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Automated Detection of Leukemia and Counting RBCs Using Image Processing Technique

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Abstract - A form of cancer known as leukemia affects the bone marrow, which makes an excessive number of aberrant white blood cells (or WBCs) that are not functioning normally. The leukemia diagnosis is typically done by a trained expert who visually observes unique features and determines the type of cancer. This paper presents a system that can automatically detect leukemia in microscopic images of blood and classify them as normal or abnormal (with leukemia). By using models that can discriminate between red blood cells and other cellular components, which have been trained on annotated datasets, the method reduces false positives and increases diagnosis accuracy. There are several benefits to the automated red blood cell counting technique described in this study, including speed, precision, and repeatability. This technology advances hematological diagnostics by using machine learning and image processing to enable faster and more accurate blood cell analysis in clinical and research contexts.

***Keywords*: Image processing; Segmentation; Red Blood cells; RBC count.**

1. INTRODUCTION

Digital image processing applications are widely used in the area of medical applications, restorations and enhancements, digital cinema, image transmission and coding, color processing, remote sensing, robot vision, hybrid techniques, facsimile, pattern recognition, registration techniques, multidimensional image processing architectures and workstations [1].

Red blood cell (RBC) counting in blood cell images can be a major factor in both the diagnosis and treatment of several diseases, such as leukemia, anemia, and others. Counting and analysis of blood cells manually by microscope is tedious, time-intensive, and entails a lot of technical Expertise. The ability to analyze and interpret medical images with precision has opened new avenues for understanding and addressing complex health challenges. The goal of the project is to use image processing techniques to develop an automated system for the detection and counting of red blood cells (RBCs). Thus, the development of an automated blood cell detection and counting system becomes necessary to help doctors diagnose patients quickly and accurately.[4]

Leukemia is a group of blood cancers that largely impact the bone marrow and blood. This condition arises when there is an abnormal increase in the number of white blood cells, which are responsible for fighting infections. [2]. Leukemia is classified into various types based on the specific type of white blood cell affected (lymphocytes or myeloid cells) and the rate of disease progression (acute or chronic). Common types include acute lymphoblastic leukemia (ALL).[4]

2. LITERATURE REVIEW

1. "Automated detection of leukemia in blood microscopic images using image processing techniques and unique features: Cell count and area ratio.
One kind of malignancy that affects WBCs in the blood is leukemia. A person with leukemia has aberrant cells because their body produces an excessive amount of one type of blood cell and not enough of another (Desai and Shet, 2018). Thus, the development of an automated blood cell detection and counting system becomes necessary to help doctors diagnose patients quickly and accurately.[1]

2. "Deep Learning for Detecting Malaria Parasites of Infected Red Blood Cells in Thin Blood Smear Image", IEEE 2020. Wong Sathon Neskowin; Picha Suwannahitatorn; Charit Watchhouses; Packet Wattay. Shortage of red blood cells (RBC), which constitute 99 percent of blood cells and are specialized as oxygen carriers, causes various blood disorders. The RBC is an important parameter in diagnosis and pathological study. Here, we create a system to detect to count the number of RBCs in the blood smear image. The primary goal of the proposed system is to detect and count all the RBCs including the overlapping one in the blood smear image.[2]

3"Implementation of Blood Cell Counting Algorithm using Digital Image Processing Techniques using Digital Image Processing Techniques" (2020) by Vilas B. Inchar Sadeem. Praveen L. S. Arion.
RBC, WBC, and platelets are among the cellular constituents of blood, which is a connective tissue. If

the blood cells are below the standard range it leads to various health diseases and hence proper blood cell counting techniques have a significant role in the pathology department. The most popular technique for counting blood cells is the microscopic approach, which produces superior results but requires more time to complete. [3]

4. "Review on Identification of Red Blood Cells by Image Processing" (2020)by Reddy Bhavana, Prajjwal Srivastava, Sangeetha N, Rashmi Reddy. Blood smear analysis is an important diagnostic procedure that is used to identify several kinds of diseases. The method of automatic diagnosis of microscopic blood smear images by Identifying and separating them into different categories of cells is highlighted in the paper.[4]

5. "An Efficient Image Processing Technique to Count Red Blood Cells" Joseph George1, T Sobha1 Arun Ashok, V 2 Jose Eldhose2 1Professors, Adi Shankara Institute of Engineering and Technology, Kaled, Kerala 2students, Adi Shankara Institute of Engineering and Technology, Kaled, Kerala [5]
In humans, mature red blood cells are flexible and oval biconcave disks. They lack a cell nucleus and most organelles, to accommodate maximum space for hemoglobin. Approximately 2.4 million new erythrocytes are produced per second. The cells begin life in the bone marrow and circulate throughout the body for around 100–120 days until macrophages recycle their constituent parts. Each circulation takes about 20 seconds.[5]

6. "Image Classification of Abnormal Red Blood Cells Using Decision Tree Algorithm" IEEE 2020. Virgnia Mari E. Batatas, Merwin Jhan G. Caballes, Abigail A. Ciudad, Micaela D. Diaz , Russel D. Flores , Engr. Rosario[6]
Counting of RBC in a blood sample can give the pathologists valuable information regarding various hematological disorders. There are four steps involved in estimating the RBC. These are acquisition, segmentation, feature extraction, and estimating. The acquisition step used the prevailing blood sample images. Next, the segmentation and feature extraction are done by using a morphological technique to distinguish the RBC from the background and other cells. The last step is estimating the amount of RBC by using Hough Transform.[6]

7. "Red blood cells and white blood cells detection by image processing" Irwin Rahami et al 2020, J. Phys.: Conf. Ser. 1539 012025,
Blood is a connective tissue composed of specialized cells suspended in a liquid medium, the plasma. The three types of cells that make up blood's cellular components are leucocytes, which are white blood cells, erythrocytes, and thrombocytes, which are platelets. These groups can be discriminated against using color, texture, size, and the morphology of the nucleus and cytoplasm. Red blood cells' (RBCs) main function is to transport carbon dioxide from the tissues to the lungs and oxygen from the lungs to the tissues.
[1] [2]. Every RBC is a biconcave, non-nucleated disc with a mean diameter of roughly 7.5 µm and a thickness of roughly 1 µm in the center and 2 µm at the periphery.[7]

4."Classification of blood cells into white blood cells and red blood cells from blood smear images using machine learning techniques". IEEE 2020. K.T Navya; Keerthana Prasad; Brij Mohan Kumar Singh. Diagnosing diseases associated with blood such leukemia, anemia, infection, malignancy, and polycythemia requires a classification of blood cells from Peripheral Blood Smear (PBS) images. In bloodcell-based analysis, hematologists always make a decision based on the total number of cells, their morphology, and distribution using a microscope. Hematology analyzer and flow cytometry provide reliable and exact Complete Blood Count (CBC) indicating abnormalities in the blood smear slide centers[8].

5."Detection of Abnormal Leucocytes Using Machine Learning Algorithms" Mrs. Tulasi M. Iriyala,1 Mr. Gangadhar Duma.
An examination of a patient's blood sample is a significant responsibility in the medical industry. Blood cell abnormalities create a variety of health issues. White blood cells are one of the most important components of blood. White blood cells are immune cells that fight infections caused by bacteria and viruses in the body. White blood cells can be classified to assist us in identifying various illnesses. The size, shape, and texture of normal white blood cells might vary due to several medical problems. This study aims to increase the quantity of identifiable abnormal white blood cells by image processing. To classify, this study employed various machine learning methods such as Random Forest, Boost, and Decision Tree. Therefore, the algorithm recognized and classified four images of white blood cells. The system used images from previous hospital patients to create these images. Furthermore, the slides are photographed.[9]

6.Kerala "An Efficient Image Processing Technique to Count Red Blood Cells" Joseph George1 T Sobha1 Arun Ashok V 2 Jose Eldhose 2 1Professors, Adi Shankara Institute of Engineering and Technology, Kaled, Kerala 2students, Adi Shankara Institute of Engineering and Technology, Kaled, Kerala.
Counting the cells in a patient's blood was performed manually, by viewing a slide prepared with a sample of the patient's blood under a microscope. These days, an

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automatic analyzer is typically used to automate this operation. It's possible that the hemocytometer was initially intended to count blood cells.[10]

3. PROPOSED WORK

Red blood cell (RBC) counting is an important task in medical diagnostics and research, providing valuable insights into various health conditions. Traditional manual counting methods are time-consuming and prone to human errors. The purpose of this project is to increase RBC counting effectiveness, precision, and dependability so that researchers and medical practitioners can use it for diagnostic and investigative purposes.[1] The entire progression is initialized by acquiring the blood image, which is then transmitted to the further processing level then its thresholding image is generated for applying morphological functions and finally, counting the total number of red blood cells. This proposed work aims to develop an automated method for counting red blood cells using image processing techniques, streamlining the process and improving accuracy.[7]

4. OBJECTIVE

Design and implement an algorithm that can automatically count red blood cells (RBCs) in blood smear images with image processing techniques. Explore methods to ensure data compatibility and coherence between the text and audio input.[1] Explore suitable feature extraction methods to represent relevant characteristics of RBCs, aiding in accurate identification and counting. Optimize the algorithm to ensure efficient processing of images and achieve real-time or near-realtime RBC counting capabilities.[4] Investigate the feasibility of transformer-based models for multimodal generation. Develop a user-friendly software interface that allows easy utilization of the automated RBC counting algorithm by healthcare professionals and researchers. Ensure that the software is user-friendly, has results visualizations, and can be customized according to individual requirements.[3]

5. SYSTEM ARCHITECTURE

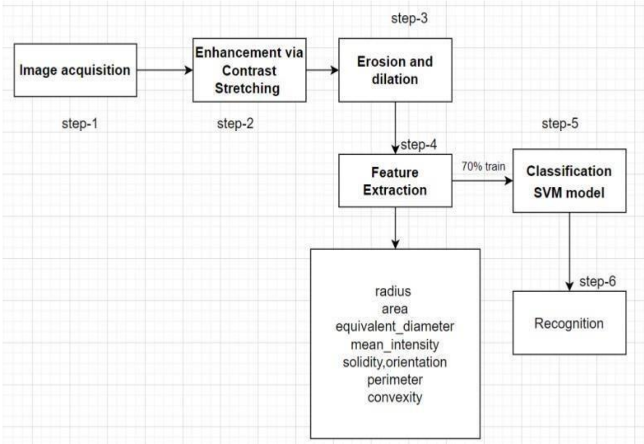

Fig 5.1: Diagram of Proposed Image Processing

ALGORITHM USED IN THE IMPLEMENTATION

Support Vector Machines (SVMs) are a type of supervised machine learning algorithm that can be used for classification and regression tasks. To classify an image using an SVM, we first need to extract features from the image. These features can be the color values of the pixels, edge detection, or even the textures present in the image. Once the features are extracted, we can use them as input for the SVM algorithm. One of the main advantages of using SVMs for image classification is that they can effectively handle high-dimensional data, such as images.[4]

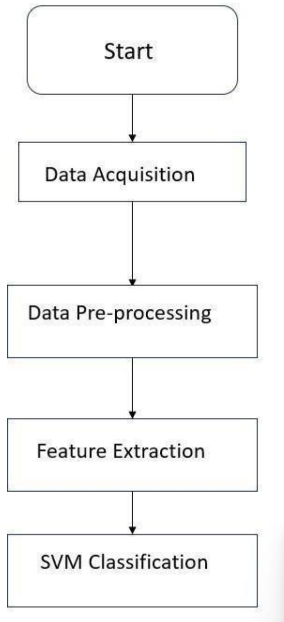

Fig 5.2: Flow diagram of algorithm

- Step 1: Start
- Step 2: If the file is selected in image acquisition,go to
- Step 3: If the file is not selected, go to step 9.

- Step 4: Noise removal will be performed.
- Step 5: Edge Detection method by canny edgedetection.
- Step 6: Morphological operation will beperformed.
- Step 7: RBC size extraction.
- Step 8: RBC will be counted i.e. RBC count.
- Step 9: End

6. SYSTEM IMPLEMENTATION

1. HOME PAGE:

Fig6.1: Home Page

STEP1: CREATE USER ACCOUNT

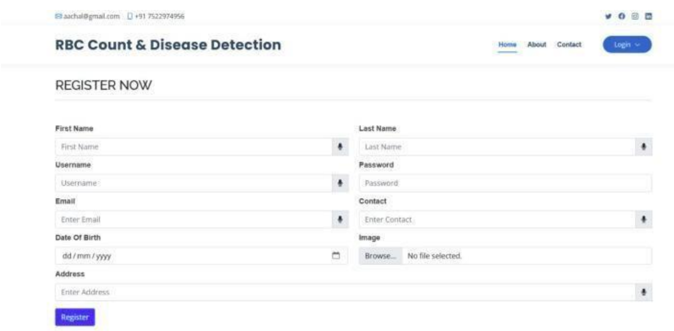

Fig6.2: User Create Account Page

STEP3: USER LOGIN:

Fig6.3: User Login Page

STEP3: Leukemia Disease Detection

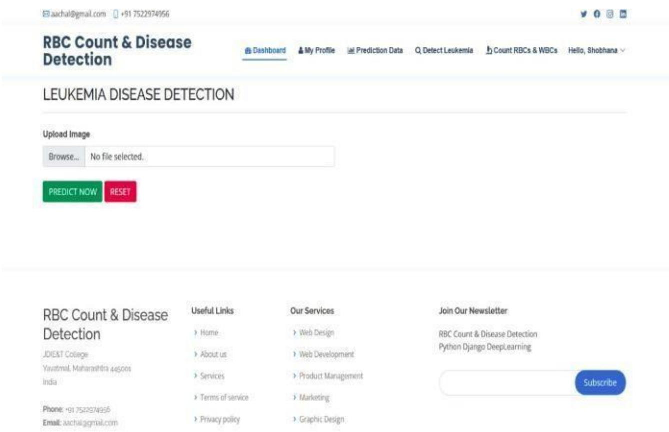

Fig6.4: User Leukemia Disease Detection Dashboard Page

STEP4: Detection & Count RBCs & WBCs CELL

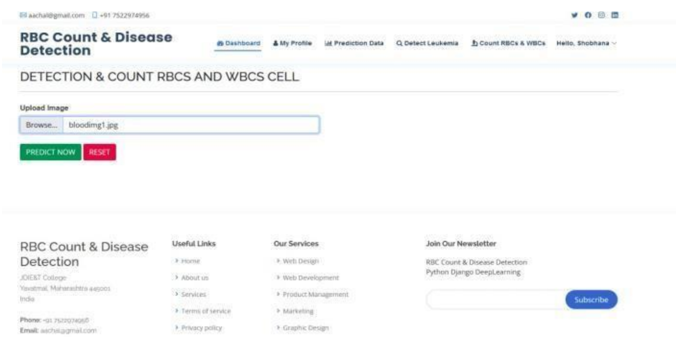

Fig6.5: Detection & Count RBCs & WBCs Cells Page

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7. RESULT AND DISCUSSION

The developed digital image processing algorithm is tested in Different bold samples of different subjects. The images obtained from an electron microscope are used to count the blood cells by using image processing.

Fig 7.1: Count RBCs & WBCs Cells Output Page - I

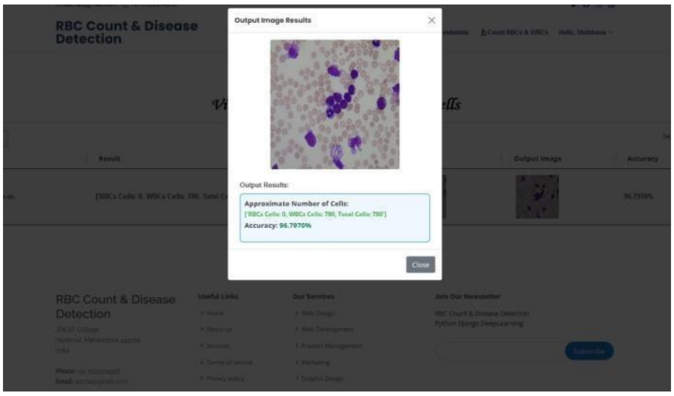

Fig 7.2: Count RBCs & WBCs Cells Output Page – II

RBC Count & Desease Detaction

#	Date	Result	Input Image	Output Image	Accuracy	Action
1.	April 2, 2024, 3:39 a.m.	Leukemia Detected	Launch demo modal --> Input Image Original Image: Close	Launch demo modal --> Output Image Results Step 1: Image Preprocessing and Enhancement (a) Original Image (b) Gray Scale (c) Contrast (d) Histogram (e) Enhancement Step 2: Edge Detection and Feature Extraction (f) Thresholding (g) Morphological Operation (h) Edge Detection (i) Final Recognition After SVM on Extracted Features: Accuracy: 94.6396% Result: Leukemia Detected Close	94.6396%	

Fig 7.3: RBC count and disease detection report

8. EXPERIMENTAL RESULT

The experimental results demonstrate the effectiveness and accuracy of the image processing-based approach for RBC counting. The combination of advanced segmentation techniques, calibration, and validation procedures ensures reliable quantification of RBCs from digital images.

This automated approach offers significant advantages in terms of speed, consistency, and scalability compared to manual counting methods automated RBC counts showed a high level of accuracy compared to manual counts. The overall accuracy of the counting algorithm was found to be over 92%. Analyzing different samples of red blood cells (RBCs) using image processing techniques can provide valuable information about their morphology, distribution, and any abnormalities present. Here's how image processing can be utilized for the analysis of different samples of RBCs:

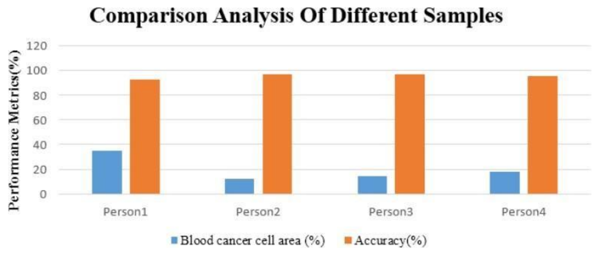

Fig. 25: Diagram of Analysis of Different Samples

FUTURE SCOPE

The exact categorization of immature leukocytes can help with decisions regarding diagnosis and treatment, which vary according to the kind of cancerous cell. This study will be applied in the future to improve classification performance using the features that were determined to be most essential and the features that were proposed. Future work should focus on compiling an extensive dataset and creating a machine-leading classifier that can handle unbalanced data and categorize all varieties of immature leukocytes. This may stand as a tool for doctors to reduce the time and cost required for diagnosing leukemia. The proposed model can expedite the detection of leukemia by identifying immature leukocytes, especially in developing countries where diagnosis takes numerous weeks, and potentially save lives because early diagnosis is vital for treatment success in leukemia patients.

CONCLUSION

Disease diagnosis by a computer algorithm (i.e. image processing) is getting more popular today due to its continuous operations that are fast, reliable, and accurate in the diagnosis of the disease. The automatic detection and classification of immature leukocytes in leukemia diagnosis through the integration of image processing techniques and a Support Vector Machine (SVM) model. Our model achieves a remarkable 92% accuracy rate in identifying immature leukocytes, which is in line with the state-of-the-art techniques at this time. Moreover, during multiclass classification, the model achieved a precision of over 65% for each of the four immature leukocyte classes, surpassing previous research efforts despite class imbalance. The system can be further improvised to detect more diseases related to different blood cell morphologies.

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