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# LEUKEMIA BLOOD CANCER DETECTION USING IMAGE PROCESSING IN MATLAB

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***Abstract:***

***The microscopic images of blood cells are observed to find out many diseases.Changes in the blood shows the development of diseases in an individual.Leukemia is cancer of blood forming tissues, hindering the body's ability to fight infection. Leukemia can lead to death if it is left untreated. Based on some statistics it is found thatthe leukemia is the fifth cause of death in men and sixth cause of death in women.***

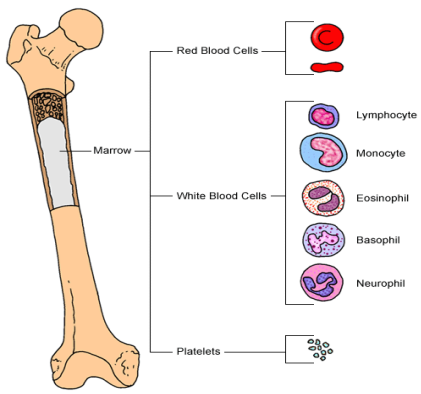
***In this work, automated approach of leukemia detection is proposed. In a manual method of Leukemia detection, experts check the microscopic images. This is lengthy and time taking process which depends on the person's skill and not having a standard accuracy.The automatedLeukemia detection system analyses the microscopic image and overcomes these drawbacks. It extracts the required parts of the images and applies some filtering techniques.***

***Keywords:***

***Image filtering, binary detection, Hole filled process.***

## Introduction:

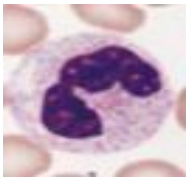
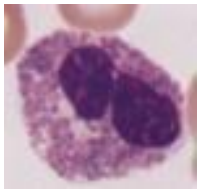
Based on some statistics it is found thatthe leukemia is the fifth cause of death in men and sixth cause of death in women.Leukemia originates in the bone marrow. Each bone contains a thin material inside itwhich is also known as a bone marrow. The components of the blood are Red Blood Cells (erythrocytes), White Blood Cells (leucocytes), plateletsandplasma. Leukemia is detected only by analyzing thewhite blood cells. Sowe here only focus on the white blood cells.



**Bone Marrow and the components of**

**white blood cells.**

Detailed description on the components of the White Blood Cells are given below :

| TYPE | DESCRIPTION |
|---|---|
| Neutrophil  | This cell is having the nucleus which is containing the cytoplasm. The granules of it are of two types – primary and secondary. Primary granules are seen at the pro-myelocyte stage while the secondary granules are seen at the myelocyte stage. The diameter of it is 12-15 μm. |
| Eosinophil  | These look very similar to the neutrophils. The only change is in the cytoplasmic granules which are red. They insert seditious exudates. They react to the allergies. The diameter of it is 12-15 μm. |
| Basophil  | Basophils can be found only in the normal peripheral blood. Basophils are having more no of cytoplasmic granules in it. These granules overlie nucleus. The diameter of it is 9-10 μm. |
| Monocyte  | Monocytes are generally bigger than the leucocytes. In the bone marrow, the ancestors of the monocytes, promonocytes and monoblasts, are very tough to differentiate from the myeloblasts. Monocytes are present in the bone marrow for very short time. After 20-40 hours they get matured and perform their duties. The diameter of it is 16-20 μm. |
| Lymphocyte  | Lymphocytes are responsible for our body health. They fight against any kind of intruders and infection. This is called are immune system. In the case of any kind of attack, our immune system generates the antigenic specificity to protect our body.The diameter of it is 8-10 μm. |

The cells in the bone marrow start changing and they get infected and become leukemia or infected cells. These leukemia cells are having strange properties than the normal cells. Their growth is abnormal and survival time is more than the normal cells. They interrupt normal cells to carry out their work. After a certain amount of time normal cells die while Leukemia cells don't. The old leukemia cells last for a long time and new leukemia cells produce in an abnormal way. The rate at which the leukemia cells progress is different according to the type of leukemia.

### Types of Leukemia:

Leukemia can be classified based upon how fast it becomes severe. Leukemia is classified as chronic or acute.

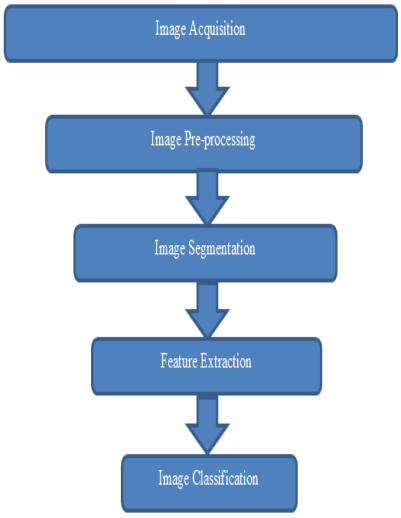
- Chronic Leukemia – Infected white blood cells perform like normal white blood cells and gradually it increases and becomes severe.
- Acute Leukemia – Infected white blood cells do not perform like normal cells and they increase rapidly in count and become severe.

We can also sub classify it based upon the stem cells generated from the bone marrow.

- Acute Lymphocytic Leukemia (ALL)
- Acute Myeloid Leukemia (AML)
- Chronic Lymphocytic Leukemia (CLL)
- Chronic Myeloid Leukemia (CML).

### Proposed Method:

The proposed system of automated leukemia detection from microscopic image is shown below




**Proposed system of Automated Leukimia Detection.**

### Image Acquisition:

Blood images of the good pixel quality are obtained from any nearest hospital.

### Image Pre-processing:

The acquired image may contain some noise. There may be a blurred region in the imagewhich is important for our study. The noise is removed from the image using medianfiltering. Wiener filter is used to remove the blurriness in the image. Image cleaning alsoneed to be performed. In the image cleaning, all the leucocytes which are at the edge of the image and all the other components which are not leucocytes are to be removed forthe better study. Solidity need to be measured for image cleaning. The image we have got is in the RGB form which is needed to be converted into the grey scale image for further processing.

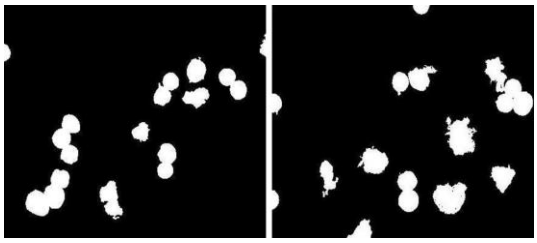
### Image Segmentation:

In this phase our main aim to identify the white blood cells. We here group only lymphocytes and myelocytes and other three white bloodcells like neutrophil, basophil and eosinophil, arediscarded from our images. We haveapplied K-mean clustering for the white blood cells detection. When we convert theimages into the grey scales then the nucleus of white blood cells become the darkestregion of the image. We have applied sobel gradient technique for the identification of thegrouped leucocytes.After the identification process, cleaning of the image has been carried out here, the nucleus and cytoplasm are extracted from the lymphocytes.

### Identification of grouped leucocytes:

One of the main problems in analyzing the blood image is the adjacent cells. If the cells are grouped or not separated from each other then we cannot study some of the featuresof cell. We have to separate these grouped leucocytes before studying themfurther.We here use roundness measure to find out thesegrouped leucocytes.The reason we chose roundness is that we can identify groupedleucocytes just by analyzing the shape of them. Most of the cells will be round in shape but the grouped cells are not having the round shape. Roundness checks whether theshape is circular or not by excluding the local irregularities. Roundness can be gained bydividing the area of a circle to the area of an object by using the convex perimeter.

The value of roundness is 1 if the object is circular and the value of roundness is less than1 for the non-circular objects. Roundness is not very much sensitive to the irregularboundaries because it excludes the local irregularities. After some well observations wefound that the value 0.80 can be used as a threshold to properly distinguish between thesingle leucocyte and the groups of leucocytes. The components which are having theroundness value more than the value of threshold are considered as the individualleucocyte while the components which are having the roundness value less than the valueofthreshold are considered as grouped leucocytes. The individual leucocytes are sentnext for the further study and the grouped leucocytes can be either sent to the separationprocess or just can be rejected from our further study. In our model, we reject thesegrouped leucocytes from our further study. The figure below shows the identified grouped leucocytes.

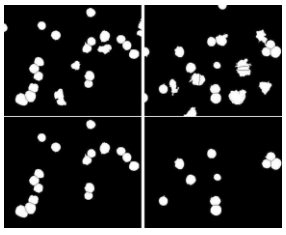


**Leucocytes identified as grouped.**

### Image cleaning:

The main object which we study in microscopic image is the leucocytes. When we take a picture of theblood there may be a case that some of the leucocytes are on the edge of the imagetherefore a portion of the leucocyte appears on the edge of the image.These partialleucocytes may create errors in the study. In the image cleaning process, all the objectswhich are not leucocytes and the leucocytes which are on the edge of the image areremoved so that we can get better results.The area and the convex areaboth need to be calculated for the removal of the components having small and very larger area.

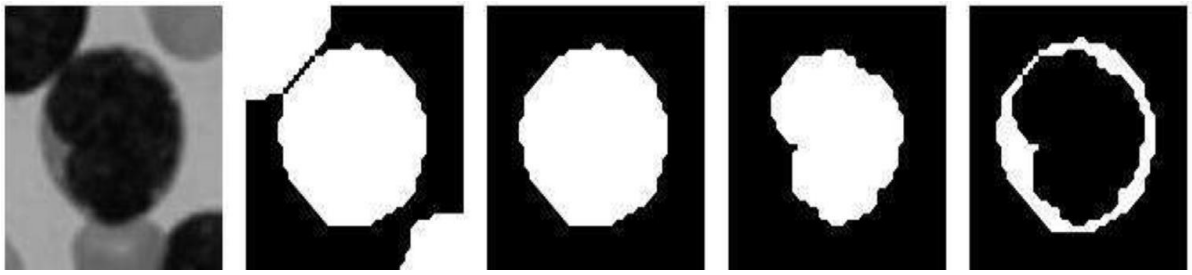
Solidity is used to find out the density of a component. Solidity value can beobtained by dividing the area to the convex hull of each component.If the solidity value is 1 then we can say it is a solid object. If the solidity value is lessthan 1 then we can say it is a component having irregular boundaries. The threshold valuefor solidity which is used for identifying the abnormal components can be obtained fromthe image which is having individual leucocytes only.0.90 is given as the threshold value for the solidity after many experiments. The components which are having the solidityvalue less than the threshold are removed. In fact, the components having lesser valuethan the threshold are the components which are on the edge of the image which need tobe discarded. Figure below shows the cleaned image which can be obtained by removing theleucocytes on the edges.



**Final separation results and image cleaning results.**

**Nucleus and cytoplasm selection:**

The leucocytes identified in above steps can now be used to extract the nucleus andcytoplasm.This method completely removes the artefacts. We have used Cseke'sobservation to find out nucleus in our method. The observation says that the white bloodcells nuclei are more in contrast on the green component of the RGB color space. So, wecan get nucleus by using the threshold. To get the cytoplasm we perform subtractionoperation between Figure 4.4 (c) and Figure 4.4 (d). The last two figures 4.4 (d) and 4.4(e) show the nucleus and cytoplasm respectively.



Left to right: grey level sub-image [a], binary sub-image [b], whole leucocyte sub-image [c], nucleus sub-image [d] and cytoplasm sub-image [e].

**Feature Extraction**

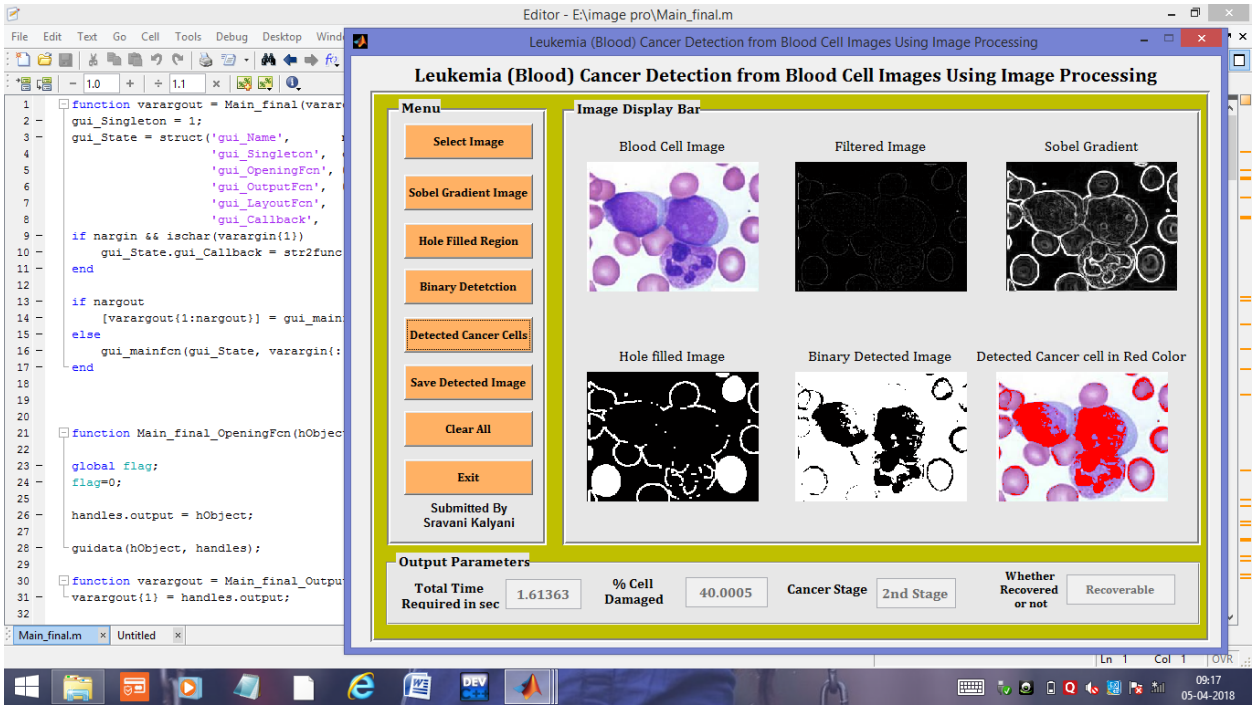
In this phase we try to extract some of the features from the processed image. Here, wetry to find out the features of the nucleus of myelocytes and lymphocytes. Featureextraction is the process of converting the image into data so that we can check thesevalues with the standard values and finally we can differentiate between the cancerousand non-cancerous data. Some of the features which are necessary to be calculated arelisted below.

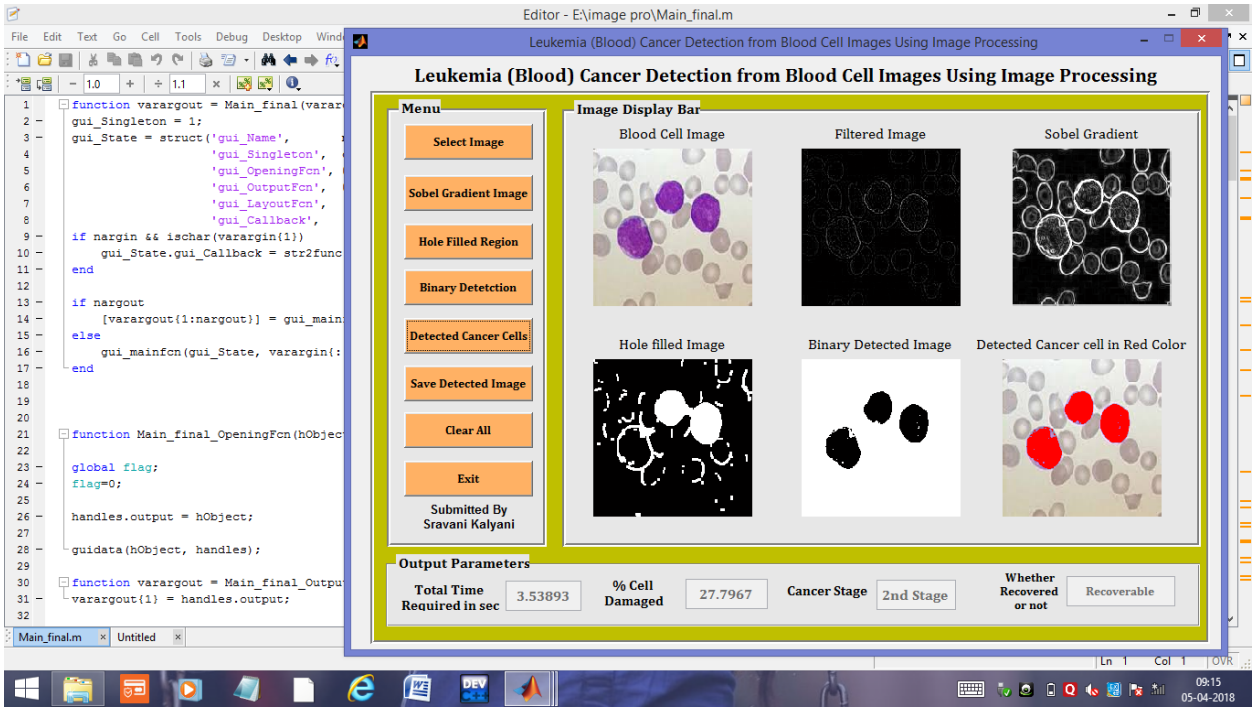
- Color Features – The mean color values of the grey images are acquired.
- Geometric Features – The perimeter, radius, area, rectangularity, compactness,convexity, concavity, symmetry, elongation, eccentricity, solidity are obtained.
- Texture Features – The entropy, energy, homogeneity, correlation are obtained.
- Statistical Features – The skew ness, mean, variance and gradient matrix areobtained.

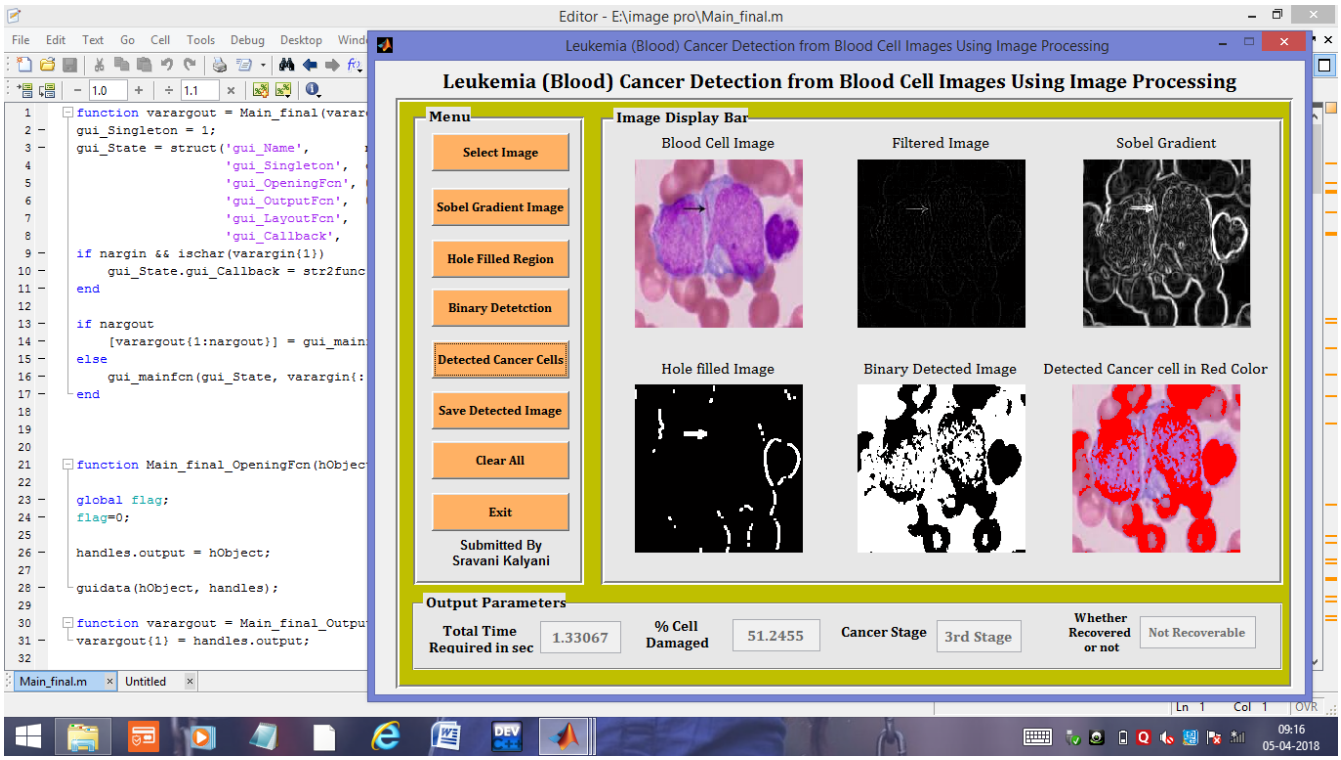
In this final phase, the features extracted are used to provide the final answer. All featureextracted are listed into the different columns with their values. When we give any imageas an input to the proposed system then we first calculate the

feature values. The valuesof the test image features are checked with the previously calculated values Based on thevalues of the input image the SVM classifier that classifies the test image into either infected or not infected class.

## Experimental Results:






## Future Scope:

There are so many ways to make this system better in future. We can improve thesegmentation scheme which can segment the overlapped cells also. There were found theuse of multiple classifiers in some systems. We can also use multiple classifiers toimprove the accuracy of the classification. Doing so will increase the cost but accuracywill also be improved. We can use parallel algorithm for the execution so that theexecution time can be decreased.

## Conclusion:

The major part of this work is to segment the lymphocytes and myelocytes white bloodcells for leukemia detection. The first phase of the proposed system is dealing with theimage cleaning and noise removal for making the image ready for the further andaccurate study. The second and major phase is the leucocytes identification from theimage. The third phase is dealing with the nucleus and cytoplasm extraction from theimage which can finally be used for the feature extraction in the last phase of theproposed system. This model has been tested against many images taken under samelightening condition and the accuracy achieved is 93.57%. We can also use the proposedsystem to find out thepercentage of leukemia infection in microscopic image. We hopethis approach will be beneficial for today's fast life and early detection of leukemia without any need of costly tests and with a better accuracy.

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