Automated Detection of Blood Cancer Diagnosis with Microscopic Image Analysis and Cell Counting of ALL, AML, CLL, and CML Cells

A PROJECT REPORT

Submitted by

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in partial fulfilment for the award of the degree of

BACHELOR OF ENGINEERING *in*

COMPUTER SCIENCE AND ENGINEERING

DHAANISH AHMED COLLEGE OF

ENGINEERING,PADAPPAI, CHENNAI - 601 301.

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MAY 2023

BONAFIDE CERTIFICATE

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ACKNOWLEDGEMENT

We thank our almighty God and our beloved parents for their consistent support and encouragement provided from the beginning of our project work and till its completion.

We express our heart-felt gratitude to our Chairman **ALHAJ K. MOOSA,** and to our Secretary **Mr. M. KADARSHAH, B.A, M.B.A,** forproviding necessary facilities for the successful completion of our project.

We take the privilege to express our indebted sense of gratitude to our beloved **Director Dr. P. PARAMASIVAN, MSC, Ph.D., MPhil, and our Principal Dr. G. UMA GOWRI, B.E, MTech. Ph.D.,** for granting permission to undertake the project in our college.

We would express our sincere thanks to our Head of the Department Prof **P. VELAVAN, M.E, [Ph.D.]** for being our Project Coordinator and for his kind permission to carry out the project.

We would like to extend our thanks to our Project Supervisor Mr. **S. MANIMARAN, M.E,** Assistant Professor, for his excellent guidance to complete the project.

We are extremely thankful to our faculty members of our department of Computer Science and Engineering, for their valuable support throughout this project. We also thank our Family and Friends for their moral.

Finally, we thank one and all those who have rendered help directly or indirectly at various stages of the project.

ABSTRACT

Leukemia could be a cancer of white blood cells (WBCs) which damagesblood and bone marrow of shape. It can be fatal illness if not diagnose atearlier stage. Typically, complete blood count (CBC) or morphological image analysis is employed to manually diagnose the malignant neoplastic disease cells. These ways are time consuming and fewer correct that must bemounted. In this paper we've got planned an automatic technique for the detection of acute lymphocytic leukemia (ALL), acute myeloid leukemia(AML), Chronic lymphocytic leukemia (CLL), Chronic myeloid leukemia(CML) by microscopic blood image analysis. This approach initial sectionout the various kinds of cells from the image i-e. White blood cells, red blood cells and platelets. Afterward Lymphocytes are separated from thewhite blood cells. Then form and color options are extracted from these lymphocytes that are given to SVM classifier to classify the cells into traditional and blast. After that the counting of the WBC cells are also detected for accurate diagnosis. This automated malignant neoplastic disease detection system found to be more practical, fast and correct as compare to manual identification ways.

OBJECTIVE

The main objective of this project is to detecting and counting the blood cell cancer cells in microscopic blood smear images. Blood circulatory system is one of the most important systems in human ‘s body. The function of this system is to transport blood throughout the body. This system consists of blood vessels which are arteries, veins, and capillaries, heart that act as pumping system, and blood that act as the medium for the system. Blood transportation is very important in order to supply oxygen to our body, carries carbon dioxide for gaseous exchange, minerals, nutrients, and ensure healthiness

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LIST OF ABBREVIATIONS

QSWTS	- QUALIFIED SIGNIFICANT WAVELET TREES
MATLAB	- MATRIX LABORATORY
IDWT	- INVERSE DISCRETE WAVELET TRANSFORM C-
PRBG	- CHAOTIC PSEUDO-RANDOM BIT GENERATOR

CHAPTER 1

INTRODUCTION

1.1 GENERAL

The term digital image refers to processing of a two-dimensional picture by a digital computer.In a broader context, it implies digital processing of any two-dimensional data. A digital image isan array of real or complex numbers represented by a finite number of bits. An image given in theform of a transparency, slide, photograph or an X-ray is first digitized and stored as a matrix of binary digits in computer memory. This digitized image can then be processed and/or displayed on a high-resolution television monitor. For display, the image is stored in a rapid-access buffer memory, which refreshes the monitor at a rate of 25 frames per second to produce a visually continuous display.

1.1.1 THE IMAGE PROCESSING SYSTEM

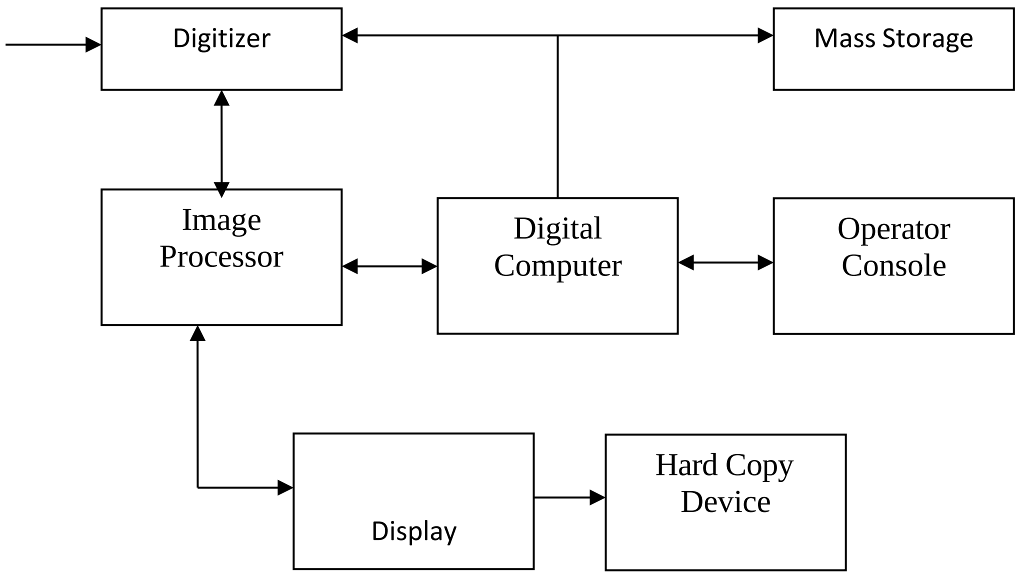


FIG 1.1 BLOCK DIAGRAM FOR IMAGE PROCESSING SYSTEM

DIGITIZER:

A digitizer converts an image into a numerical representation suitable for input into adigital computer. Some common digitizers are

1. Microdensitometer
2. Flying spot scanner
3. Image dissector
4. Videocon camera
5. Photosensitive solid- state arrays.

IMAGE PROCESSOR:

An image processor does the functions of image acquisition, storage, preprocessing, segmentation, representation, recognition and interpretation and finally displays or records the resulting image. The following block diagram gives the fundamental sequence involved in an image processing system.

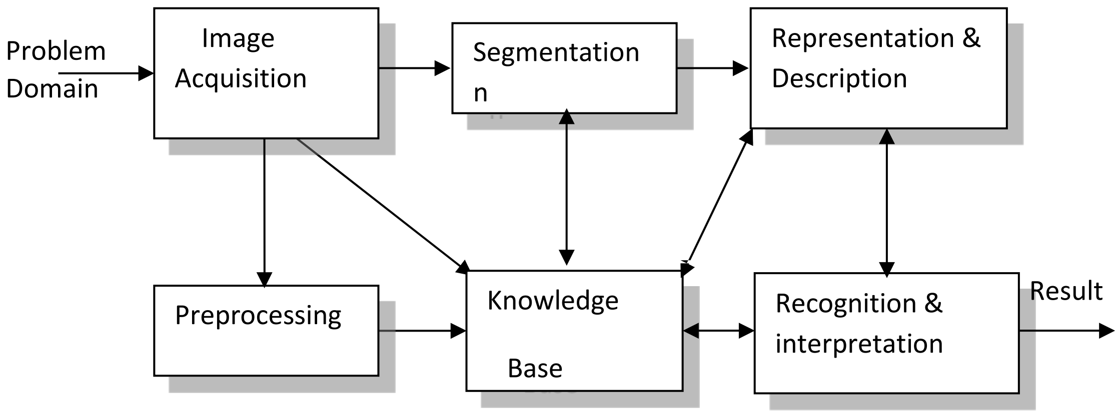


FIG 1.2 BLOCK DIAGRAM OF FUNDAMENTAL SEQUENCE INVOLVED IN ANIMAGE PROCESSING SYSTEM

As detailed in the diagram, the first step in the process is image acquisition by an imaging sensor in conjunction with a digitizer to digitize the image. The next step is the preprocessing step where the image is improved being fed as an input to the other processes. Preprocessing typicallydeals with enhancing, removing noise, isolating regions, etc. Segmentation partitions an image intoits constituent parts or objects. The output of segmentation is usually raw pixel data, which consistsof either the boundary of the region or the pixels in the region themselves. Representation is the process of transforming the raw pixel data into a form useful for subsequent processing by the computer. Description deals with extracting features that are basic in differentiating one class of objects from another. Recognition assigns a label to an object based on the information provided byits descriptors. Interpretation involves assigning meaning to an ensemble of recognized objects. Theknowledge about a problem domain is incorporated into the knowledge base. The knowledgebaseguides the operation of each processing module and also controls the interaction between the modules. Not all modules need be necessarily present for a specific function. The composition ofthe image processing system depends on its application. The frame rate of the image processor is normally around 25 frames per second.

DIGITAL COMPUTER:

Mathematical processing of the digitized image such as convolution, averaging, addition,subtraction, etc. are done by the computer.

MASS STORAGE:

The secondary storage devices normally used are floppy disks, CD ROMs etc.

HARD COPY DEVICE:

The hard copy device is used to produce a permanent copy of the image and for the storage of the software involved.

OPERATOR CONSOLE:

The operator console consists of equipment and arrangements for verification of intermediate results and for alterations in the software as and when require. The operator is also capable of checking for any resulting errors and for the entry of requisite data.

1.1.2 IMAGE PROCESSING FUNDAMENTAL:

Digital image processing refers processing of the image in digital form. Modern cameras may directly take the image in digital form but generally images are originated in optical form. They are captured by video cameras and digitalized. The digitalization process includes sampling, quantization. Then these images are processed by the five fundamental processes, at least any oneof them, not necessarily all of them.

IMAGE PROCESSING TECHNIQUES:

This section gives various image processing techniques.

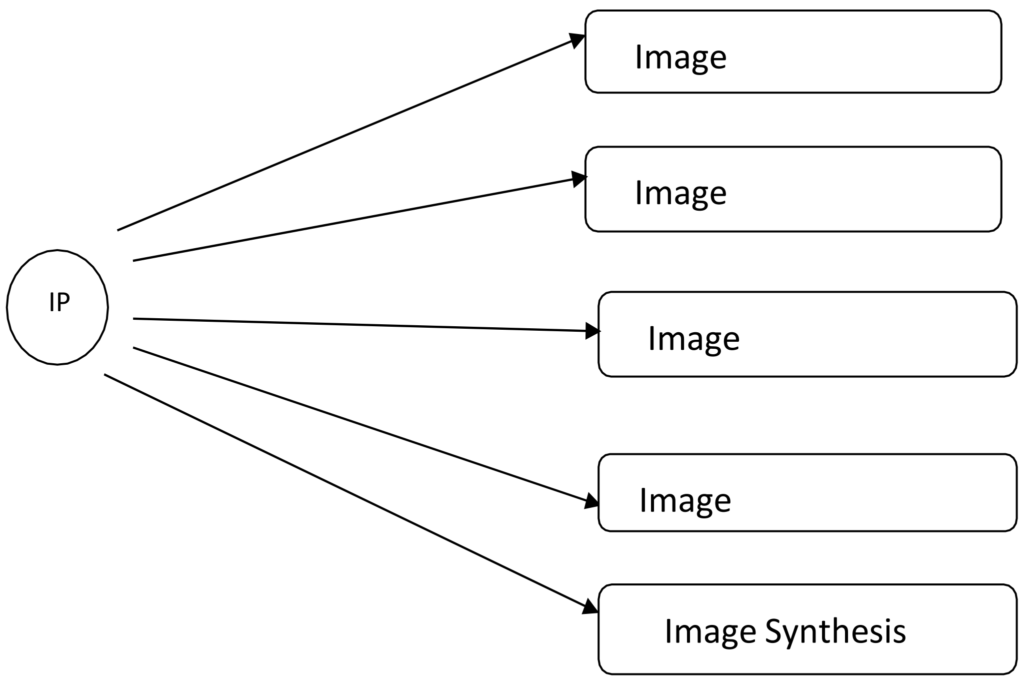


FIG1.3: IMAGE PROCESSING TECHNIQUES

IMAGE ENHANCEMENT:

Image enhancement operations improve the qualities of an image like improving the image’s contrast and brightness characteristics, reducing its noise content, or sharpen the details. This just enhances the image and reveals the same information in more understandable image. It does not add any information to it.

IMAGE RESTORATION:

Image restoration like enhancement improves the qualities of image but all the operationsare mainly based on known, measured, or degradations of the original image. Image restorations are used to restore images with problems such as geometric distortion, improper focus, repetitive noise, and camera motion. It is used to correct images for known degradations.

IMAGE ANALYSIS:

Image analysis operations produce numerical or graphical information based on characteristics of the original image. They break into objects and then classify them. They dependon the image statistics. Common operations are extraction and description of scene and image features, automated measurements, and object classification. Image analyzes are mainly used in machine vision applications.

IMAGE COMPRESSION:

Image compression and decompression reduce the data content necessary to describe the image. Most of the images contain lot of redundant information, compression removes all the redundancies. Because of the compression the size is reduced, so efficiently stored or transported. The compressed image is decompressed when displayed. Lossless compression preserves the exactdata in the original image, but Lossy compression does not represent the original image but provideexcellent compression.

IMAGE SYNTHESIS:

Image synthesis operations create images from other images or non-image data. Image synthesis operations generally create images that are either physically impossible or impractical toacquire.

APPLICATIONS OF DIGITAL IMAGE PROCESSING:

Digital image processing has a broad spectrum of applications, such as remote sensing viasatellites and other spacecrafts, image transmission and storage for business applications, medical processing, radar, sonar and acoustic image processing, robotics and automated inspection of industrial parts.

MEDICAL APPLICATIONS:

In medical applications, one is concerned with processing of chest X-rays, cineangiograms,projection images of trans-axial tomography and other medical images that occur in radiology, nuclear magnetic resonance (NMR) and ultrasonic scanning. These images may be used for patientscreening and monitoring or for detection of tumors' or other disease in patients.

SATELLITE IMAGING:

Images acquired by satellites are useful in tracking of earth resources; geographical mapping; prediction of agricultural crops, urban growth and weather; flood and fire control; and many other environmental applications. Space image applications include recognition and analysisof objects contained in image obtained from deep space-probe missions.

COMMUNICATION:

Image transmission and storage applications occur in broadcast television, teleconferencing, and transmission of facsimile images for office automation, communication of computer networks, closed-circuit television-based security monitoring systems and in military communications.

RADAR IMAGING SYSTEMS:

Radar and sonar images are used for detection and recognition of various types of targets or in guidance and maneuvering of aircraft or missile systems.

DOCUMENT PROCESSING:

It is used in scanning, and transmission for converting paper documents to a digital imageform, compressing the image, and storing it on magnetic tape. It is also used in document readingfor automatically detecting and recognizing printed characteristics.

DEFENSE/INTELLIGENCE:

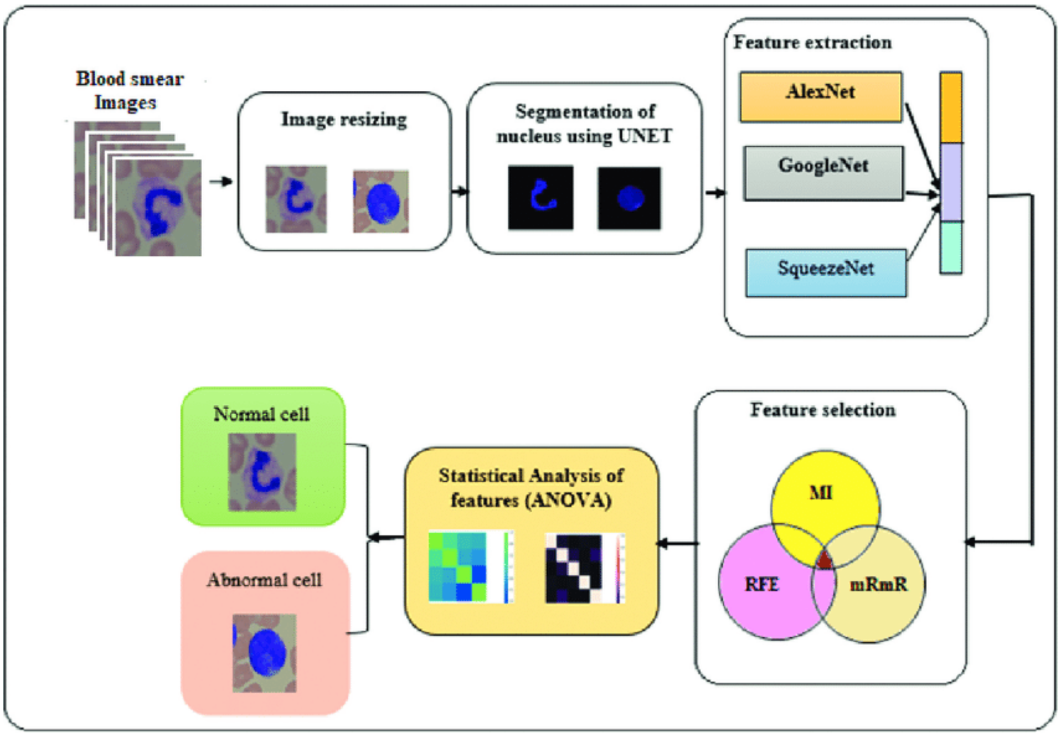
It is used in reconnaissance photo-interpretation for automatic interpretation of earth satellite imagery to look for sensitive targets or military threats and target acquisition and guidancefor recognizing and tracking targets in real-time smart-bomb and missile-guidance systems.

1.2 OBJECTIVE

The main objective of this project is to detecting and counting the blood cell cancer cellsin microscopic blood smear images. Blood circulatory system is one of the most important systemsin human ‘s body. The function of this system is to transport blood throughout the body. This system consists of blood vessels which are arteries, veins, and capillaries, heart that act as pumpingsystem, and blood that act as the medium for the system. Blood transportation is very important inorder to supply oxygen to our body, carries carbon dioxide for gaseous exchange, minerals, nutrients, and ensure healthiness.

1.3 EXISTING SYSTEM

This paper proposes histogram equalization and median filtering to perform pre-processing of blood images. Then fuzzy c-mean was carried out for the segmentation of white blood cells. After extracting features using Gabor texture extraction method, classification was carriedout using support vector machine (SVM) to classify normal and blast cells.



1.3.1 DISADVANTAGES OF EXISTING SYSTEM

- The fuzzy c-means technique is not segmenting the WBC cells alone.
- Because the size and shape of the WBC cells is only identifying the healthy and cancer cells.
- In this process the output accuracy is less when compared to the proposed system.
- Here the counting of the WBC cells is not calculated. Because the counting is also importantparameter for doctor diagnosis references.

1.3.2 LITERATURE SURVEY:

1. Micro-scopic image segmentation using Fuzzy C means for leukemia diagnosis."Leukemia 4, no. 1 Karthikeyan. T, and N. Poornima. -2017

In this paper they used **histogram equalization** and median filtering to perform pre- processing of blood images. Then **fuzzy c-mean** was carried out for the segmentation of white blood cells. After extracting features using Gabor texture extraction method, classification was carried out using support vector machine (SVM) to classify normal and blast cells.

2. Segmentation of white blood cell from acute lymphoblastic leukemia images using dual-threshold method." Li, Yan, Rui Zhu, Lei Mi, Yihui Cao, and Di Yao-2016.

In this paper they proposed a **dual threshold** method for the segmentation of lymphocytes, where they have achieved decent accuracy. They enhanced the standard single threshold method by utilizing golden section search to determine optimal threshold value of lymphocytes.

3. Enhanced recognition of acute lymphoblastic leukemia cells in microscopic images basedon feature reduction using principal component analysis MoradiAmin, Morteza, Nasser Samadzadehaghdam, Saeed Kermani, and Ardeshir Talebi-2015

In this paper they process the ALL recognition by deploying **fuzzy c mean clustering** for lymphocytes segmentation. Principle component analysis used to reduce different shape based features. After that, SVM was trained over those features to classify the normal and blastlymphocytes.

4. White blood cells identification and counting from microscopic blood image. Putzu,Lorenzo, and Cecilia Di Ruberto-2013

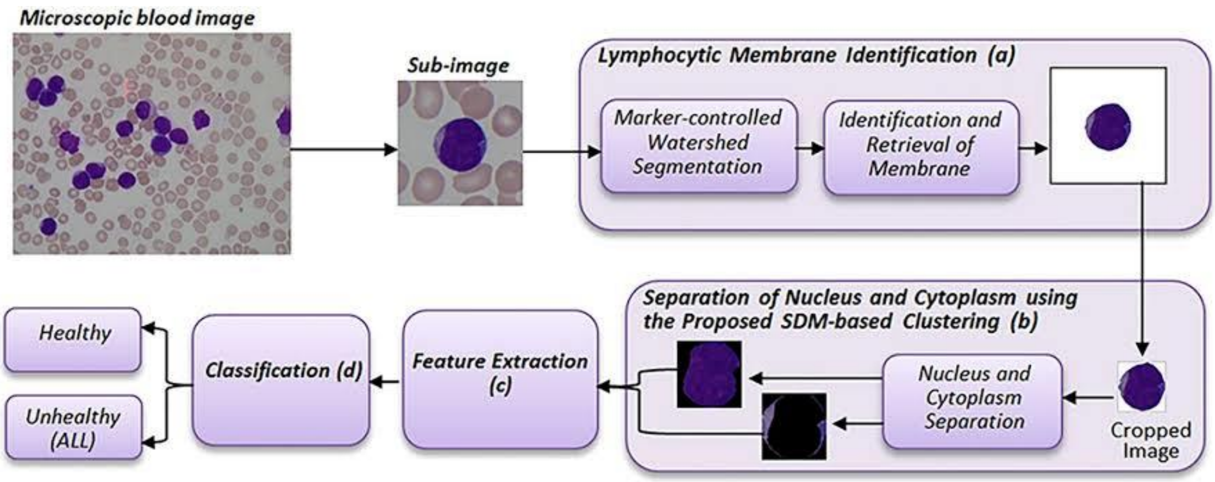
This paper presented the white blood cell cancer detection using **triangle threshold** for segmentation of white blood cells. Features including shape features, colour featuresand texture features were extracted using GLCM. After that, SVM was used for classification of blast and normal cells.

5. An ensemble classifier system for early diagnosis of acute lymphoblastic leukemia in blood microscopic images Mohapatra, Subrajeet, Dipti Patra, and Sanghamitra Satpathy-2014

This paper used **contrast enhancement** and selective median filtering for for preprocessing of the images. After that Shadowed c-mean clustering was used for the segmentation of lymphocytes into3 regions i-e. background, cytoplasm and nucleus. After that, different features including fractal dimension, shape-based features, colour features and texture features were extracted from those lymphocytes. Then an ensemble classifier (Naive Bayesian, K-nearest neighbor, Multilayerperceptron, Radial basis functional neural network, Support vector machines) was trained to classify normal and blast cells.

1.4 PROPOSED METHOD

In this paper we propose efforts have been made for the detection of Acute lymphoblastic leukemia, Acute myeloid leukemia, Chronic lymphocytic leukemia, Chronic myeloid leukemia from microscopic blood images by using image processing techniques. Preprocessing was applied over the images to remove any noise, and then segmentation is performed to detect lymphocytes from the image. Watershed is used to separate the grouped lymphocytes for counting of cells, after extracting shape and color features; SVM is used to classify normal and blast cells.



1.4.1 PROPOSED SYSTEM ADVANTAGES

1. In this technique we use color space conversion and WATERSHED segmentation algorithm inorder to segment the size and shape of the WBC cells more accurately.

2. By using the accurate shape and size of the WBC cells we have to differentiate the healthy andcancer cells.

3. Not only detect the cancer cells but also, we are going the counting the number of WBC cells fordoctor diagnosis. In this process the output accuracy is more when compared to the existing system.

SCOPE OF THE PROJECT

Blood circulatory system is one of the most important systems in human ‘s body. The function of this system is to transport blood throughout the body. This system consists of blood vessels which are arteries, veins, and capillaries, heart that act as pumping system, and blood that act as the medium for the system. Blood transportation is very important in order to supply oxygen to our body, carries carbon dioxide for gaseous exchange, minerals, nutrients, and ensure healthiness. Blood cell composed of White Blood Cells (WBCs), Red Blood Cells (RBCs), platelets, and plasma. There are five types of WBC which are Monocyte,Lymphocyte, Neutrophil, Basophil, and Eosinophil. Each component in the blood cells plays theirown role in maintaining living activities and health. The number of each element plays importantrole to ensure healthiness. Lack or extreme amount of blood cells, and the shape of RBC ‘s in thebody can cause disease such as leukemia or anemia, and other medical problem. WBCs number is important to conclude human ‘s health state. This is due to the number or quantity of this cell determined the individual health condition and indicates diseases which might occur. WBCs involve directly in human body defend system. Knowledge on typical range of WBC counts in Afro-Caribbean adults will be immediate clinical value to physician and the WBC counts in Jamaicans are comparable to those African origin. There are several ecological factors that affectthe result obtained which are widespread infections, migrant populations living in the developed countries, and social factor. Therefore, orientation value of WBC must be obtained from their native habitat population for accurate analysis in cell counting.

BLOCK DIAGRAM:

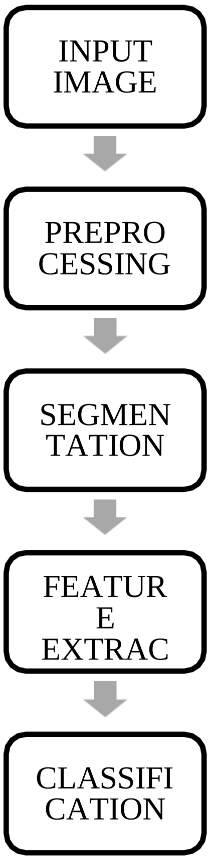


FIG 1.4: BLOCK DIAGRAM OF PROPOSED SYSTEM

CHAPTER 2

PROJECT DISCRIPTION

2.1 INTRODUCTION

Acute lymphoblastic leukemia is a type of cancer associated with blood in which leukocytes (WBCs) start growing abnormally. These abnormal cells strike the blood and bone marrow due to which immune system of human body become vulnerable. Furthermore, it suppresses the production of normal red blood cells and platelets hence lead towards anemia, the blood deficiency. Moreover, these abnormal leukocytes predominantly spread into the human blood swiftly and can also capture other different body parts like kidney, liver, spleen, brain and lymph nodes. Leukemia is classified as either Lymphoblastic or Myelogenous depending on the type of white blood cells being infected. If the infected cells are granulocytes and monocytes, thenthe leukemia will be classified as Myelogenous (AML) and if the infected cells are lymphocytes, then the leukemia will be classified as Lymphoblastic (ALL). According to French American British (FAB) classification, ALL is further categorized into 3 subtypes, which are L1, L2 and L3. L1 type cells are normally small in size and are homogeneous with little cytoplasm. Their nucleusis discoid and well structured. L2 type cells have shape dissimilarity and are over-sized as compared to L1. Their nucleus is not regular and contains variations in their cytoplasm. L3 type cells are of identical shape and normal size with round or oval nucleus. They have adequate amountof cytoplasm which includes vacuoles. They are usually larger in size than L1.

2.1.1 RGB COLOR IMAGE:

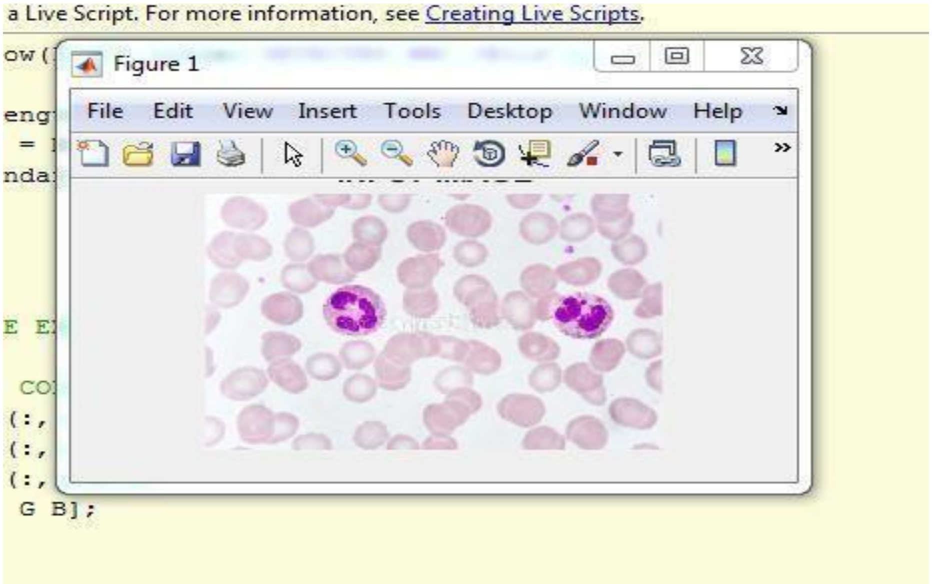
The RGB color model is an additive color model in which red, green, and blue light are added together in various ways to reproduce a broad array of colors. The name of the model comesfrom the initials of the three additive primary colors, red, green, and blue.

The main purpose of the RGB color model is for the sensing, representation, and display of images in electronic systems, such as televisions and computers, though it has also been used in conventional photography. Before the electronic age, the RGB color model already had a solidtheory behind it, based in human perception of colors.

RGB is a device-dependent color model: different devices detect or reproduce a given RGBvalue differently, since the color elements (such as phosphors or dyes) and their response to the individual R, G, and B levels vary from manufacturer to manufacturer, or even in the same deviceover time. Thus, an RGB value does not define the same color across devices without some kind of color management.

Typical RGB input devices are color TV and video cameras, image scanners, and digital cameras. Typical RGB output devices are TV sets of various technologies (CRT, LCD, plasma, etc.), computer and mobile phone displays, video projectors, multicolor LED displays, and large screens such as JumboTron. Color printers, on the other hand, are not RGB devices, but subtractivecolor devices (typically CMYK color model).

Fig 2.1.1.(a) Example of RGB color image is given below



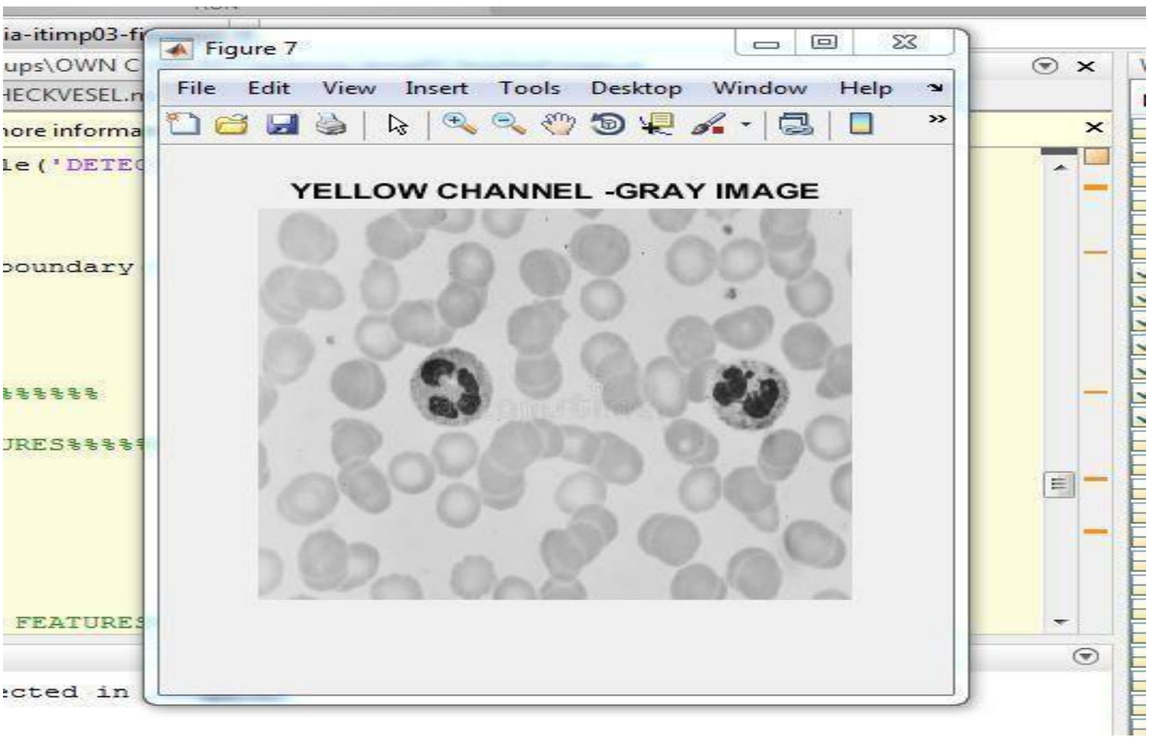
2.1.2 GRAYSCALE:

In photography and computing, a grayscale or greyscale digital image is an image in whichthe value of each pixel is a single sample, that is, it carries only intensity information. Images of this sort, also known as black-and-white, are composed exclusively of shades of gray, varying from black at the weakest intensity to white at the strongest.

Grayscale images are distinct from one-bit bi-tonal black-and-white images, which in the context of computer imaging are images with only the two colors, black, and white (also called bilevel or binary images). Grayscale images have many shades of gray in between. Grayscale images are also called monochromatic, denoting the presence of only one (mono) color(chrome).

Grayscale images are often the result of measuring the intensity of light at each pixel in a single band of the electromagnetic spectrum (e.g. infrared, visible light, ultraviolet, etc.), and in such cases they are monochromatic proper when only a given frequency is captured. But also, theycan be synthesized from a full color image; see the section about converting to grayscale.

Fig 2.1.2(a) Example of gray scale image is given belo



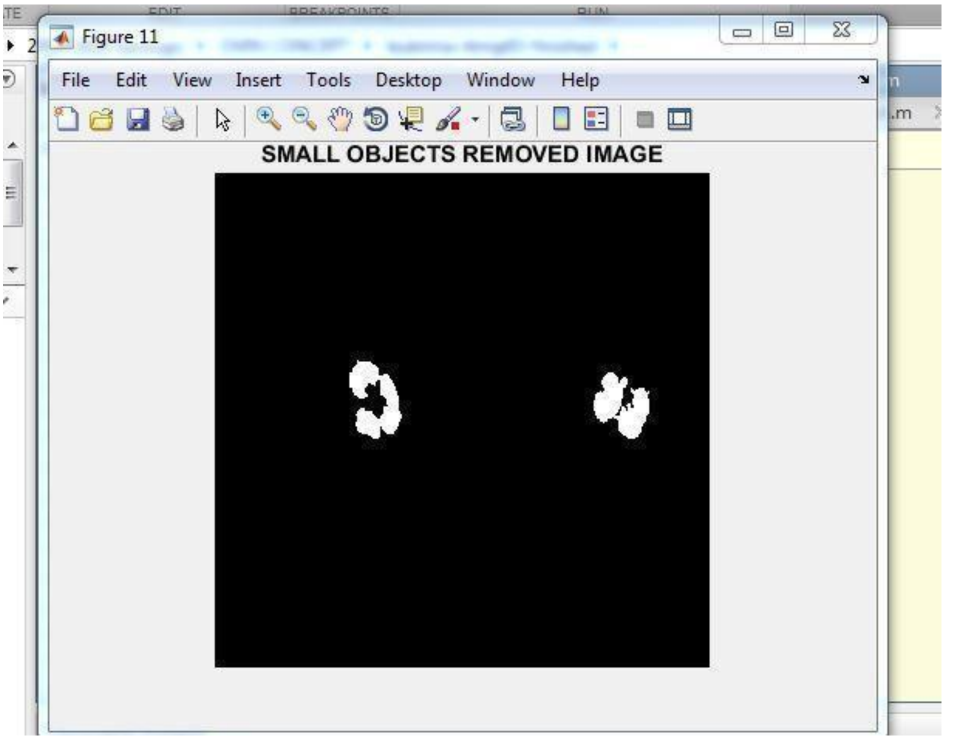
2.1.4 BORDER CORRECTED MASK:

A mask is a filter. Concept of masking is also known as spatial filtering. Masking is also known as filtering. In this concept we just deal with the filtering operation that is performed directly on the image. In image processing, a kernel, convolution matrix, or mask is a small matrix useful for blurring, sharpening, embossing, edge-detection, and more. This is accomplishedby means of convolution between a kernel and an image.

The mask is created to find the exact operations in an image. So that we can identify the problems or the features which we need to find in an image.

The border corrected mask is a mask in which the edges are closed to find all the featuresof an image.

Example of border corrected mask is given below



2.1.5 SEGMENTATION:

In computer vision, image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful andeasier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics.

The result of image segmentation is a set of segments that collectively cover the entire image, ora set of contours extracted from the image (see edge detection). Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same

characteristic(s). When applied to a stack of images, typical in medical imaging, the resulting contours after image segmentation can be used to create 3D reconstructions with the help of interpolation algorithms like marching cubes.

2.1.6 CONNECTED COMPONENT ANALYSIS (CCA) AND OBJECTSEXTRACTION:

CCA is a well-known technique in image processing that scans an image and groups pixels in labeled components based on pixel connectivity. An eight-point CCA stage is performed to locate all the objects inside the binary image produced from the previous stage. The output of thisstage is an array of N objects shows an example of the input and output of this stage.

2.2 APPLICATIONS:

- To support early detection, diagnosis and optimal treatment.
- Image segmentation plays an essential role in many medical applications.
- Low SNR conditions and various artifacts makes its automation challenging.
- To achieve robust and accurate segmentation.
- It also reduces the checking process.
- Hence, we have to find the better solution for blood cell cancer detection.

2.3 METHODOLOGIES:

2.3.1 MODULE NAMES

1. **INPUT**
2. **PREPROCESSING THE INPUT IMAGE**
3. **TO SEGMENT THE AFFECTED PART**
4. **FEATURE EXTRACTION**
5. **CLASSIFICATION**

2.3.2 MODULE DESCRIPTIONS:

MODULE DESCRIPTION: (IMPLEMENTATION)

1. **INPUT IMAGE:**

Read and display an input Image. Read an image into the workspace, using the In read command. In image processing, it is defined as the action of retrieving an image from some source, usually a hardware-based source for processing. It is the first step in the workflow sequence because, without an image, no processing is possible. The image that is acquired is completely unprocessed.

2. **PREPROCESSING.**

Pre-processing is a common name for operations with images at the lowest level of abstraction both input and output are intensity images. The aim of pre-processing is an improvement of the image data that suppresses unwanted distortions or enhances some imagefeatures important for further processing. Image pre-processing methods use the considerableredundancy in images. Neighboring pixels corresponding to one object in real images have essentially the same or similar brightness value. Thus, distorted pixel can often be restored as an average value of neighboring pixels.

1. RESIZING THE INPUT IMAGE:

All the input images are resized into same dimensions. If the specified size does not produce the sameaspect ratio as the input image, the output image will be distorted.

2. CONVERTING COLOUR FORMAT:

For many applications of image processing, color information doesn't help us. If you get into the business of attempting to distinguish colors from one another, then one reason forconverting RGB image to BLACK AND WHITE or GRAYSCALE or RGB image to HSV formats in image.

3. SEGMENTATION

Image segmentation is a commonly used technique in digital image processing and analysis to partition an image into multiple parts or regions, often based on the characteristics of the pixels in the image. In computer vision, Image Segmentation is the process of subdividing a digital image into multiple segments (sets of pixels, also known as super pixels. Segmentation is a process of grouping together pixels that have similar attributes. Image Segmentation is the process of partitioning an image into non- intersecting regions such that each region is homogeneous and the union of no two adjacent regions is homogeneous Pixels in a region are similar according to some homogeneity criteria such as color, intensity or texture so as to locate and identify objects and boundaries (lines, curves, etc.) in an image. Segmentation accuracy determines the eventual success or failure of computerized analysis procedure.

1. COLOUR SPACE CONVERSIONS:

Color space conversion is the translation of the representation of a color from one basis to another. This typically occurs in the context of converting an image that is represented in one color space to another color space, the goal being to make the translated image look as similar as possible to the original. Here we use rgb to ycbcr color space conversion for white blood cell segmentation.

2. MORPHOLOGICAL OPERATIONS:

Morphological image processing is a collection of non-linear operations related to the shape or morphology of features in an image. Morphology is a broad set of image processing operations that process images based on shapes. Morphological operations apply a structuring element to an input image, creating an output image of the same size.

Some segmentation techniques are,

A) ROI (Region of Interest)

B) WATER SHED SEGMENTATION

4. FEATURE EXTRACTION

In machine learning, pattern recognition and in image processing, featureextraction starts from an initial set of measured data and builds derived values (features) intendedto be informative and non-redundant, facilitating the subsequent learning and generalization steps, and in some cases leading to better human interpretations. Feature extraction is related to dimensionality reduction. When the input data to an algorithm is too large to be processed and it is suspected to be redundant (e.g., the same measurement in both feet and meters, or the repetitiveness of images presented as pixels), then it can be transformed into a reduced set of features (also named a feature vector). Determining a subset of the initial features is called featureselection. The selected features are expected to contain the relevant information from the input data, so that the desired task can be performed by using this reduced representation instead of thecomplete initial data.

a) Shape features
b) Color features
c) Geometrical features
d) Texture features

A) SHAPE FEATURES:

Visual features of objects are called the shape characteristics or visual features. For example, circular object or triangular objects or other shapes, perimeter boundary of the object, the diameter of the border and so on. The visual features showed intuitively are all belongs to shape features.

B) COLOR FEATURES:

Global features include color and texture histograms and color layout of the whole image. Local features include color, texture, and shape features for sub images, segmented regions, and interest points. These features extracted from images are then used for image matching and retrieving

C) GEOMETRICAL FEATURES:

Geometric features are features of objects constructed by a set of geometric elements likepoints, lines, curves or surfaces. These features can be corner features, edge features, Blobs, Ridges, salient point's image texture and so on, which can be detected by feature detection methods. Here we use area, diameter, density features for calculations.

D) TEXTURE FEATURES:

An image texture is a set of metrics calculated in image processing designed to quantify the perceived texture of an image. Image texture gives us information about the spatial arrangement of color or intensities in an image or selected region of an image. Here we use GLCM(Grey Level Co-occurrences Matrix) for texture feature analysis.

Some feature extraction methods are,

A) GLCM (Grey level co-occurrence matrix)

B) LBP (Local Binary Pattern)

C) PCA (Principal Component Analysis)

5. CLASSIFICATION:

Image classification refers to the task of extracting information classes from a multiband raster image. The resulting raster from image classification can be used to create thematic maps. The recommended way to perform classification and multivariate analysis is through the Image Classification toolbar. There are many classification algorithms are available and some classification algorithm that are given below,

A) SVM (SUPPORT VECTOR MACHINE CLASSIFICATION)

CHAPTER 3
SOFTWARE SPECIFICATION

3.1 GENERAL

MATLAB (**mat**rix **lab**oratory) is a numerical computing environment and fourth- generation programming language. Developed by Math Works, MATLABallows matrix manipulations, plotting of functions and data, implementation of algorithms,creation of user interfaces, and interfacing with programs written in other languages,including C, C++, Java, and Fortran.

Although MATLAB is intended primarily for numerical computing, an optional toolboxuses the MuPAD symbolic engine, allowing access to symbolic computing capabilities. An additional package, Simulink, adds graphical multi-domain simulation and Model-Based Design for dynamic and embedded systems.

In 2004, MATLAB had around one million users across industry andacademia. MATLAB users come from various backgrounds of engineering, science, and economics. MATLAB is widely used in academic and research institutions as well asindustrial enterprises.

MATLAB was first adopted by researchers and practitioners in control engineering, Little's specialty, but quickly spread to many other domains. It is now also used in education, in particular the teaching of linear algebra and numerical analysis, and is popular amongst scientists involved in image processing. The MATLAB application is built around the MATLAB language.The simplest way to execute MATLAB code is to type it in the Command Window, which is oneof the elements of the MATLAB Desktop. When code is entered in the Command Window, MATLAB can be used as an interactive mathematical shell. Sequences of commands can be savedin a text file, typically using the MATLAB Editor, as a script or encapsulated into a function, extending the commands available.

MATLAB provides a number of features for documenting and sharing your work. You canintegrate your MATLAB code with other languages and applications, and distribute your MATLAB algorithms and applications.

3.2 FEATURES OF MATLAB

- High-level language for technical computing.
- Development environment for managing code, files, and data.
- Interactive tools for iterative exploration, design, and problem solving.
- Mathematical functions for linear algebra, statistics, Fourier analysis,filtering, optimization, and numerical integration.
- 2-D and 3-D graphics functions for visualizing data.
- Tools for building custom graphical user interfaces.
- Functions for integrating MATLAB based algorithms with external applications andlanguages, such as C, C++, Fortran, Java™, COM, and Microsoft Excel.

MATLAB is used in vast area, including signal and image processing, communications, control design, test and measurement, financial modeling and analysis, and computational. Add- on toolboxes (collections of special-purpose MATLAB functions) extend the MATLAB environment to solve particular classes of problems in these application areas.

MATLAB can be used on personal computers and powerful server systems, including the Cheaha compute cluster. With the addition of the Parallel Computing Toolbox, the language can be extended with parallel implementations for common computational functions, including for-loop unrolling. Additionally, this toolbox supports offloading computationally intensive workloads to Cheaha the campus compute cluster. MATLAB is one of a few languages in which each variable is a matrix (broadly construed) and "knows" how big it is. Moreover, the fundamental operators (e.g., addition, multiplication) are programmed to deal with matrices when required. Andthe MATLAB environment handles much of the bothersome housekeeping that makes all this possible. Since so many of the procedures required for Macro-Investment Analysis involves matrices, MATLAB proves to be an extremely efficient language for both communication and implementation.

3.2.1 INTERFACING

Development

Environment

- Startup Accelerator for faster MATLAB startup on Windows, especially on WindowsXP, and for network installations.
- Spreadsheet Import Tool that provides more options for selecting and loading mixedtextual and numeric data.
- Readability and navigation improvements to warning and error messages in theMATLAB command window.
- Automatic variable and function renaming in the MATLAB Editor.

Developing Algorithms and Applications

MATLAB provides a high-level language and development tools that let you quicklydevelop and analyze your algorithms and applications.

The MATLAB Language

The MATLAB language supports the vector and matrix operations that are fundamental toengineering and scientific problems. It enables fast development and execution. With the MATLAB language, you can program and develop algorithms faster than with traditional languages because you do not need to perform low-level administrative tasks, such as declaring variables, specifying data types, and allocating memory. In many cases, MATLAB eliminates theneed for 'for' loops. As a result, one line of MATLAB code can often replace several lines of C orC++ code.

At the same time, MATLAB provides all the features of a traditional programming language, including arithmetic operators, flow control, data structures, data types, object-orientedprogramming (OOP), and debugging features.

MATLAB lets you execute commands or groups of commands one at a time, without compiling and linking, enabling you to quickly iterate to the optimal solution. For fast execution of heavy matrix and vector computations, MATLAB uses processor-optimized libraries. For general-purpose scalar computations, MATLAB generates machine-code instructions using its JIT(Just-In-Time) compilation technology.

This technology, which is available on most platforms, provides execution speeds that rival those of traditional programming languages.

Development Tools

MATLAB includes development tools that help you implement your algorithmefficiently. These include the following:

MATLAB Editor

Provides standard editing and debugging features, such as setting breakpoints and single stepping

Code Analyzer

Checks your code for problems and recommends modifications to maximize performanceand maintainability

MATLAB Profiler

Records the time spent executing each line of code

Directory Reports

Scan all the files in a directory and report on code efficiency, file differences, file dependencies, and code coverage

Designing Graphical User Interfaces

By using the interactive tool GUIDE (Graphical User Interface Development Environment) to layout, design, and edit user interfaces. GUIDE lets you include list boxes, pull-down menus, push buttons, radio buttons, and sliders, as well as MATLAB plots and Microsoft ActiveX® controls. Alternatively, you can create GUIs programmatically using MATLAB functions.

3.2.2 ANALYZING AND ACCESSING DATA

MATLAB supports the entire data analysis process, from acquiring data from external devices and databases, through preprocessing, visualization, and numerical analysis, to producingpresentation-quality output.

Data Analysis

MATLAB provides interactive tools and command-line functions for data analysisoperations, including:

- Interpolating and decimating
- Extracting sections of data, scaling, and averaging
- Thresholding and smoothing
- Correlation, Fourier analysis, and filtering
- 1-D peak, valley, and zero finding
- Basic statistics and curve fitting
- Matrix analysis

Data Access

MATLAB is an efficient platform for accessing data from files, other applications, databases, and external devices. You can read data from popular file formats, such as Microsoft Excel; ASCII text or binary files; image, sound, and video files; and scientific files, such as HDFand HDF5. Low-level binary file I/O functions let you work with data files in any format. Additional functions let you read data from Web pages and XML.

Visualizing Data

All the graphics features that are required to visualize engineering and scientific data are available in MATLAB. These include 2-D and 3-D plotting functions, 3-D volume visualization functions, tools for interactively creating plots, and the ability to export results to all popular graphics formats. You can customize plots by adding multiple axes; changing line colors andmarkers; adding annotation, Latex equations, and legends; and drawing shapes.

2-D Plotting

Visualizing vectors of data with 2-D plotting functions that create:

- Line, area, bar, and pie charts.
- Direction and velocity plots.
- Histograms.
- Polygons and surfaces.
- Scatter/bubble plots.
- Animations.

3-D Plotting and Volume Visualization

MATLAB provides functions for visualizing 2-D matrices, 3-D scalar, and 3-D vector data. You can use these functions to visualize and understand large, often complex, multidimensional data. Specifying plot characteristics, such as camera viewing angle, perspective,lighting effect, light source locations, and transparency.

3-D plotting functions include:

- Surface, contour, and mesh.
- Image plots.
- Cone, slice, stream, and isosurface.

3.2.3 PERFORMING NUMERIC COMPUTATION

MATLAB contains mathematical, statistical, and engineering functions to support all common engineering and science operations. These functions, developed by experts in mathematics, are the foundation of the MATLAB language. The core math functions use the LAPACK and BLAS linear algebra subroutine libraries and the FFTW Discrete Fourier Transformlibrary. Because these processor-dependent libraries are optimized to the different platforms that MATLAB supports, they execute faster than the equivalent C or C++ code.

MATLAB provides the following types of functions for performing mathematicaloperations and analyzing data:

- Matrix manipulation and linear algebra.
- Polynomials and interpolation.
- Fourier analysis and filtering.
- Data analysis and statistics.
- Optimization and numerical integration.
- Ordinary differential equations (ODEs).
- Partial differential equations (PDEs).
- Sparse matrix operations.

MATLAB can perform arithmetic on a wide range of data types, including doubles,singles, and integers.

CHAPTER 4

IMPLEMENTATION

4.1 GENERAL

MATLAB is a program that was originally designed to simplify the implementation of numerical linear algebra routines. It has since grown into something much bigger, and it is used toimplement numerical algorithms for a wide range of applications. The basic language used is verysimilar to standard linear algebra notation, but there are a few extensions that will likely cause yousome problems at first.

4.2 IMPLEMENTING CODE

```
%%%%%%%%%%%%%%%%%BLOOD CANCER DETECTION
AND CLASSIFICATION %%%%%%%%

clc

close all;

clear all;

warning off;


%%%%%%Get the input image %%%%%
[filename,pathname]=uigetfile('/MATLAB Drive/CANCER WBC/ALL(a).jpg');

%%%% Read Input Image %%%%%
 I=imread([pathname,filename]);
figure,imshow(I),title('INPUT IMAGE');

%%%%% Resize The input image %%%%%%
I=imresize(I,[512 512]);
figure,imshow(I);title('RESIZED INPUT IMAGE');

%%%%%%CONVERT RGB2CMYK COLOUR SPACE CONVERSIONS
    %%%%%%

cyan=I;
megenta=I;
```

```
yellow=I;

cyan(:,:,1)=0;
cyan(:,:,1)=0;
megenta(:,:,2)=0;
megenta(:,:,2)=0;
yellow(:,:,3)=0;
yellow(:,:,3)=0;

figure,imshow(cyan),title('CYAN  CHANNEL IMAGE');
figure,imshow(megenta),title('MEGENTA CHANNEL IMAGE');
figure,imshow(yellow),title('YELLOW CHANNEL IMAGE');

figure,
subplot(1,3,1),imshow(cyan),title('CYAN');
subplot(1,3,2),imshow(megenta),title('MEGENTA');
subplot(1,3,3),imshow(yellow),title('YELLOW');


%%%%SELECT THE YELLOW CHANNEL AND PERFORM RGB TO
GRAY CONVERSION %%%%%%

%% RGB to Gray conversion
[m n o]=size(yellow);
if o==3
   gray=rgb2gray(yellow);
else
   gray=yellow;
end
figure,imshow(gray);title('YELLOW CHANNEL -GRAY IMAGE');

%
%%%%%%ADJUST THE CONTRAST OF THE GRAY CHANNEL
    IMAGE%%%%
ad=imadjust(gray);
figure,imshow(ad);title('ADJUSTED GRAY IMAGE');
%
%%%%TO PERFORM BINARY CONVERSION ON THE ADJUSTED
GRAY IMAGE%%%%%
bw=im2bw(gray,0.5);
figure,imshow(bw);title('BLACK AND WHITE IMAGE');
%
%%%%TAKE COMPLEMENT TO THE BLACK AND WHITE IMAGE
    %%%%
```

```
bw=imcomplement(bw);
figure,imshow(bw);title('COMPLEMENT IMAGE');
%
%%%%REMOVE SMALL OBJECTS ON THE COMPLEMENTED
IMAGE %%%%
magnification_value=2000;
II=round(magnification_value/15);
bw1 = bwareaopen(bw,II);
figure,imshow(bw1);title('SMALL OBJECTS REMOVED IMAGE');
%
%%%%PERFORM MORPHOLOGICAL FILL OPERARTION%%%
bw5 = imfill(bw1,'holes');
figure,imshow(bw5),title('MORPHOLOGICAL FILLED IMAGE');
%%%%TO REMOVE SMALL OBJECTS%%%%
bwx = bwareaopen(bw5,300);
figure,imshow(bwx);title('SMALL OBJECTS REMOVED IMAGE');
%
%%%%%APPLY WATERSHED SEGMENTATION%%%%%
L = watershed(bw5);
Lrgb = label2rgb(L);
imshow(Lrgb)
bw2 = ~bwareaopen(~bw5, 10);
imshow(bw2)
D = -bwdist(~bw5);
imshow(D,[])
Ld = watershed(D);
imshow(label2rgb(Ld))
bw2 = bw5;
bw2(Ld == 0) = 0;
imshow(bw2)
mask = imextendedmin(D,2);
imshowpair(bw,mask,'blend');
D2 = imimposemin(D,mask);
Ld2 = watershed(D2);
bw3 = bw5;
bw3(Ld2 == 0) = 0;
figure,imshow(bw3),title('WATERSHED TRANSFORMED IMAGE');

%%%%REMOVE SMALL OBJECTS ON THE WATERSHED
    IMAGE%%%%
bww = bwareaopen(bw3,300);
figure,imshow(bww);title('SMALL OBJECTS REMOVED IMAGE');
```

```
%%%TO LABEL THE SMALL OBJECTS REMOVED IMAGE%%%%
label=bwlabel(bww);

%%%%APPLY REGION SEGMENTATION (REGION
    PROPERTIES)%%%%%
S=regionprops(label,'ALL');
figure,imshow(I),title('REGION PROPERTY IMAGE');

%%%FIND THE PERIMETER FOR THE BOUNDARY%%%%%
u=bwperim(bww);


%%%%%CONVERT TO DOUBLE FOEMAT%%%%%
u=im2double(u);

% % %%%TO ASSIGN THE BOUNDARIES FOR THE DETECTION
OF NUMBER OF WBC CELLS %%%%%5
[B,L] = bwboundaries(bww,'noholes');
% imshow(label2rgb(L, @jet, [.5 .5 .5]))
figure,imshow(I,[]);
hold on
for k = 1:length(B)
   boundary = B{k};
   plot(boundary(:,2), boundary(:,1), 'g', 'LineWidth', 2)
end



%%%%%FEATURE EXTRACTION%%%%%%

%%%%TO TAKE COLOUR FEATURES%%%%%%
R = mean2(I(:,:,1));
G = mean2(I(:,:,2));
B = mean2(I(:,:,3));
Co_Fea = [R G B];

%
%%%%TO TAKE GEOMETRICAL FEATURES%%%%
Area = mean([S.Area]);

for i = 1:size(S,1)
    diameters(i) = mean([S(i).MajorAxisLength S(i).MinorAxisLength])/2;
radii(i) = diameters(i)./2;
```

```
end
perimeter = mean([S.Perimeter]);
ecc = mean([S.Eccentricity]);
elg = mean([S.Solidity]);
% Elongation = mean(Elong);
dia = mean(diameters);
rad = mean(radii);
Geome_Fea = [Area dia rad perimeter ecc elg];


%%%%%TAKE IMPORTANT TEXTURE FEATURES (GRAY LEVEL
CO-OCCURENCE MATRIX) %%%%%

g = graycomatrix(bww);
stats = graycoprops(g,'Contrast Correlation Energy Homogeneity');
Contrast = stats.Contrast;
Correlation = stats.Correlation;
Energy = stats.Energy;
Homogeneity = stats.Homogeneity;
Tex_feat= [Contrast,Correlation,Energy,Homogeneity];

feat_tot=[Co_Fea Geome_Fea Tex_feat];

%%%%LOAD ALL THE FEATURES%%%%
load featurewbc2.mat
load featurewbc1.mat
%
%%%%%CLASSIFICATION%%%%

%%%PERFORM SVM CLASSIFICATION %%%%%%


test1 = zeros(1,2);
test1(1:1)= 1;
test1(2:2)=2;
A=fitcsvm(fea_wbctest,test1);
result=predict(A,feat_tot);
%
%
if result==1

   %%%TO ASSIGN THE BOUNDARIES FOR THE DETECTION
OF NUMBER OF WBC CELLS %%%%%5
[B,L] = bwboundaries(bwx,'noholes');
```

```
%%%%%TO SHOW THE NUMBER OF PARASITES DETECTED IN
THE INPUT IMAGE%%%%%
a = length(B);

disp('Total number of WBC cells detected in image = ');
disp(a);

   ccf=1;
   msgbox('HEALTHY WBC CELL');
   disp('HEALTHY WBC CELL');
%
elseif result==2


   [B,L] = bwboundaries(bww,'noholes');

%%%%%TO SHOW THE NUMBER OF PARASITES DETECTED IN THE
    INPUT IMAGE%%%%%
a = length(B);
disp('Total number of WBC cells detected in image = ');
disp(a);

   label=ones(1,48);
label(1:7)=1;
label(8:15)=2;
label(16:23)=3;
label(24:28)=4;
label(29:48)=5;
% % %
model=fitcknn(fea_wbc1,label);
result=predict(model,feat_tot);

if result==1

   ccf=2;
   msgbox('ACUTE LYMPHOCYTIC LEUKEMIA(ALL)');
   disp('ACUTE LYMPHOCYTIC LEUKEMIA(ALL)');
   disp(' BLOOD CANCER DETECTED ');
elseif result==2
   ccf=3;
   msgbox('ACUTE MYELOID LEUKEMIA(AML)');
   disp('BLOOD CANCER DETECTED');
elseif result==3
```

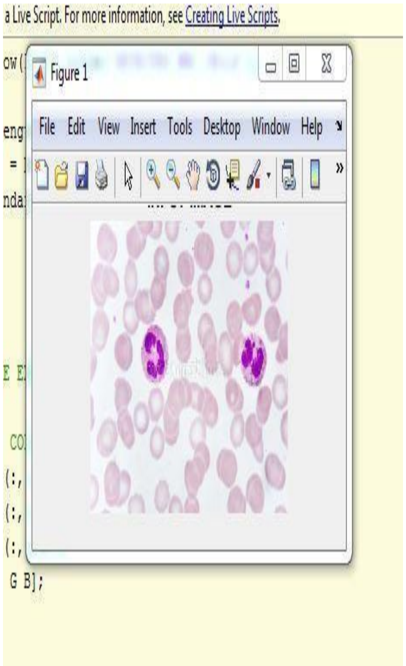
```
   ccf=4;
   msgbox('CHRONIC LYMPHOCYTIC LEUKEMIA(CLL), ');
   disp('BLOOD CANCER DETECTED');
elseif result==4
   ccf=5;
   msgbox('CHRONIC MYELOID LEUKEMIA(CML) ');
   disp('BLOOD CANCER DETECTED');
elseif result==5
   ccf=6;
   msgbox('HEALTHY WBC CELL');
   disp('BLOOD CANCER NOT DETECTED');
end
end

    %%%%%%%%%%%%%%%%%%%%%%END PROGRAM
    %%%%%%%%%%%%%%%%%%%%%%
```

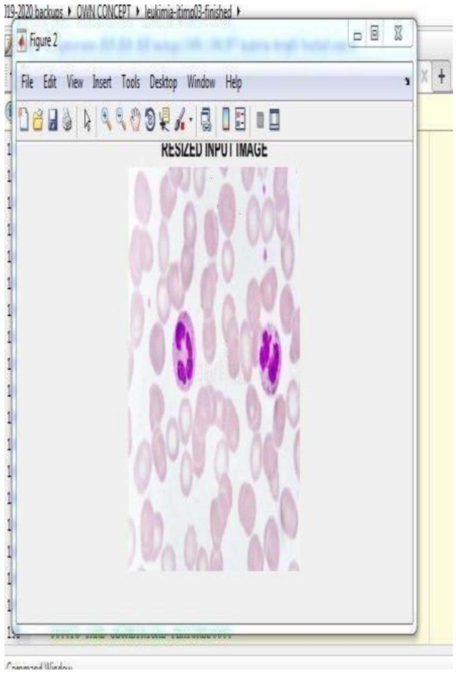
4.3 SNAPSHOT

FOR HEALTHY BLOOD CELL

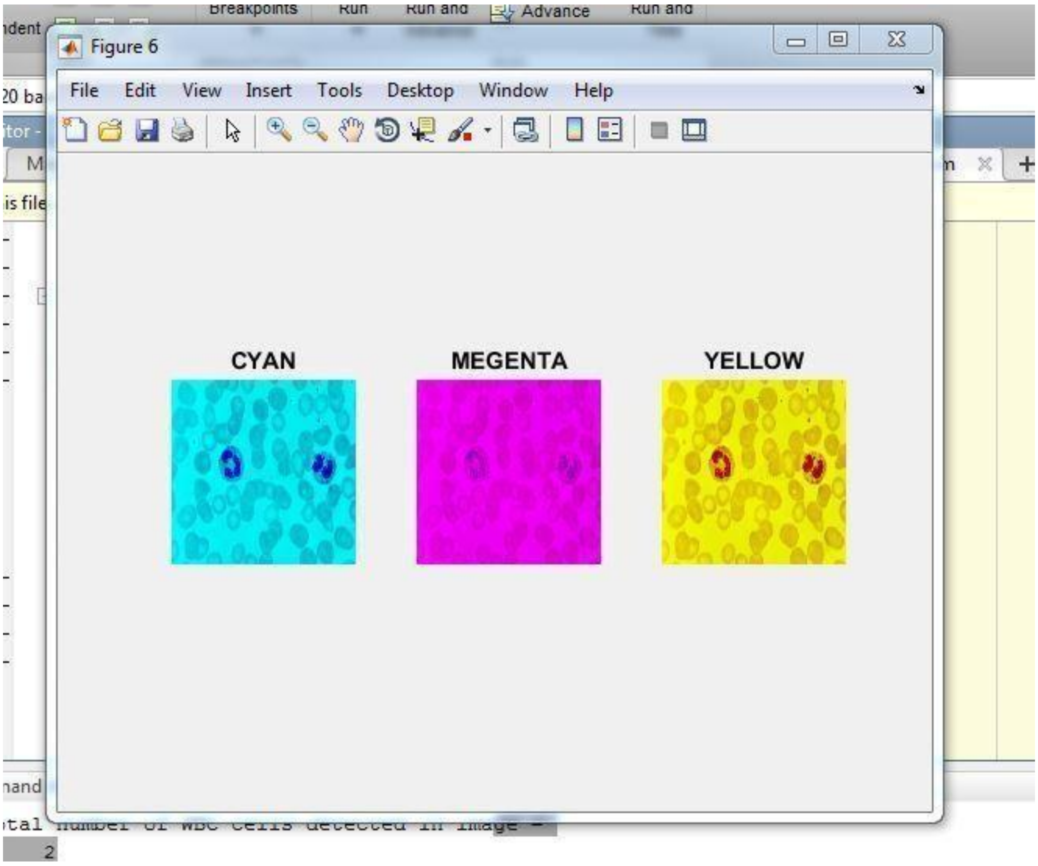
1. INPUT IMAGE



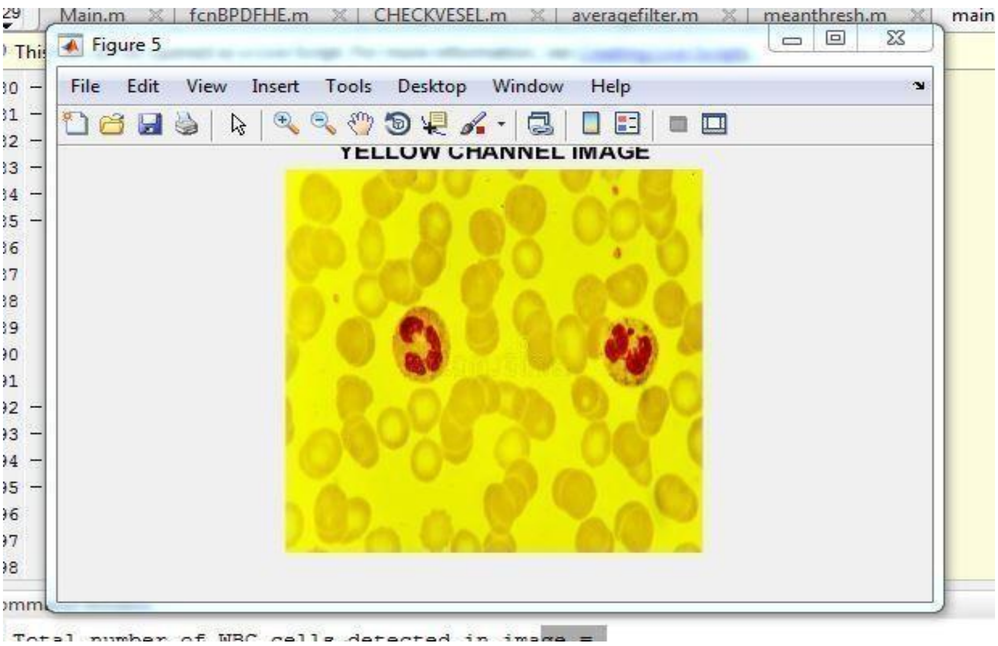
2. RESIZED IMAGE



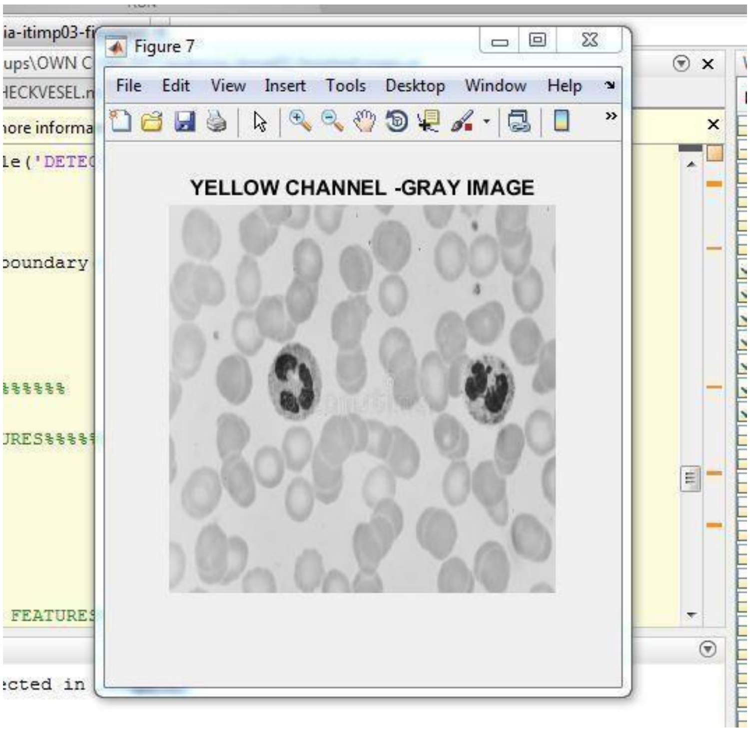
3. RGBTOCMYK COLOR IMAGE



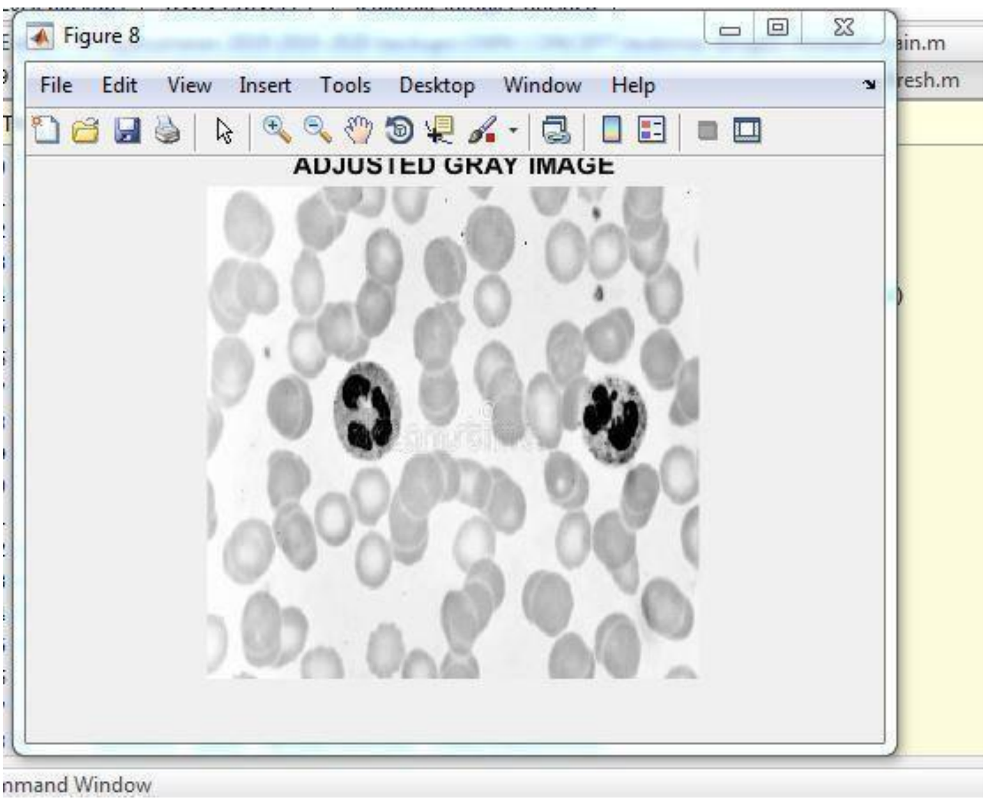
4. SELECTED Y- COLOR IMAGE



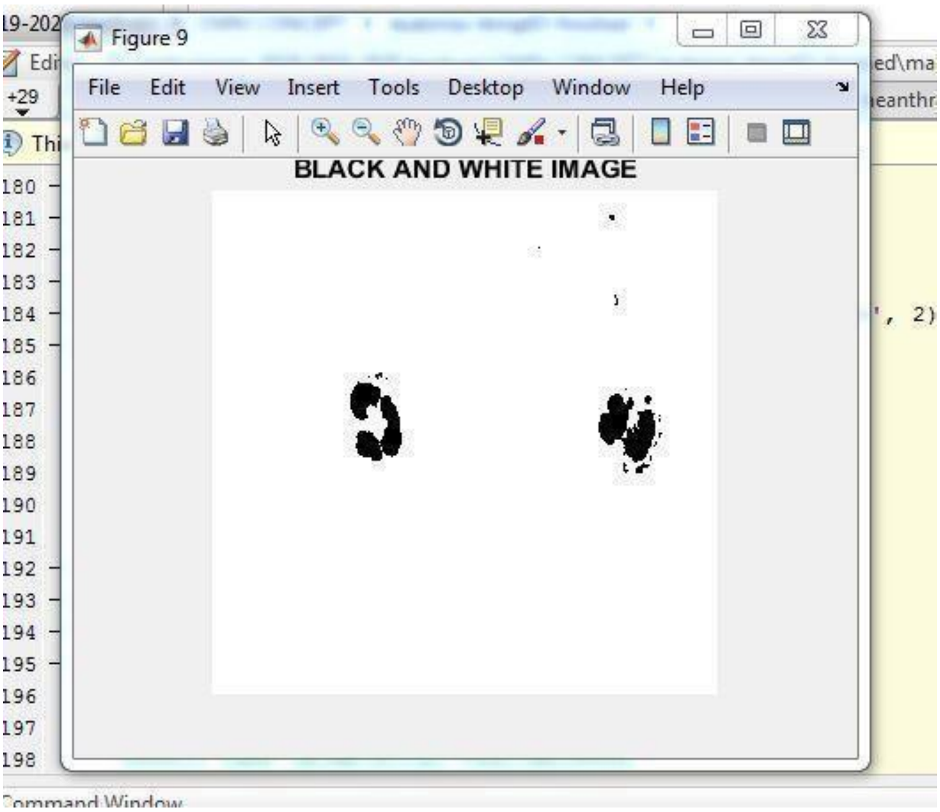
5 GRAY CONVERTED Y- COLOR IMAGE



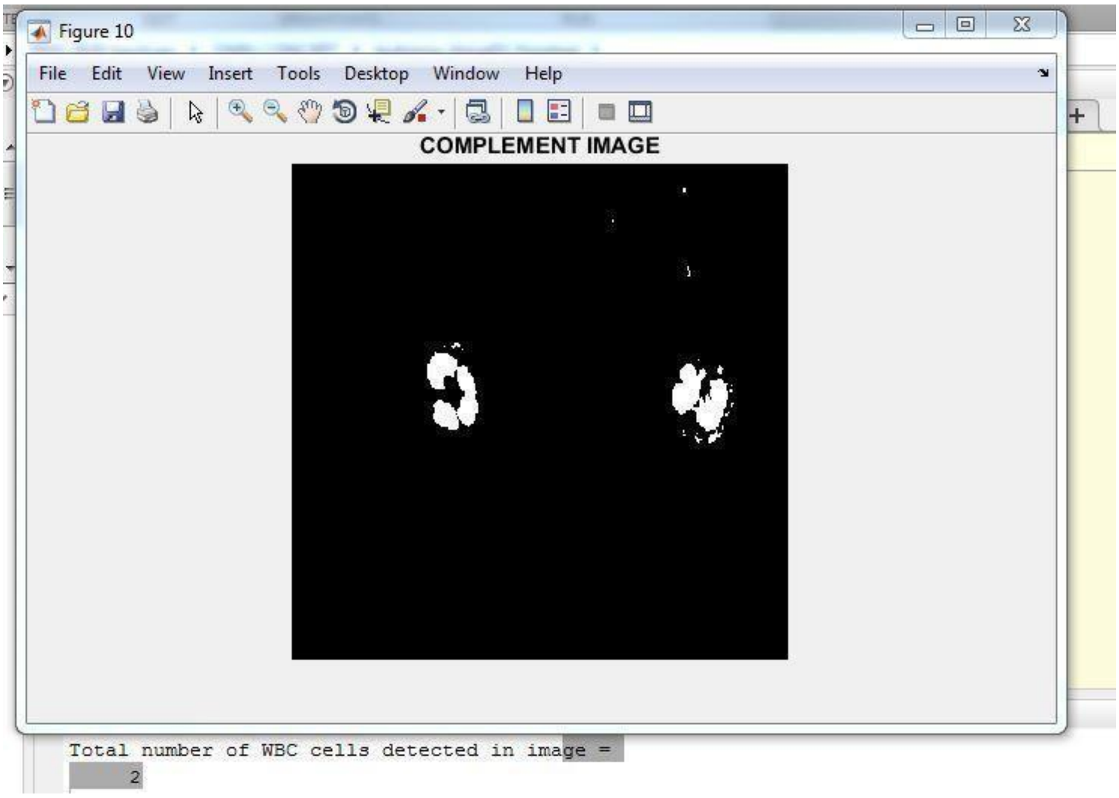
6 ADJUSTED GRAY Y- COLOR IMAGE



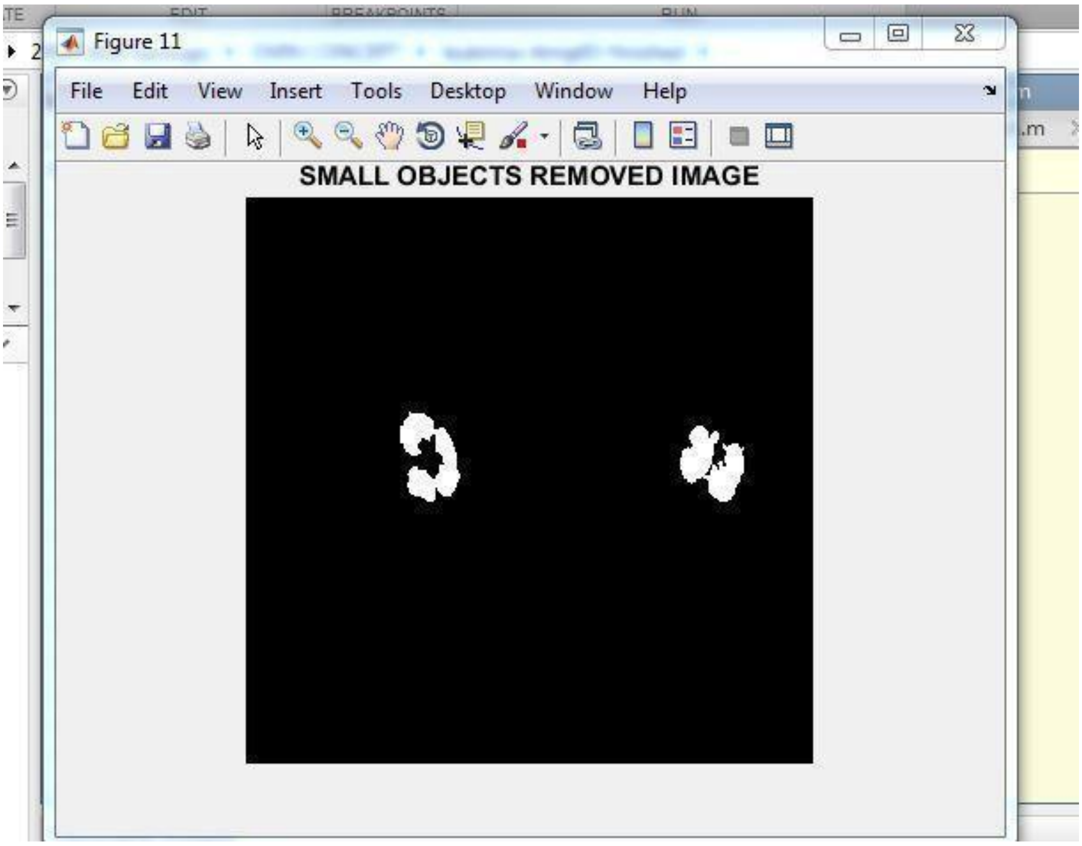
7 BLACK AND WHITE IMAGE



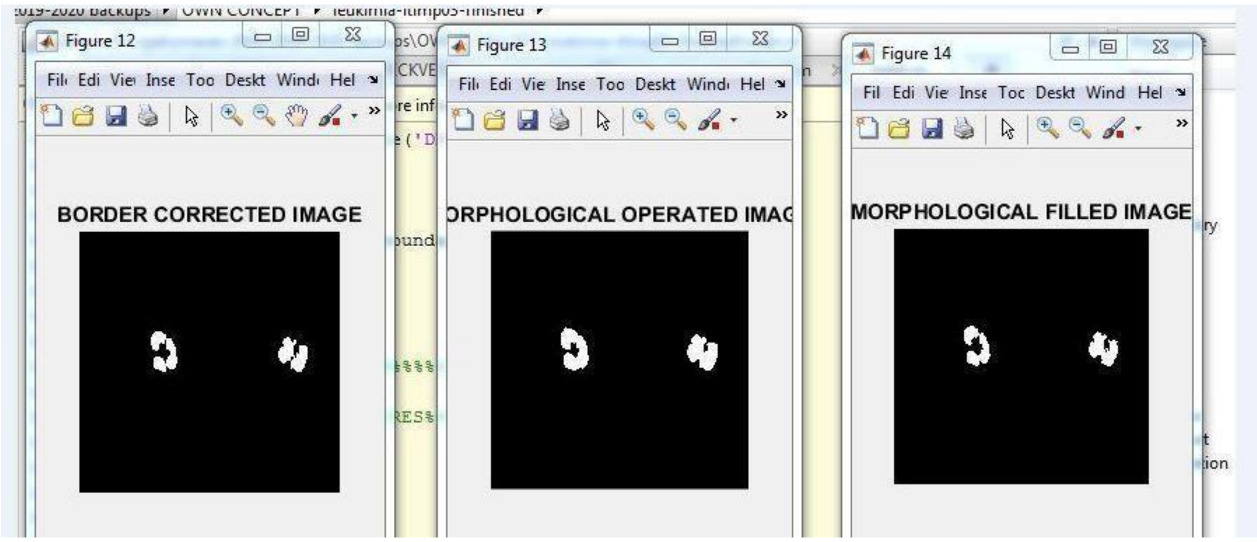
8 COMPLEMENT IMAGE



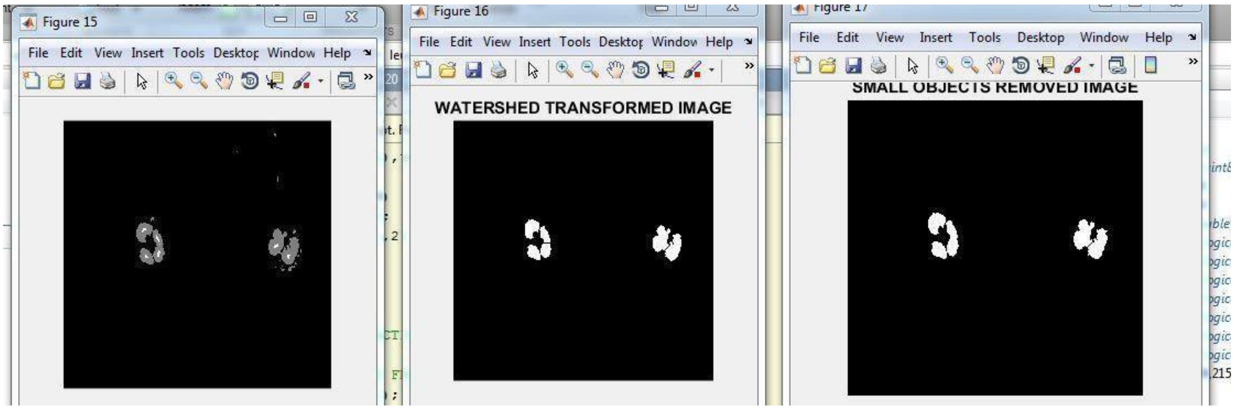
9 SMALL OBJECTS REMOVED IMAGE



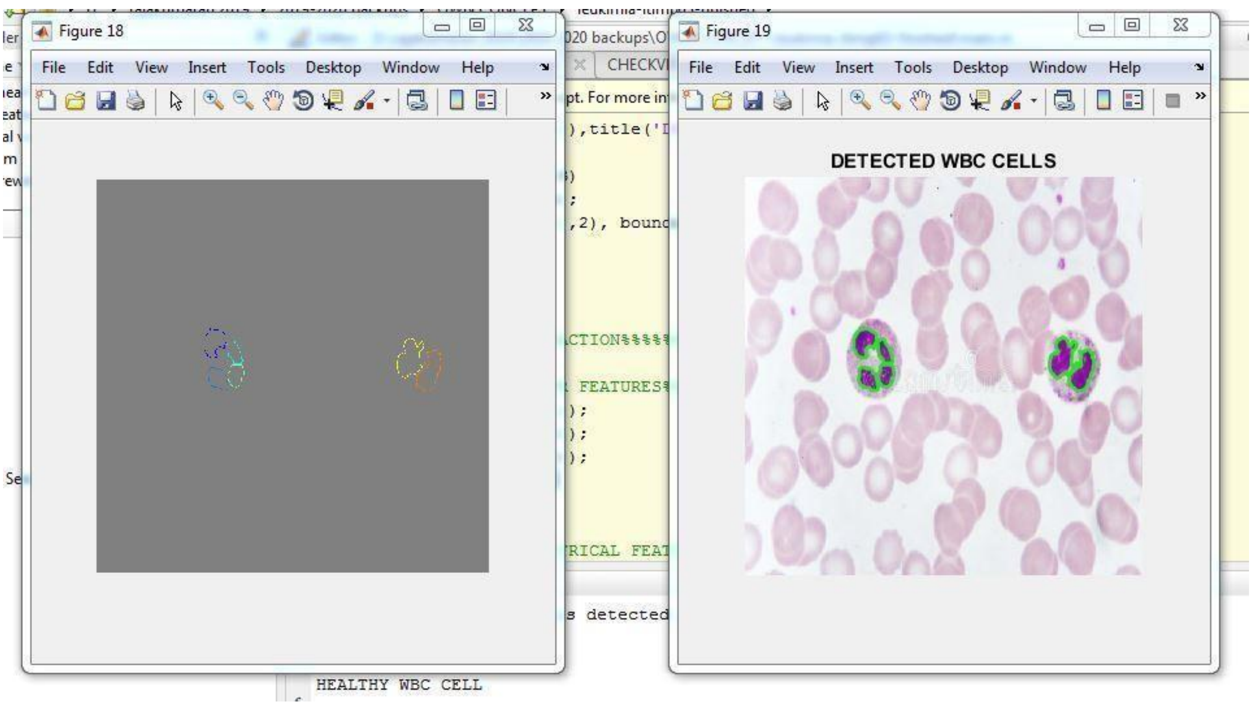
10 MORPHOLOGY OPERATED IMAGE



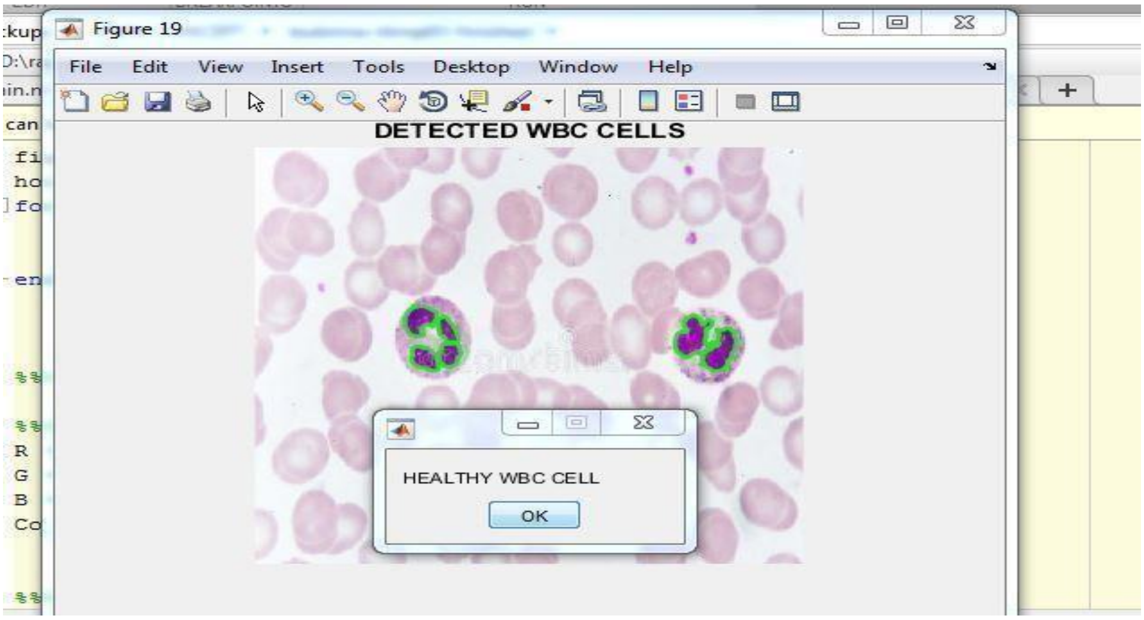
11 WATERSHED TRANSFORMED IMAGE



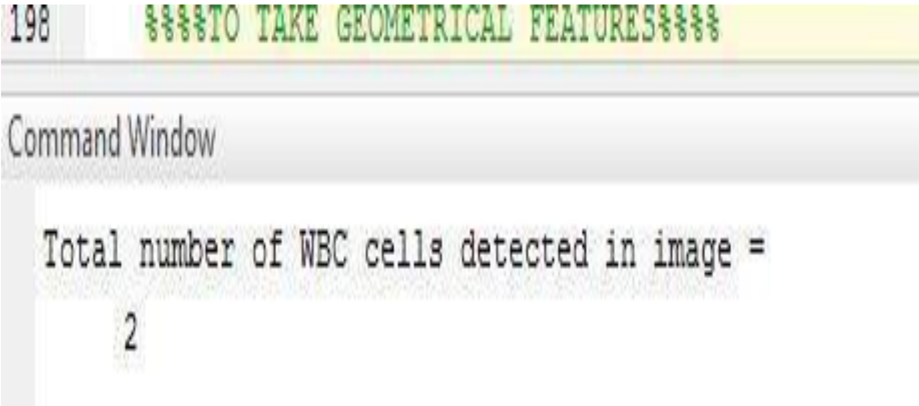
12. FINAL SEGMENTED IMAGE



13. FINAL OUTPUT IMAGE



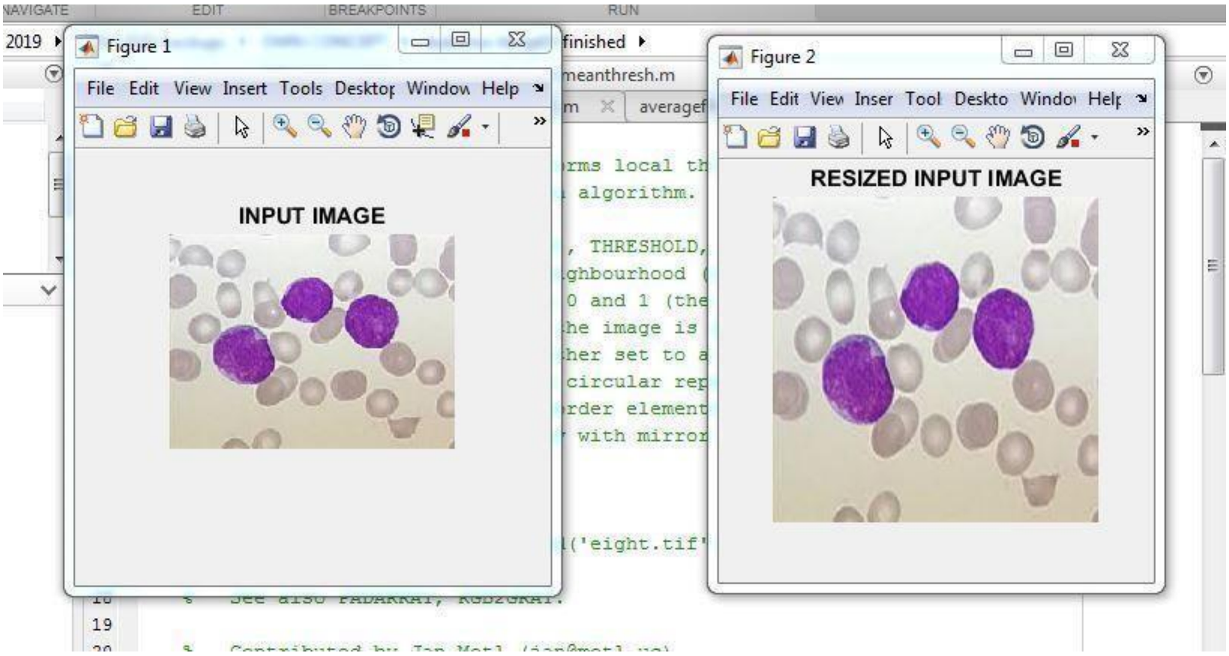
13. TOTAL NUMBER OF CANCER CELLS



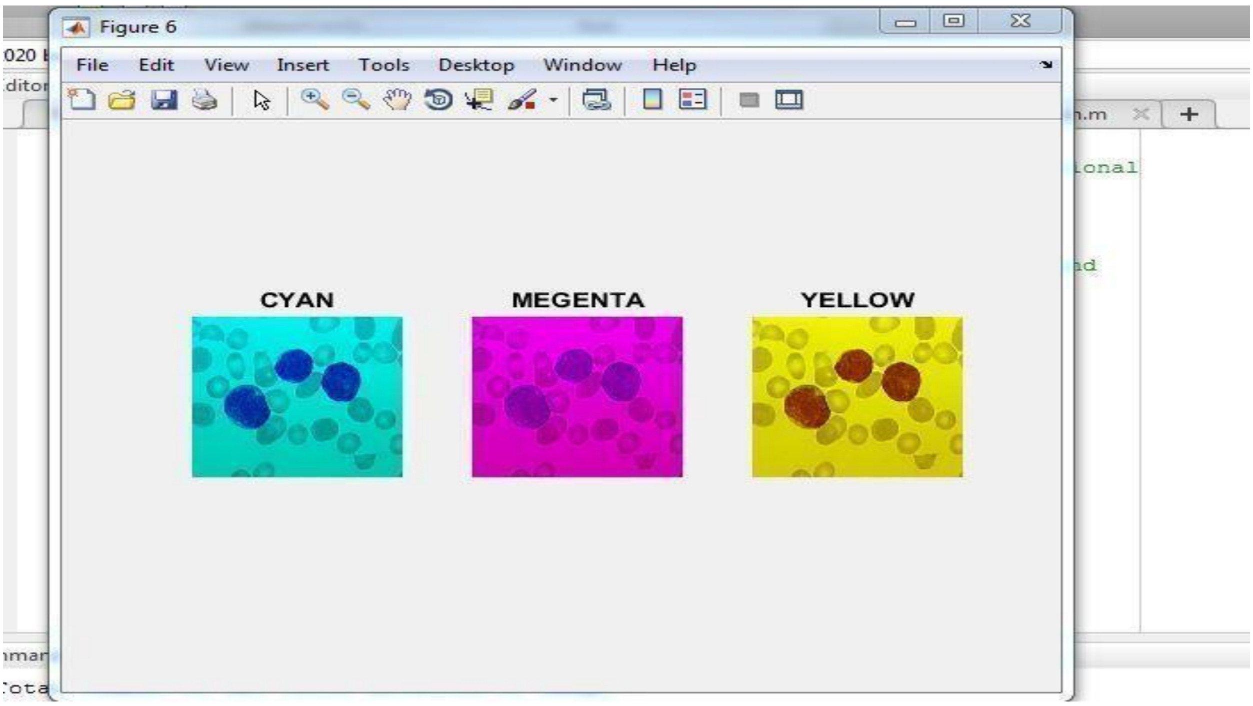
FOR CANCER BLOOD CELL

1. INPUT IMAGE

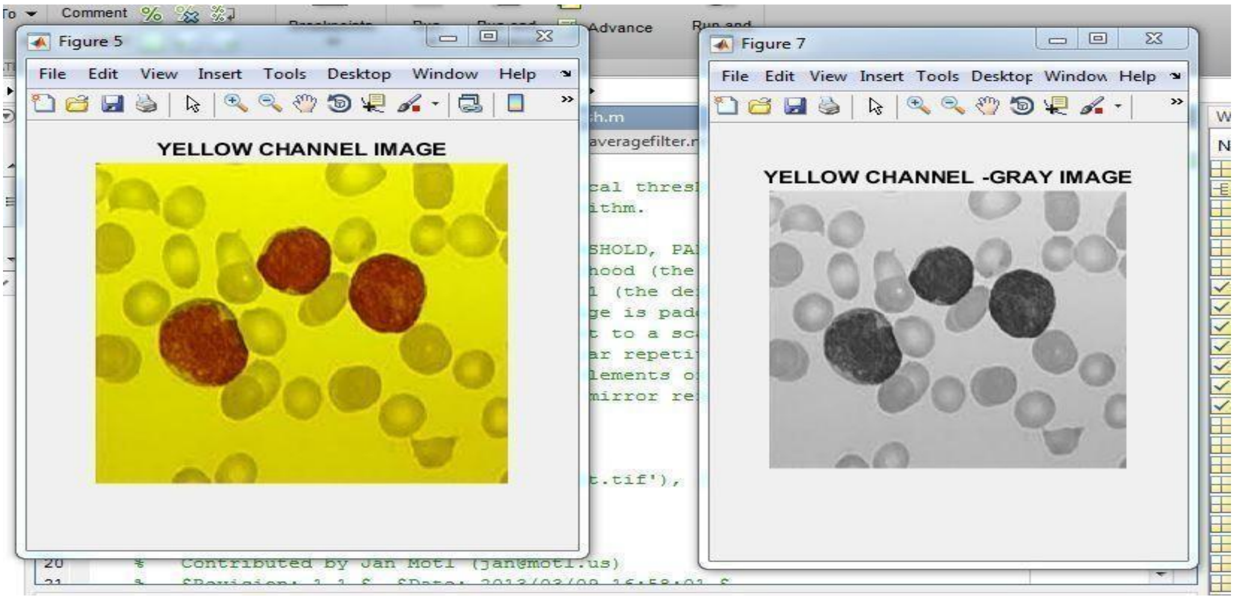
2. RESIZED IMAGE



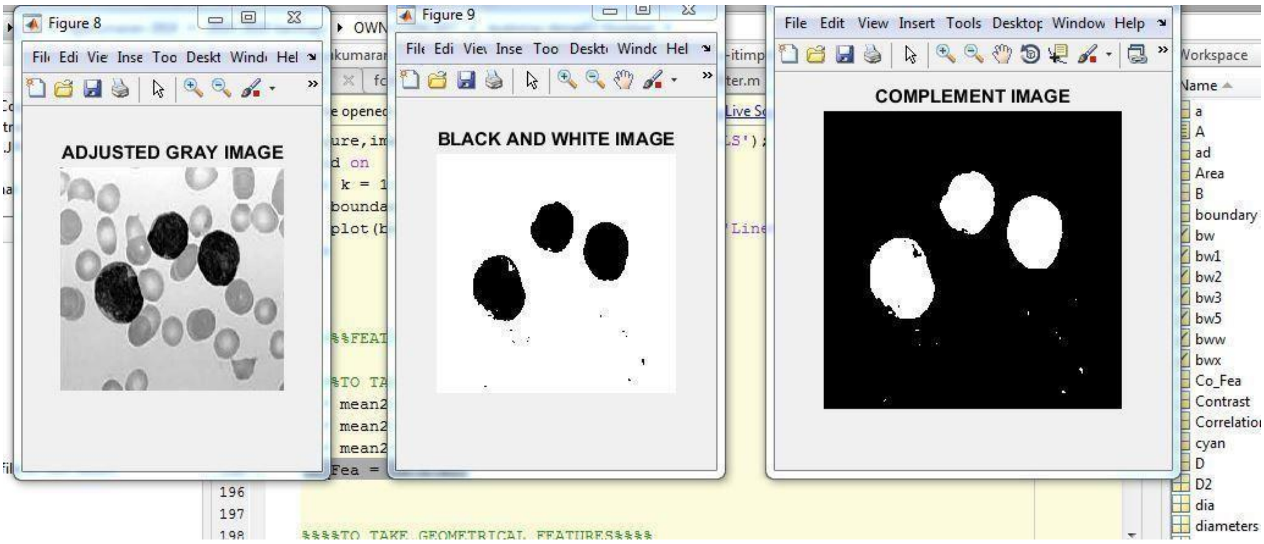
3. RGBTOYCBCR COLOR SPACE IMAGE



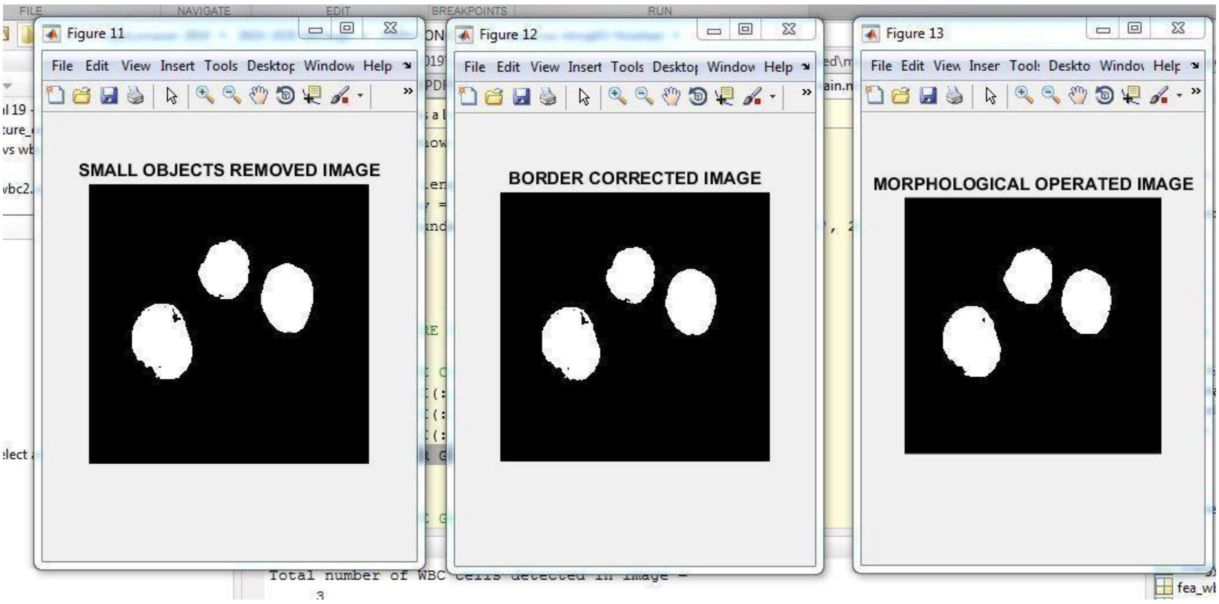
4. SELECTED Y-CHANNEL & GRAY CONVERTED Y-CHANNE



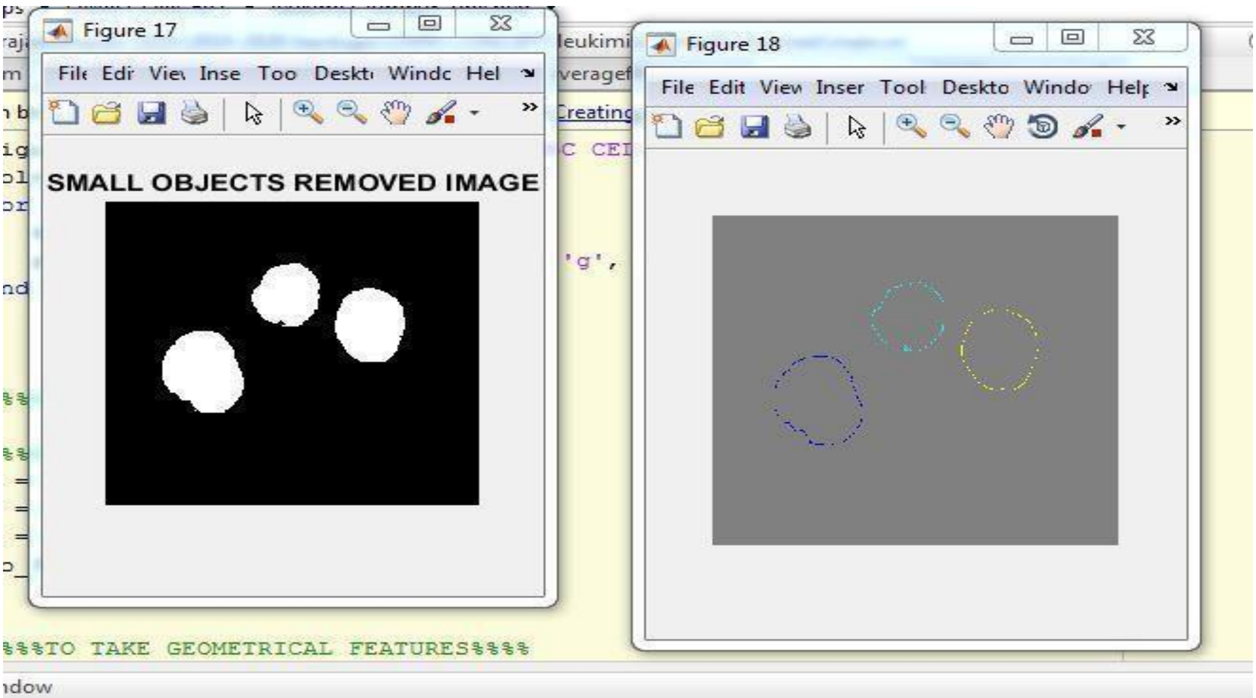
3.ADJUST & BW & COMPLEMENT IMAGES



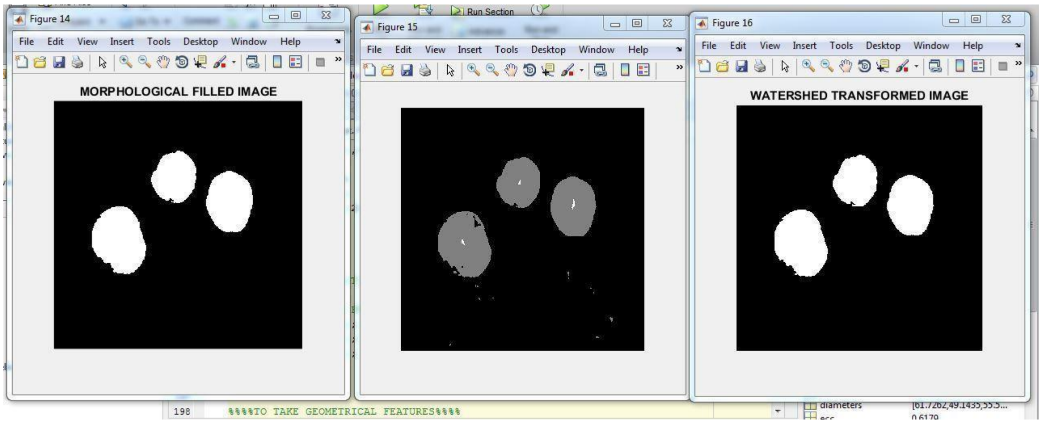
4.MORPHOLOGY OPERATED IMAGES



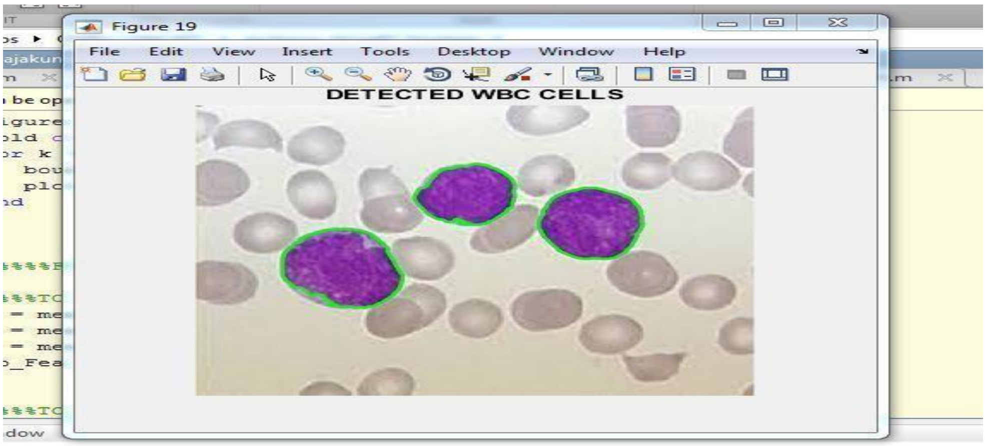
5. MORPHOLOGY OPERATED IMAGES



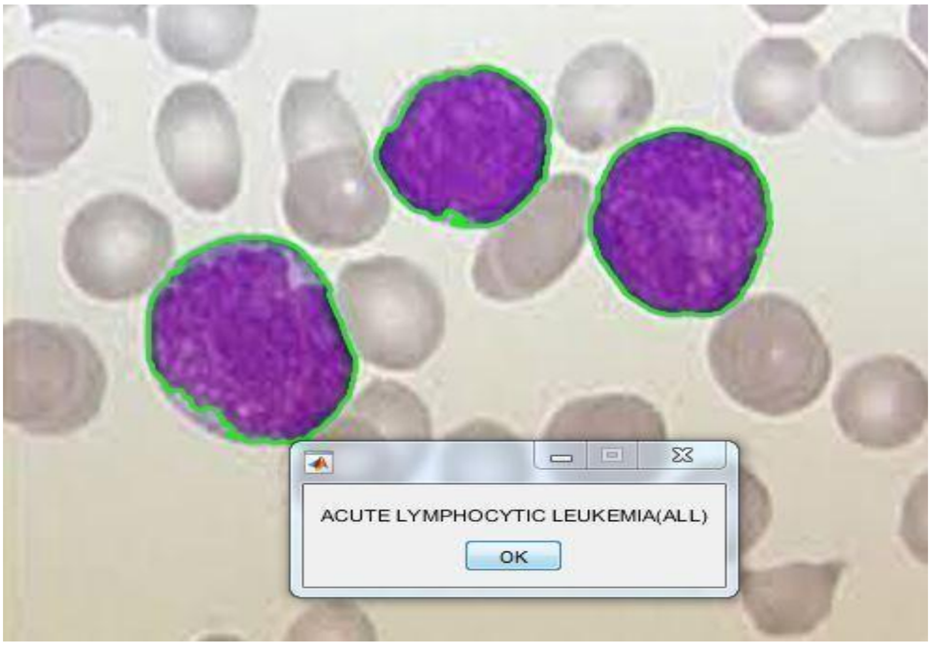
6. WATER SHED TRANSFORMED IMAGE



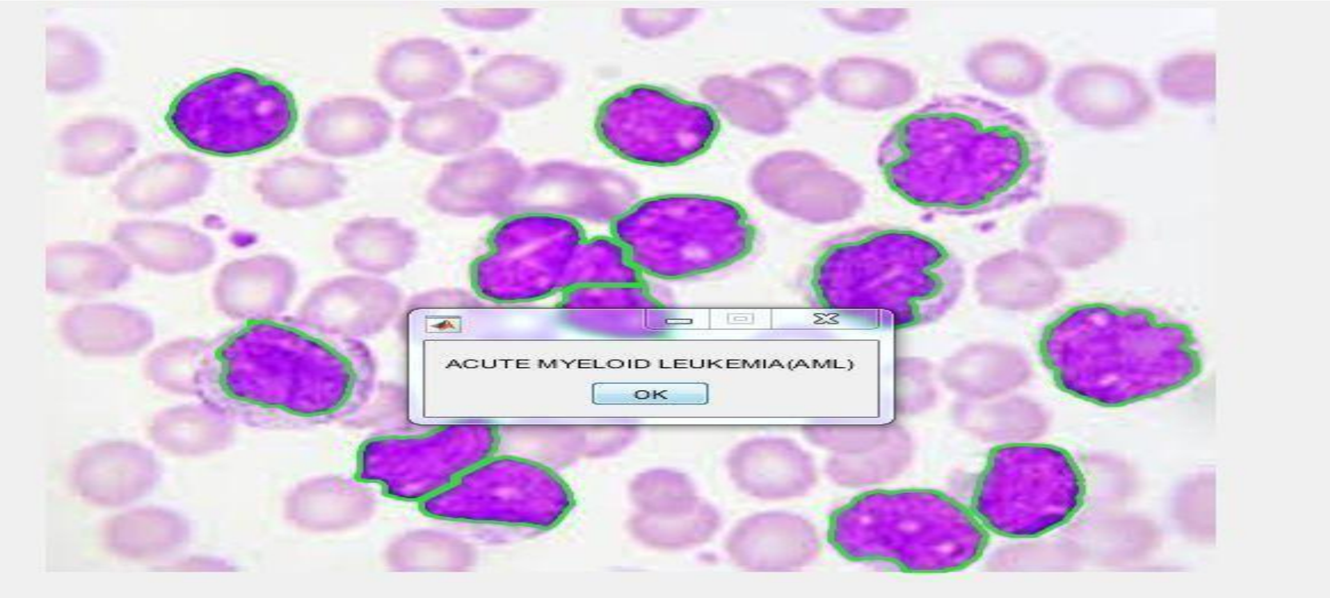
7. SEGMENTED IMAGE



8. FINAL OUTPUT IMAGE

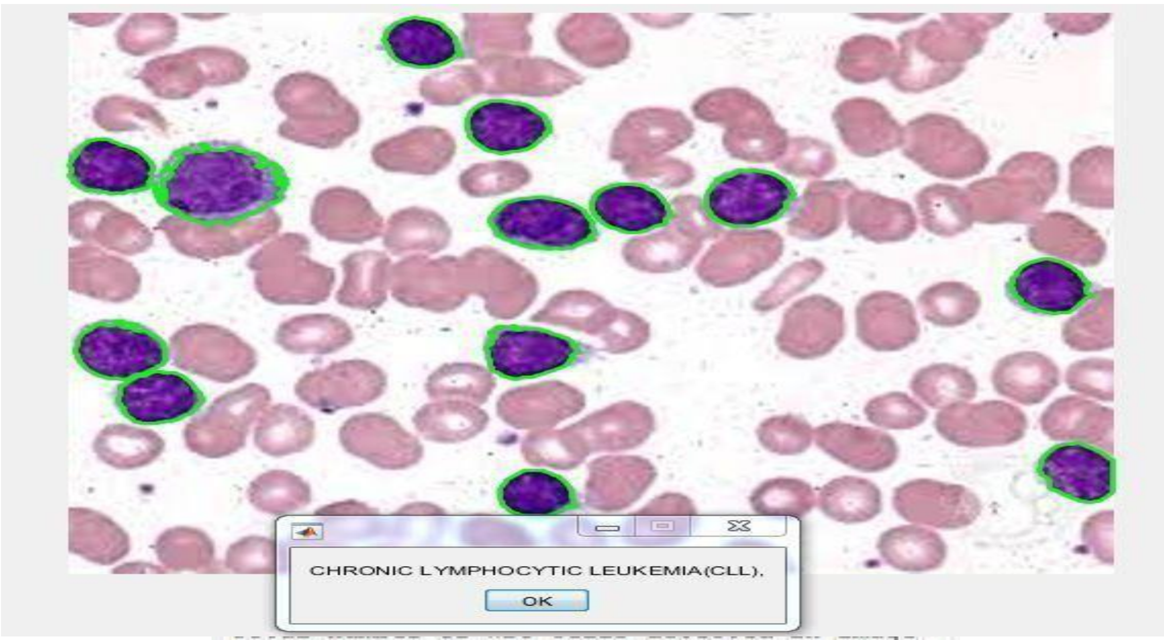


9. TOTAL NUMBER OF WBC CELLS

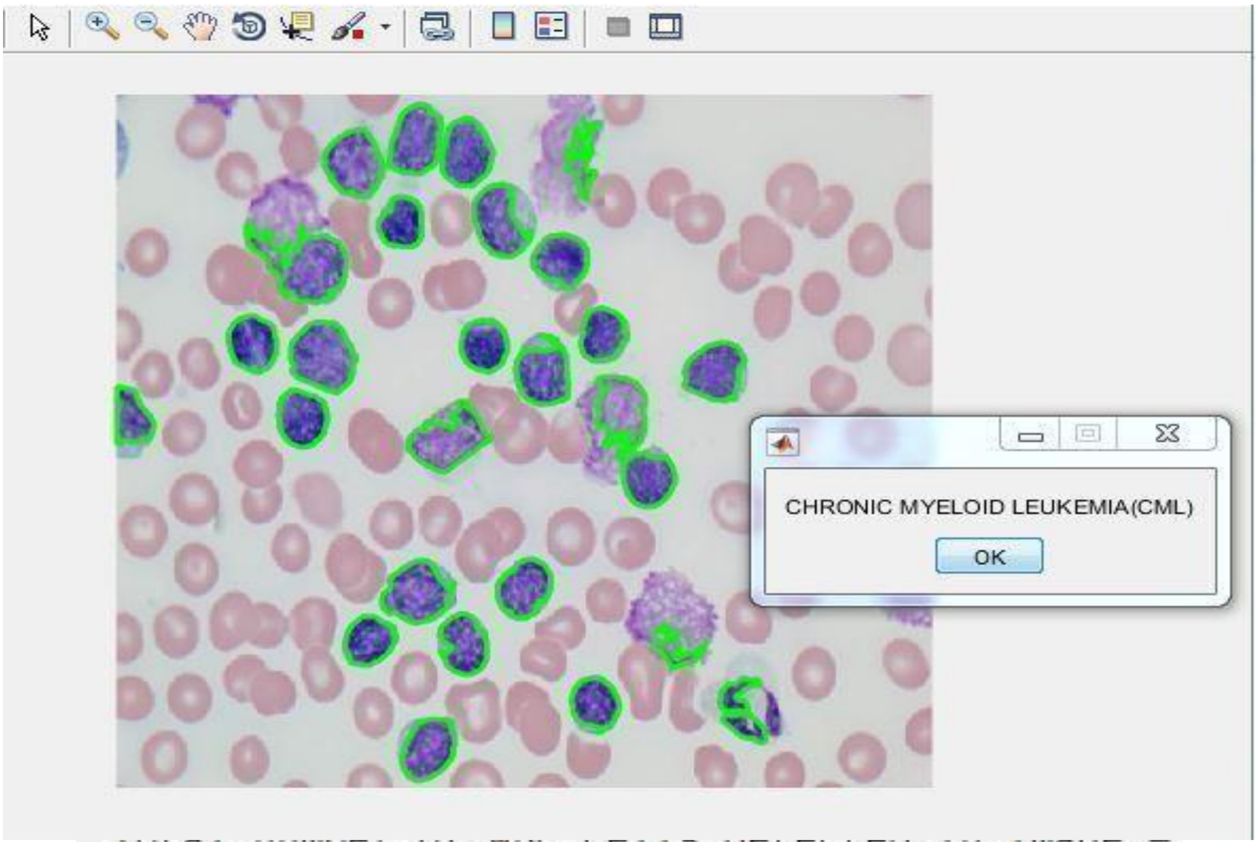



```
Total number of WBC cells detected in image =

    13
```




```
    13
```



Total number of WBC cells detected in image =

28

CHAPTER 5

CONCLUSION AND REFERENCES

5.1 CONCLUSION

In this paper, efforts have been made for the detection and counting of acute lymphoblastic leukemia from microscopic blood images by using image processing techniques. Preprocessing was applied over the images to remove any noise, and then segmentation is performed to detect lymphocytes from the image. Watershed is used to separate the grouped lymphocytes after extracting shape and color features; SVM is used to classify normal and blast cells. In future, we can further improve this system to detect different types of leukemia and otherblood related diseases.

5.2 PUBLICATIONS OF PAPER


ISSN: 2582-3930

ACCEPTANCE CERTIFICATE

Impact Factor: 8.176
DOI Prefix: 10.55041

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5.3 REFERENCES

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