Developing a Computer based Information System to Improve the Diagnosis of Blood Anemia - Part I

Prof. Rupali Satpute[1] Kalpita Nimje[2] Sharad Shrivastava[2] Shraddha Parab[4] Tanvi Sharma[5]
[1]Assistant Professor [2,3,4,5]UG Student
[1,2,3,4,5]KJSIEIT, Sion, Mumbai India

Abstract— This paper presents Design and implementation of a computer based information system by utilizing a developed methodology. This methodology includes a set of procedures and processes to analyse blood smear images (image reading, pre-processing, feature extraction, RBCs classification, results and diagnosis). Essentially an efficient method using the image processing technique (image enhancement, segmentation and feature extraction) has been constructed which can be used to analyse blood smear images taken by photomicroscope. Usually blood smear images contain red blood cells, white blood cells and platelets. In this work the method isolates and determines the type of all red blood cells in the smear which could be either normal or abnormal. Taking into consideration that abnormal red blood cells indicate to the associated blood anaemia. Focus is directed to the process of classifying types of abnormal cells. The system counts the overall red blood cells and calculates percentage of different types of counted abnormal cells (macrocyte, target cell, howel-jolley body, sickle cell, elliptocyte, tear drop, spherocyte, stomatocyte and nucleated RBCs). The existence of different abnormal types and the related percentages indicates the type of anemia.

Key words: Bone Marrow, HB, HCT-Hematocrit, MCV, Mean Corpuscular Hemoglobin, Hemolytic Anemia, MCHC, RDW, Mean Corpuscular Volume, HMS

I. INTRODUCTION

A stained smear is examined to determine the percentage of each type of leukocyte (WBCs) present and assess the Erythrocyte (RBCs) and platelet morphology. But in this work we concentrate on Erythrocyte which is examined by analyst (someone with experience in analyzing blood) using a microscope to see the blood cells on blood smear then we can identify if a person has a type of anemia or not. This traditional method suffers from basic problems such as:

- It consumes too much time and effort.
- It needs a blood expert analyst.
- Disease is determined based on approximate result rather than on exact ones.

The aim of this work is to show the importance of computer based information system using image processing at the fields of Biomedical Sciences making use of the intelligence and speed of computer technique to extract information of great significance to physicians and to specialists. The early diagnoses types of anemia could assist in quick treatment, blood anemia is a common blood disease that affects a range of people. Anemia is due to lack of pigment, which imparted a red color of hemoglobin, a substance found in red blood cells, carry and distribute oxygen to all body cells. Red Blood Cells (RBC) image analysis in blood smear is very important to determine the type of anemia, and a typical blood smear consists of white blood cells (WBC), RBC (red blood cells) and platelets.

II. SYSTEM MODEL DESIGN

The system composes of HMS (Hospital Management), Laboratory from the pathological section, the database collected from the HMS and diagnosis implementation of blood anemia.

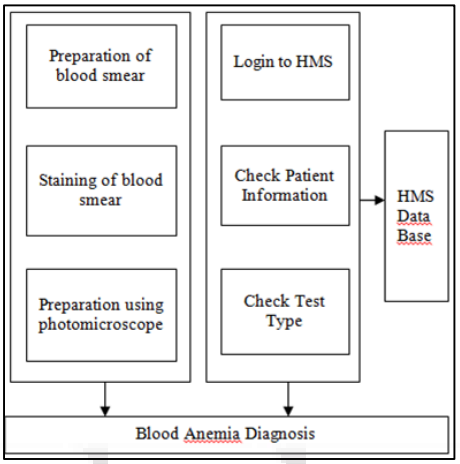

Fig. 1: System Model

III. SYSTEM APPLICATION PHASE

A. Image Acquisition

In healthcare, ubiquitous computing integrates computation into the environment through the use of wired sensor networks. Miniature sensors can perform long-term and ambulatory health monitoring, such as heart rate and blood pressure monitoring. The use of smaller, cheaper and less power hungry diagnostic devices, allows obtaining health related information from wearable or embedded sensors. Coupling the pervasive communications mentioned above with the lightweight portable devices such as tablets, notebook PCs, etc., Healthcare personnel can access vital signs information, review patient data, and update patients' records seamlessly. The main benefits of ubiquitous computing integration in healthcare include, but are not limited to the following: mobility and continuity support in medical monitoring and treatment, patient status report through the placement of a wide range of monitors in a home environment, improved patient satisfaction through on-line viewing and self-management of the healthcare process, improved quality of patient care by reducing medical errors through automated order entry and alerting systems, as well as remote access provisioning to medical facilities and specialists [5].

B. Image Preprocessing

A set of processes is used in data preparation and filtering to remove the noise. An intelligent implementation is used to make it ready for later analysis later with the aim to

automate cognition of the image and its content without human help. A set of sequential processes has been applied to the original image after image acquisition and reading as a digital image.

C. Feature Extraction

After inserting the image of sample on the computer system, then enhancing that, the feature will be extracted from the image. Feature extraction is the phase in which we are getting the information that is important to us from the image studied, in this work the method extract the features for each labeled region (cell area) and compute geometric shape features (area, Major/Minor Axis length, circularity, Bounding Box, Center), Variation in erythrocyte color, Inclusions and nucleated for each cell.

1) Geometric Shape Features
2) Variation in Erythrocyte Color
3) Inclusions and nucleated

IV. PROCESS FLOW DESCRIPTION

The system is divided into three main sub systems as shown below:

A. Lab

It is the environment in which the sample is taken, sample preparation, and staining to be ready for examination is executed.

1) Preparation and Staining of blood smear

It is the process of staining blood smear by one of stain type such as Wright, Leishman, Giemsa stain or other stains.

2) Preparation of image using photomicroscope

Process of taking image of blood smear under microscope that supplied with a camera.

B. Hospital Management System (HMS):

1) Login to HMS

Access to Hospital Management System.

2) Check patient information

The patient check in process includes verifying and updating information in the HMS system.

3) Check test type

Check the case, verify the query if the particular patient has any.

C. Blood Anemia Diagnosis System:

1) Boundary Tracing

Used to determine each cells as area and labeling it.

2) Morphological Recognition

Extraction of all morphological features of each cell.

3) Measure Properties

A measure of set of properties, the measurable sets for each element used to determine the type and properties of each cell.

4) Save Result

Save all the results in main storage or server or secondary storage as needed.

V. WORKING

Lastly after developing computer-based information, the results are computed and represented which aims to enhance blood anemia diagnosis, so the main results consist of three main points:

1) Classifying each cell alone: the system classifies cells after extracting properties and examining them.
2) Computing the number of cells for each kind: system counts number of cells for each kind alone which helps counting percentages.
3) Computing the percentage of cells number: depending on cells number that were examined and classified and the number of cells in each kind, this system counts the percentage of each kind depending on the whole number of cells that were examined.

VI. RESULTS

The work for this research has reached the identification of sickle cell anemia and the outputs of the same using MATLAB Image Processing Toolbox are as follows:

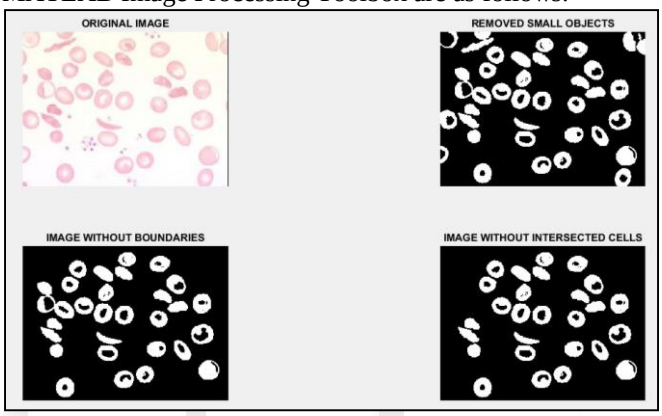

Fig. 2: Outputs for image processing

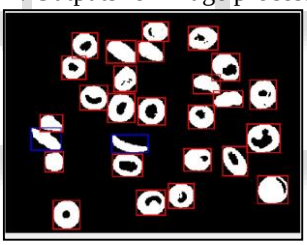

Fig. 3: Bounding Box for abnormal cells

VII. APPLICATIONS

The need to save both time and effort of patients and physicians may well be the driver behind developing more research in utilizing image processing in this regard, saving time and faster diagnoses lead to determining the right cure which surely stops the suffering of the affected person.

By automation, the need for specialized trained staff is not essential, less effort is required and possible human mistakes will not affect the output noticeably, this will have a great effect on the exactness of the result.

Briefly, the motivation is to work in favor of both patients and people taking care of those patients regarding reducing time for diagnose, reducing the effort and cost until achieving more exact output.

The current developed computer technologies available provide additional motive to focus more on researches in the favor of biomedical sciences.

VIII. CONCLUSION

The approach was adapted to utilize the widespread computers technologies and image processing techniques to make the analysis of blood smears more efficient, using

MATLAB environment a computer – based information system with proper software was developed to analyze RGB blood smear images.

In this work the researcher has successfully identified a large number of abnormal RBCs, classification of those identified RBCs in certain types, and calculating the percentages assist the physicians to determine the associated blood anemia. The main advantage of this approach is to gain more accuracy when analyzing blood smear, and to save time and effort which consequently reducing the cost.

There is many previous work in that field that is merely concentrated on normal cells segmentation, whether white or red, without specifying their state. This system has uniquely provided means to identify RBC counts and abnormalities.

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