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Automated Blood Cancer Detection Using Image Processing Based on Fuzzy System

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Abstract— Blood cancer is the most prevalent and it is very much dangerous among all type of cancers. Early detection of blood cancer has the potential to reduce mortality and morbidity. There are many diagnostic technologies and tests to diagnose blood cancer. However many of these tests are extremely complex and subjective and depend heavily on the experience of the technician. To obviate these problems, image processing techniques and a fuzzy inference system is use in this study as promising modalities for detection of different types of blood cancer. The accuracy rate of the diagnosis of blood cancer by using the fuzzy system will be yield a slightly higher rate of accuracy then other traditional methods and will reduce the effort and time. We first discuss the preliminary of cell biology required to proceed to implement our proposed method. This paper presents a new automated approach for blood Cancer detection and analysis from a given photograph of patient's cancer affected blood sample. The proposed method is using Wavelet Transformation for image improvement, image segmentation for segmenting the different cells of blood, edge detection for detecting the boundary, size, and shape of the cells and finally Fuzzy Inference System for Final decision of blood cancer based on the number of different cells.

Keywords— blood cancer, fuzzy system, image processing, image segmentation, edge detection.

I. INTRODUCTION

Blood cancer is unwanted growth and unwanted contraction of different compositions of blood cell with differing causes and varying degrees of malignancies. Primarily, Blood cancer is divided into three basic types. Each of the variety may also include several variations, but in general this cancer is categorized as Leukemia, Lymphoma and Myeloma.

Leukemia- It affects white blood cells (WBC). Blood tests are likely to present higher counts of white blood corpuscles.

Lymphoma- Lymphoma is a type of blood cancer that affects lymphatic system. Lymphoma means it makes too many lymphocytes, a type of white blood cell (WBC). Lymphocytes are one of the varieties of white blood corpuscles.

Myeloma- Myeloma (also called multiple myeloma) is a blood cancer of the plasma cells. Plasma cells are found in mammals bone marrow and produce antibodies which help fight infection. In myeloma, groups of abnormal plasma cells gather in bone marrow and stop it producing normal blood cells.

II. BACKGROUND

Blood performs two major functions: transport through the body of oxygen and carbon dioxide, food molecules, wastes, hormones, etc. Defences of the body against infections and other foreign materials. All the WBCs participate in these defences. Blood cell primarily consists of three different cells namely RBC, WBC and PLATELET. Each of them has specific structure and each of them has particular function to balance human body.

Red Blood Cells (RBC): It carries oxygen from the lungs to the rest of the body. They also carry carbon dioxide back to the lungs so it can be exhaled. If the RBC count is low (anemia), the body may not be getting the oxygen it needs. If the count is too high (a condition called polycythemia), there is a chance that the red blood cells will clump together and block tiny blood vessels (capillaries).

This also makes it hard for red blood cells to carry oxygen. The most numerous types in the blood. Average 7 µm in diameter. Women average about 4.8 million of these cells per cubic millimeter (mm3; which is the same as a microliter [µl]) of blood. Men average about 5.4 x 106 per µl. These values can vary over quite a range depending on such factors as health and altitude.

White Blood Cell (WBC): It protects the body against infection. White blood cells are bigger than red blood cells but fewer in number (the ratio between the two is around 1:700). When a person has a bacterial infection, the number of white cells rises very quickly. The number of white blood cells is sometimes used to find an infection or to see how the body is dealing with cancer treatment.

Platelets: Platelets are cell fragments produced from megakaryocytes. These polyploid (128n) cells in the bone marrow send pseudopodia-like projections into the lumen of adjacent blood vessels. Blood normally contains 150,000–400,000 per microliter (µl) or cubic millimetre (mm3). If this value should drop much below 20,000/µl, there is a danger of uncontrolled bleeding.

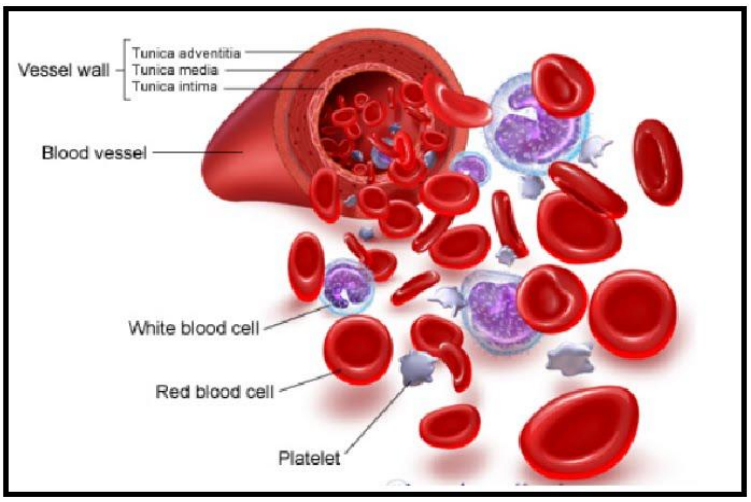

Figure 1: Blood cell and its composition

Plasma: Plasma is the straw-colour liquid in which the blood cells are suspended. Plasma transports materials needed by cells and materials that must be removed from cells.

III. TRADITIONAL CANCER DIAGNOSED

There is no single test that can accurately diagnose cancer. The complete evaluation of a patient usually requires a thorough history and physical examination along with diagnostic testing. Many tests are needed to determine whether a person has cancer, or if another condition (such as an infection) is mimicking the symptoms of cancer. Diagnostic procedures for cancer may include imaging, laboratory tests (including tests for tumor markers), tumor biopsy, endoscopic examination, surgery, or genetic testing.

IV. DIFFERENT TYPES OF LABORATORY TESTS

Clinical chemistry uses chemical processes to measure levels of chemical components in body fluids and tissues. The most common specimens used in clinical chemistry are blood and urine. Many different tests exist to detect and measure almost any type of chemical component in blood or urine. Components may include blood glucose, electrolytes, enzymes, hormones, lipids (fats), other metabolic substances, and proteins.

V. ONE OF THE MORE COMMON LABORATORY TEST: BLOOD TESTS

A variety of blood tests are used to check the levels of substances in the blood that indicate how healthy the body is and whether infection is present. For example, blood tests revealing elevated levels of waste products, such as creatinine or blood urea nitrogen (BUN), indicate that the kidneys are not working efficiently to filter those substances out. Other tests check the presence of electrolytes - chemical compounds such as sodium and potassium that are critical to the body's healthy functioning. Coagulation studies determine how quickly the blood clots.

A complete blood count (CBC) measures the size, number, and maturity of the different blood cells in a specific volume of blood. This is one of the most common tests performed. Red blood cells are important for carrying oxygen and fighting anemia and fatigue. White blood cells fight infection. Increased numbers of white blood cells, therefore, may indicate the presence of an infection. Platelets prevent the body from bleeding and bruising easily. In this proposed method we worked on the concept of complete blood count (CBC).

VI. PROPOSED WORK OVERVIEW

When typical virus attacks human blood cells. The infected cells can be visualized using a special microscope. The microscope generates digital images that medical doctors can analyse and identify the infected cells. The virus causes the infected cells to change their size, shape and quantity (number of cell). Shown in Fig. 2

A digital image process can be applied to the image. This process generates two variables, p, is related to quantity (pixels) and the second variable, S, is related to the shape of the cell. If they are circular or elliptic. In this image, it is often difficult to actually count the number, or to identify the circular cluster of pixels; hence both these variable must be estimated in a linguistic way.

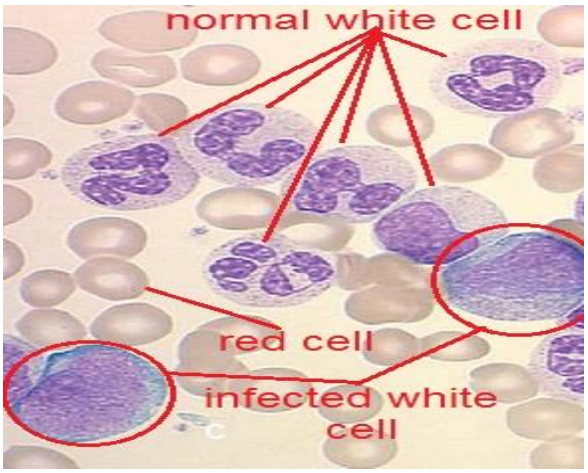

Figure 2: Infected cell and normal cells shown with different shapes in a microscope

Here we have two fuzzy sets; P represents the number of infected cell (c1=few with infected pixel, c2=a few with infected pixel and c3= a lot of infected pixels) and S that represents the shape of the infected pixel clusters (s1= an ellipse and s2= a circle)

Say, we have

P= {0.1/c1 + 0.5/c2 + 0.9/c3} and
S= {0.3/s1 + 0.7/s2}

Now the relation between quantity of infected pixels and the shape of the infected pixel clusters. Using fuzzy Cartesian product between "P" and "S" gives.

$$R=P \times S= \begin{array}{c} \\ c1 \\ c2 \\ c3 \end{array} \begin{array}{c} \begin{array}{cc} s1 & s2 \end{array} \\ \begin{pmatrix} 0.1 & 0.1 \\ 0.3 & 0.5 \\ 0.3 & 0.7 \end{pmatrix} \end{array}$$

Another microscope image is taken and the number of infected pixels is slightly different;
I.e. P'= {0.3/c1 + 0.7/c2 + 9.0/c3}

Using max-min composition with the relation R will produce a new value for Fuzzy set of pixel cluster shapes that are associated with the new infected pixel quantity.

$$S'=P' \circ R = \begin{bmatrix} 0.3 & 0.7 & 0.9 \end{bmatrix} \circ \begin{bmatrix} 0.1 & 0.1 \\ 0.3 & 0.5 \\ 0.3 & 0.7 \end{bmatrix} = \begin{bmatrix} 0.3 & 0.7 \end{bmatrix}$$

From the above result (value of S') a physician can easily Conclude the percentage of infection present, as the result is based on the infected cell and their shapes.

VII. PROPOSED METHOD

This proposed method will work on four different steps (modules) namely, Step 1 Image Pre-processing, Step 2 Image Segmentation, Step 3 Feature Extraction and Step 4 Fuzzy rule based decision system.

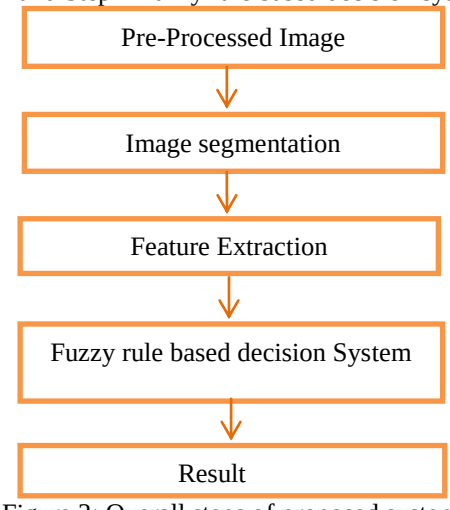

Figure 3: Overall steps of proposed system

Step 1: Image Pre-processing

Digital images of Blood cells are collected in Bitmap or JPEG format from different sources. Image pre-processing makes a sample image suitable for a particular application. It primarily involves enhancement of image, which includes cropping or resizing, sharpening, de blurring, brightening, change in image contrast, noise removal, edge highlighting. The pre-processing step removes the unwanted parts, enhances the image.

Step 2: Image Segmentation

Image segmentation involves selecting only the area of interest in the image. It is a process of image partitioning into multiple segments or regions or structures of interest, so that the contents of each region have similar characteristics. It is a process of extracting and representing information from the image to group pixels together with region of similarity. Changing the image representation into a meaningful and easy-to-analyse one is the main goal of segmentation. In a given image, it assigns a label to each pixel, such that pixels with same labels share common visual characteristics. It makes an image processing tasks easier for analysis. A segmentation can be used for locate objects and boundaries, object recognition, occlusion boundary estimation in improved images. Image segmentation results in a set of regions that collectively cover the entire image or set of contours extracted from the images. A segmentation method is usually designed taking into consideration the properties of a particular class of images. Here only the blood cells are selected, because they are the areas of interest.

In our proposed method we used Thresholding techniques to segment the image, which make decisions based on pixel information are effective when the intensity levels of the objects fall squarely outside the range of levels in the background. Because spatial information is ignored however, blurred region boundaries can create havoc.

Step 3: Feature Extraction

Feature extraction also called description deals, Feature extraction is a sub-division of improved image into constituent parts or isolation of some aspects of an image for identifying or interpreting meaningful object forms, which includes finding lines, circles or specific shapes etc. that are basic for differentiating one class of objects from another.

The features are of two types: shape based feature and statistical based feature. For the shape based feature extraction mathematical parameters like Radius, Perimeter and Compactness are used. The statistical parameters refer to the distribution of colour present in the blood cell image. The features considered are based on Shape, Colour and Texture.

Step 4: Fuzzy rule based decision system

Fuzzy set is a generalized of classical set theory. Fuzzy sets try to capture the way humans represent and reason with real world knowledge in fuzzy set, many degrees of membership(between 0 and 1) are allowed. Fuzzy logic is a form of many valued logic; it deals with reasoning that is approximate rather than fixed and exact. The membership function defines the fuzziness of an image and also to define the information contained in the image. Fuzzy logic has been extended to handle the concept of partial truth, where the truth value may range between completely true and completely false.

Fuzzy rules are linguistic IF-THEN- constructions that have the general form "IF A THEN B" where A and B are (collections of) propositions containing linguistic variables. A is called the premise and B is the consequence of the rule. In effect, the use of linguistic variables and fuzzy IF-THEN- rules exploits the tolerance for imprecision and uncertainty. In this respect, fuzzy logic mimics the crucial ability of the human mind to summarize data and focus on decision-relevant information.

VIII. EXPERIMENT AND RESULT

From the threshold outputs we first count the infected cells and make some relationship (membership of number of cells and their shape) among them by using fuzzy rules. From the relationship one physician or biologist can easily conclude the percentage of infection one suffering from.

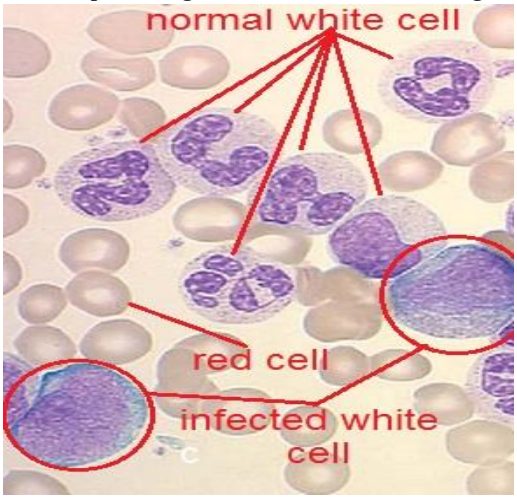

Figure 4: Original input image (sample 1.)

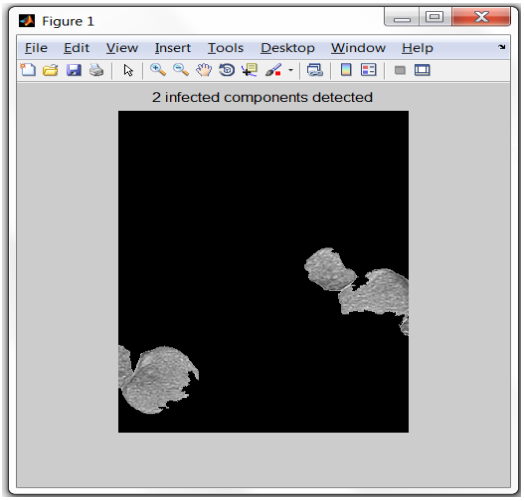

Figure 5: Threshold output sample 1.

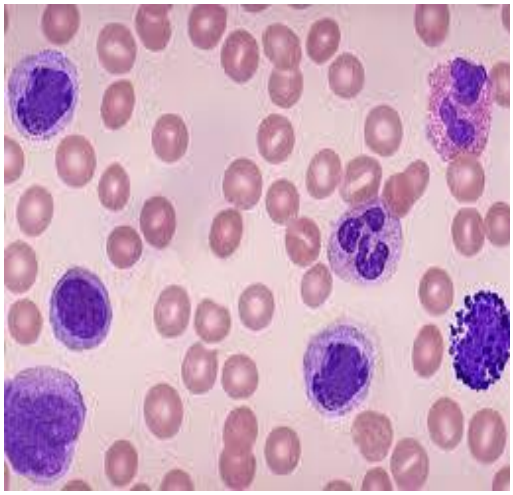

Figure 6: Original input image(sample 2.)

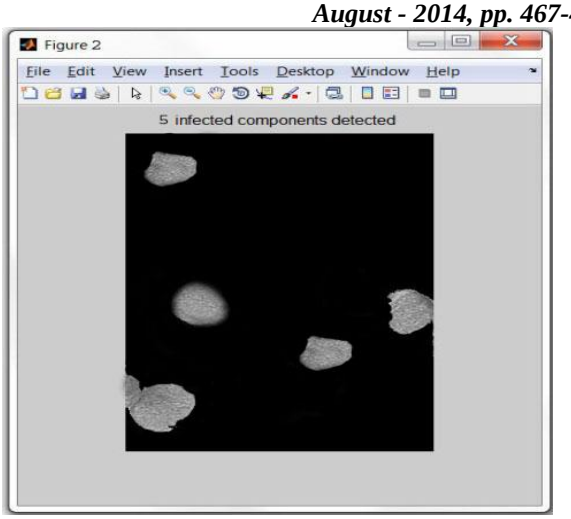

Figure 7: Threshold output sample 2.

P (number of infected cells)			S (shape of the cells)		R= P X S (Cartesian relation)		P'(another new image and number of infected cells)			S'= P' º R (max-min)
C1 (few)	C2 (a few)	C3 (lots)	S1 (ellipse)	S2 (circle)	s1	s2	C1 (few)	C2 (a few)	C3 (lots)	----------
					c1	c1Xs1 c1Xs2				
					c2	c2Xs1 c2Xs2				
					c3	c3Xs1 c3Xs2				
0.1	0.5	0.9	0.3	0.7	0.1 0.3 0.3	0.1 0.5 0.7	0.3	0.7	0.9	[0.3 0.7]
0.2	0.5	0.6	0.2	0.8	0.2 0.2 0.2	0.2 0.5 0.6	0.2	0.6	0.8	[0.2 0.6]

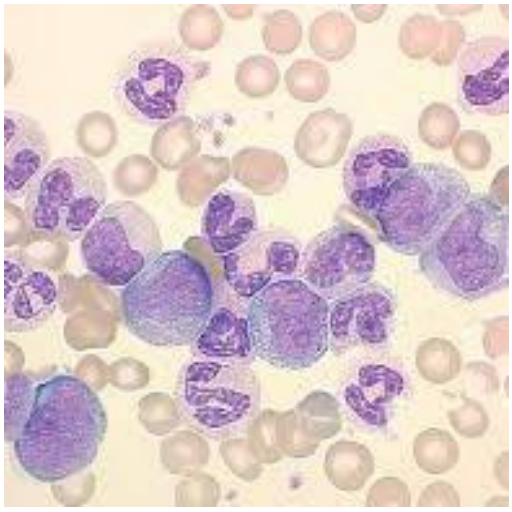

Figure 8: Original input image(sample 3.)

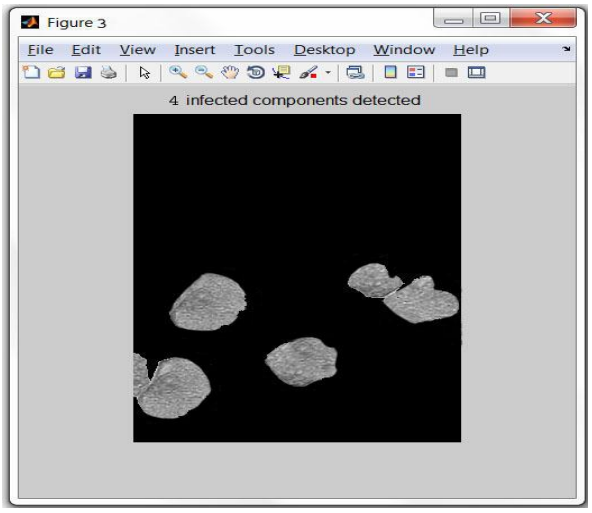

Figure 9: Threshold output sample 3.

Table 1: Different types of variable used in the proposed method, their relation, calculation and results.

IX. CONCLUSIONS

The primary goal of this work is to develop an automated system to detect blood cancer using soft computing. Blood cancer is the major causes of death globally and the early detection of this disease is very important chore. The computer aided automated cancer detection system helps the physician as a tool for cancer diagnosis. From the analysis it is concluded that, Fuzzy techniques plays an important role in cancer classification and detection. Fuzzy rules are widely used today for their great accuracy, coverage area and less time requirement. We hope that the proposed method will help physician or biologists for cancer diagnosis by reducing time and effort.

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