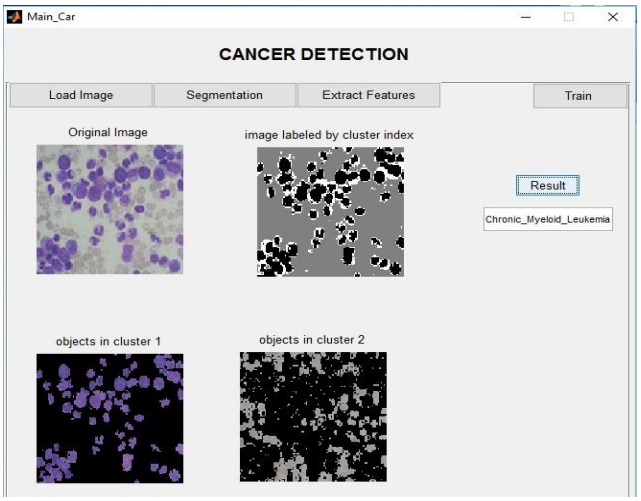


Fig 4.15: GUI representation of the final result of CML.

The features that have been extracted for classification of the three types which are mentioned above are tabulated below in table 5.1. When a new image is given to the system, the image undergoes the above mentioned steps and the features are extracted. According to the values that have been recorded the image will be categorized.

We have categorized the table into three different set of types with various features such as:

Mean, Entropy, Standard Deviations, Smoothness, Skewness, Contrast, Kurtosis, Homogeneity, Correlation and Variance.

Table 4.1: Features Extracted

Features Extracted	Acute Leukemia	Chronic lymphocytic leukemia	Chronic Myeloid Leukemia
Mean	190.7673 ± 5	202.7006 ± 5	152.7996 ± 5
Entropy	38.0781 ± 2	30.4031 ± 2	33.0520 ± 2
Standard Deviation	-0.7693 ± 0.01	-0.8140 ± 0.01	-0.7635 ± 0.01
Smoothness	-0.0246 ± 0.002	-0.0154 ± 0.002	-0.0284 ± 0.002
Skewness	-0.1914 ± 0.01	-0.2827 ± 0.01	-0.3271 ± 0.01
Contrast	1.0000	1.0000	1.0000
Kurtosis	0.0548 ± 0.003	0.0173 ± 0.003	0.0370 ± 0.003
Homogeneity	0.0581 ± 0.001	0.0637 ± 0.001	0.0586 ± 0.001
Correlation	0.3959 ± 0.005	0.3523 ± 0.005	0.4106 ± 0.005
Variance	15.9375	15.9375	15.9375

5. Conclusion and Future Scope

5.1 Conclusion

The current method is able to detect different types of leukemia in the given blood sample. It is effective and an automated way to identify the cancer cells with the help of the blood samples. The current method is able to classify amongst three different types of leukemia. The patient can be diagnosed with low cost and more effectively. The code was written and executed in MATLAB R2014a

5.2 Future Scope

This method can be extended for other types of leukemia detections. Other clustering and segmentation methods can also be used instead of K-Mean clustering algorithm. The features which

are extracted in this project can be used as input to other classifiers like fuzzy or neural networks. We can also add number of cells present in the given image.

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