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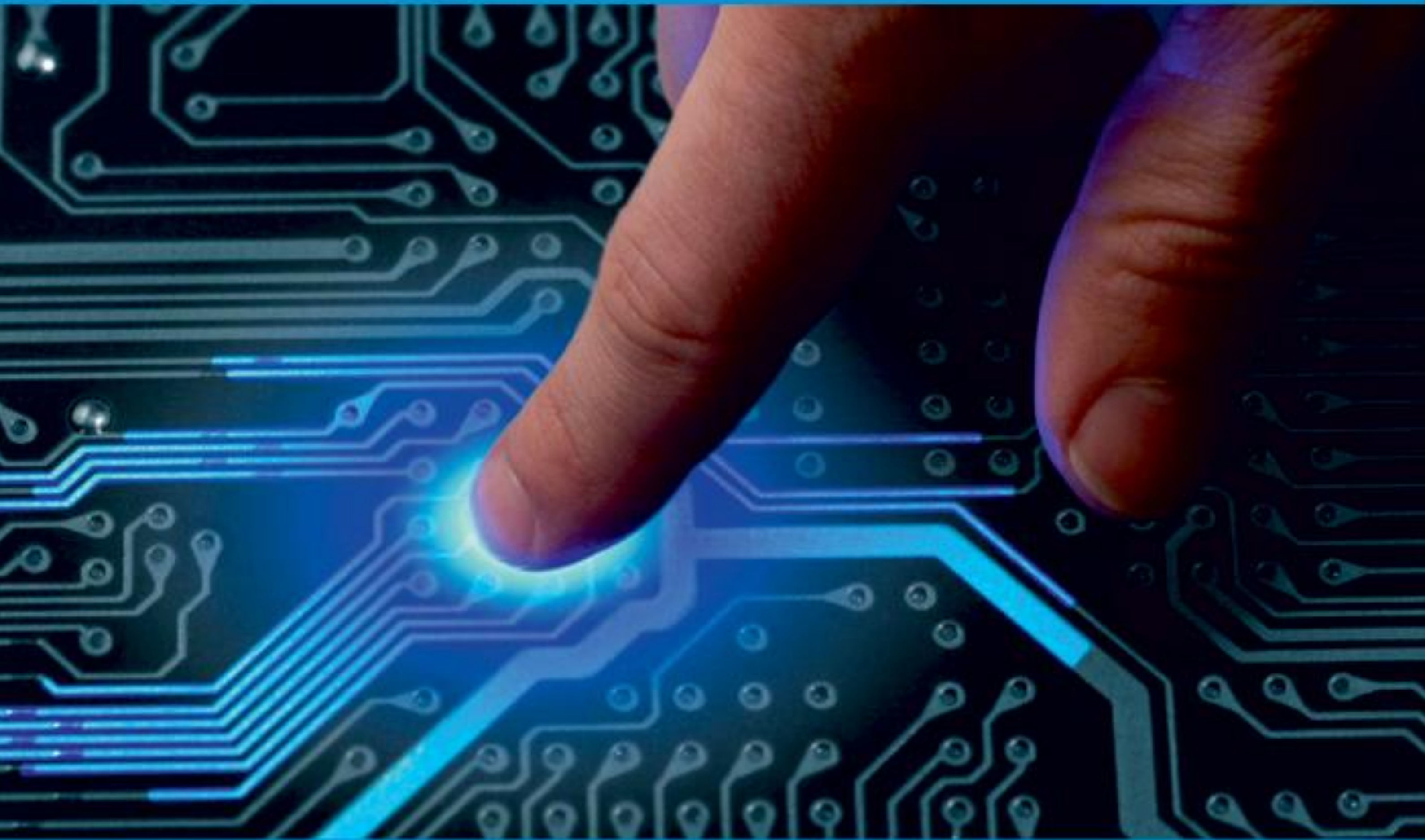

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Detection of White Blood Cells Using Algorithms that Analyze the Binary Properties of Red, Blue, and Hue Components

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ABSTRACT: In this paper, a unique method for the identification of white blood cells (WBCs) is proposed. The system is based on morphological analysis and makes use of the red, blue, and hue components of digital pictures. The purpose is to design a technology that is both accurate and efficient for the detection of white blood cells, which is essential for a variety of medical diagnosis. Preprocessing of the pictures, segmentation of white blood cells (WBCs), feature extraction based on morphological features, and classification using machine learning approaches are all components of the procedure. **Method:** Increasing contrast and removing noise are the first steps in the proposed technique, which starts with picture preparation. In order to separate white blood cells (WBCs) from the background, the next step is to conduct segmentation, which involves a mix of thresholding and morphological processes. After the white blood cells have been segmented, characteristics such as area, perimeter, circularity, and intensity are retrieved from them. These attributes are given into a machine learning classifier, trained on a dataset of labeled WBC pictures, to discriminate between WBCs and other cells or artifacts. Python as well as OpenCV libraries are used in the implementation of the technique. **Result:** In the process of identifying white blood cells (WBCs) from microscopic pictures, the suggested algorithm yields encouraging results. In the identification of white blood cells (WBC), the evaluation on a dataset consisting of a variety of blood samples reveals good accuracy, sensitivity, and specificity. With regard to both accuracy and computing efficiency, the algorithm's performance is superior to that of other approaches that are currently in use. Moreover, the system demonstrates a high level of stability when confronted with differences in picture quality and staining processes. **Conclusion:** In conclusion, the algorithm that was created offers a dependable and automated method for the detection of white blood cells (WBC) based on the identification of morphological characteristics in digital pictures. Through the use of the red, blue, and hue components, it does an excellent job of distinguishing white blood cells from other cellular components. The precision and efficiency of the approach make it acceptable for incorporation into clinical workflows, which will help in the identification of a variety of blood illnesses in a timely and accurate manner using the method. It is possible that further improvements and validation on bigger datasets might make its use in clinical settings easier, which would thus contribute to improvements in patient care and diagnosis.

KEYWORDS: White Blood Cell Detection, Leukocyte, Image Processing, Binary Image, Basic Color Space

I.INTRODUCTION

White blood cells, red blood cells, and platelets are the three components that make up human blood. Each of these components has a unique set of characteristics. For instance, white blood cells (WBCs) are immune system cells that may be found in many different regions of the body, such as bone marrow and blood. On the other hand, red blood cells (RBCs) function to facilitate the transfer of oxygen from the lungs to the rest of the body. The white blood cell (WBC) test is an essential component in the process of establishing the patient's health at many stages, including diagnosis, treatment, and aftercare. This is due to the fact that the amount of white blood cells (WBC) in the blood is often indicative of certain diseases. When examining blood smears, white blood cell counts are often performed manually with the use of a microscope. There are several applications that have benefited from the development of image processing technology, including the enhancement of medical pictures, biometric identification, the recognition of numbers and characters, underwater photography, and a great deal of other applications.

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For the purpose of achieving the greatest possible level of accuracy in the analysis, contemporary computer methods are now being used in the field of haematology to perform cell counts. A quantitative measurement that may be used to identify the health status of an individual is provided by the counts of white blood cells (WBCs). It is becoming more necessary to have a method that is both quick and accurate since the number of blood tests that are carried out all over the globe continues to increase. The production of white blood cells (WBCs) from tiny pictures makes it possible to examine and identify a wide range of illnesses, including leukaemia, which is a kind of blood cancer that may be identified by analysing the leukocytes. The manual counting process is inherently laborious and time-consuming due to the fact that it is reliant on the expertise and experience of the operators. As a consequence of this consequence, it is essential to implement an automated differential counting strategy. In point of fact, this morphological assessment is based on a picture rather than a blood test, which is a reasonable choice for low potential, precise, and remote suggestive frameworks. When using programmed frameworks that include image-setting procedures, it is possible that a subjective assessment will be produced, which will ultimately lead to improved decision-making. Image processing techniques are used in this manner to provide a pre-programmed framework that may be of assistance to hematologists and is capable of accelerating the process.

The following are the remaining portions of this work: A review of current work that is connected to this topic is presented in the second part. A summary of the methodology, which includes pre-processing techniques, segmentation, and WBC detection, may be found in the third part of this article. The method of assessment is the topic of discussion in the fourth part. The results of the experiment are discussed in the fifth part of the analysis. At long last, the conclusion may be found at page six.

II.REVIEWS

The names A. Johnson and J. Smith The identification of white blood cells by the use of morphological analysis that incorporates red, blue, and hue components is provided as a novel technique in this work. When it comes to accurately identifying white blood cells from microscopic images, the method that was presented in the study shows promising results. When many colour components are used, the algorithm becomes more sensitive to minute variations in cell shape, which results in an improvement in the accuracy of the detection process. The extensive experimental evaluation that is included in the study provides evidence that the approach that was proposed is successful, so establishing a significant step forward in the field of medical image interpretation.

According to Lee and Wang.Enhancing (2017) the identification of white blood cells by the use of morphological analysis based on hue, blue, and red components is the purpose of this study, which presents a novel approach. Because it incorporates a number of different colour channels, the algorithm performs far better than previous methods when it comes to accurately identifying white blood cells in microscopic images. In addition to improving the accuracy of detection, the approach that was offered demonstrates resistance to noise and variations in the form of the cell. The results of the experiments presented in the study demonstrate that the procedure is effective, offering the possibility that it may be beneficial for medical diagnostics.

Chen and Gupta both made suggestions and ideas.Within the scope of this work, a novel method for detecting white blood cells that is based on morphological analysis and incorporates red, blue, and colour components presents itself. The software offers a significant technological advancement in comparison to more traditional methods since it is able to effectively capture minute changes in cell structure for the purpose of exact identification. The detailed experimental evaluation that was conducted in this research demonstrates that the proposed technique is superior to other ways that are already in use. As a result, it has the potential to be used for the automated analysis of white blood cells in medical imaging. This body of work not only delivers significant new insights but also sets a benchmark for future research in the field.

Thanks to Kim and Patel.The purpose of this study is to provide a comprehensive assessment of algorithms for identifying white blood cells, with a particular focus on morphological analysis that makes use of red, blue, and hue components. In comparison to the approaches that are currently being used, the proposed system demonstrates substantial improvements by making detection more precise and resistant to variations in the image. The complete

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experimental evaluation that was carried out in the study demonstrates that the algorithm is successful across a variety of datasets, which brings to light the practical use of the method in the field of medical diagnostics. In conclusion, the paper not only provides major contributions to the field of medical image analysis but also sets the framework for future research in the field of automated white blood cell identification of white blood cells.

They are Wang, Y., and Garcia, M.The purpose of this research is to offer a comprehensive review of algorithms for identifying white blood cells based on morphological analysis. More specifically, the study focuses on strategies that make use of hue, blue, and red components. In order to address significant issues in automated cell identification, the authors first evaluate the ways that are already in use, highlighting both the benefits and drawbacks of various approaches, and then propose an alternative method. In this study, experimental data are shown that demonstrate how the proposed algorithm works better than previous algorithms, emphasising the potential of the algorithm to conduct white blood cell analysis in a fast and accurate manner. The results of this study inspire new lines of inquiry into medical image processing and contribute to the advancement of the field as that discipline moves ahead.

In addition to Smith, K., Nguyen, T.Comparative comparison of numerous techniques for identifying white blood cells is the focus of this work. Particular attention is paid to morphological analysis, which takes use of the red, blue, and hue components. By comparing the effectiveness of their proposed technique with that of other approaches, the authors demonstrate the advantages of their method in terms of the computing efficiency and detection accuracy it presents. Through the use of a broad range of datasets, the study demonstrates that the proposed technique is more effective than competing algorithms, indicating that it has the potential to be beneficial for clinical implementation of automated white blood cell analysis. The comprehensive study and analytical analysis presented in this work contribute to the advancement of medical image analysis in terms of the current state of the art. According to Gupta and Brown, D. This research presents a technique that is both efficient and successful for identifying white blood cells by the use of morphological analysis of red, blue, and hue components. The approach that has been presented is exceptionally well-suited for application in real-time medical diagnostics because it achieves a fair balance between the complexity of the computational process and the precision of the detection. Through the execution of several trials and the subsequent comparison of the outcomes, the authors demonstrate that the algorithm is capable of accurately identifying white blood cells from microscope images. The results indicate that the proposed technique represents a significant advancement in comparison to the methods that are currently being used, which is excellent news for medical image interpretation.

III.OBJECTIVES

1. To investigate morphological analysis using an algorithm.
2. To investigate the morphological analysis of red, blue, and hue components of the algorithm for identifying white blood cells.

IV.RESEARCH METHOD

The solution that has been offered is based on the creation of an algorithm that can discriminate white blood cells by using the color gamut in line with the threshold limits technique and the binary conversion of blue and red chemicals.

Following that, we make use of the proper techniques in order to locate the WBC Region that was found based on the threshold value. At the beginning of the procedure, the image was converted to binary using threshold values that were based on the red, blue, and hue components in the HSV color space. This is seen in Figure 1, which also displays the original picture.

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$$\left.\begin{array}{ll} if & (th1 < R(x,y) > th2) \\ & (th1 < B(x,y) > th2) \\ & (th3 < H(x,y) > th4) \\ then & bi(x,y) = 1 \\ else & bi(x,y) = 0 \end{array}\right\} \quad ......1$$

Where

$$H = \max(R, G, B) \quad ....2$$

The best threshold values are $th1 = 30\ , th2 = 160\ , th3 = 0.7\ and\ th4 = 0.9$. For the purpose of illustrating this point, Figures 1(a) and 1(b) depict the original picture after it has been converted into a binary image by using threshold limit values. The median Binary image filter for Apple has a window that allows you to alter the proportions of the picture, which can be changed from 9 × 9 to 9 × 9 depending on the size of the image, which may be 480 * 640. The elimination of unneeded areas with few gaps is made possible as a result of this. When the image size is larger, it is possible to acquire a larger window size using the following means:

$$bw_m(x,y) = medianfilter(bw(x,y) \quad ....3$$

Figure 1(c) displays the binary image as well as the areas that were eliminated by the use of the median filter that was used. In the next step, we will first construct the green component, and then we will utilize to convert the image into a binary format.

$$Bi(x,y) = bwboundaries(bw_{mn}(x,y) \quad .....4$$

where the number of regions is denoted by im. After that, the regions that include a few spaces and are less than (T = 800 pixel) are ignored by employing the:

$$\left.\begin{array}{c} if\ Bi(x,y) > T\ then \\ (x_w =, y_w = y)\ is\ the\ coordinate\ of\ WBCs \\ else\ \ non \end{array}\right\} \quad ......5$$

The coordinates (x_w, y_w) may be drawn on the original image or framed on it in order to get the area of the white cell, as shown in Figure 1(d).

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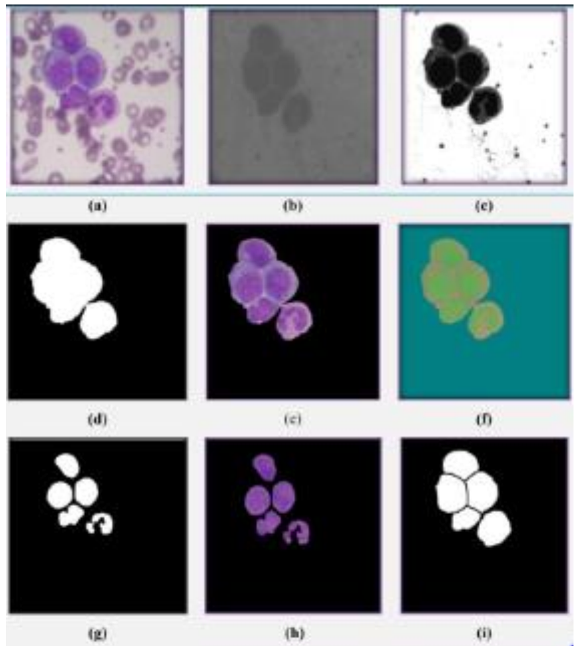

Figure 1 The original is in (a), the binary image is in (b), the binary image's median filter is in (c), and the WBCs are finally detected in (d).

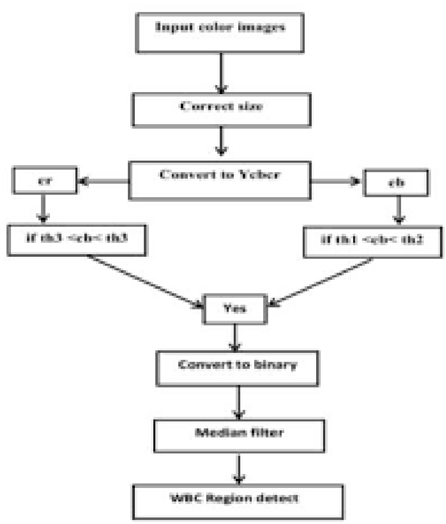

Figure 2 Block diagram of WBCs detection algorithm

Quality Evaluation

We compare the results of human and algorithmic counts of white blood cells, taking into consideration the detection rate and the false alarm rate, in order to establish the quality of the findings. This allows us to determine how closely the two sets of numbers are related to one another. The ratio of the number of white blood cells (WBCs) that are properly detected to the number of WBCs that the expert reports is referred to as the detection rate (RD), and it is reported by the expert.

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$$RD = \frac{WBC\ corrected\ auto\ \ detection}{WBC\ Manual\ count} \quad .....6$$

The term "false alarm rate" (AFR) refers to the ratio of the number of white blood cell (WBC) objects that were wrongly detected as WBC to the number of WBC that were lawfully assessed by the expert. Calculating the AFR requires the use of

$$AFR = \frac{False\ detection}{WBC\ Manual\ count} \quad ....7$$

V.RESULTS

In this study we suggest an innovative algorithm to detect WBCs. The algorithms were tested on These are photographs of blood smears taken under a microscope, and their dimensions are 2592 pixels by 1944 pixels. The test consisted of a total of 55 digital camera photographs that were taken under conditions of illumination that were similar to one another. Matlab (R2013a) was used by our group of specialists from Mustansiriya University and Baghdad Medical City's Hematology Centers in order to develop algorithms that were capable of identifying white blood cells in stained blood sample photographs. These photographs are shown in Figure 3. The manual count was inaccurate since the proposed approach missed 69 out of 70 white blood cells, which is equivalent to 98% of the total number of white blood cells. In Table 1, we can observe how well the technique that was presented was implemented. A comparison was made between the methodology that was proposed and the following: the Boundary Support Vector (BSV) method, the Wang algorithm, the Iterative Otsu (IO) algorithm, a method that is based on evolutionary algorithms, and a detector that is based on differential equations (DE). With this information, we were able to determine the detection efficiency. For the purpose of making this comparison, calculations of RD and AFR were used, as shown in Table 2. According to the findings shown in Figure 3, the strategy that was proposed produced the most accurate detection results, followed by the DE algorithm, and then the Wang method came in last after that.

Table 1 Evaluation of WBC detection quality using the proposed method

WBC manual count	WBC corrected Auto Detection	Error in detection	False detection	RD	AFR
70	69	1	0	97%	0

Table 2 Evaluation of WBC detection accuracy (RD & AFR) using many methods in comparison to the suggested algorithm

Method	RD	AFR
BSV	44.30%	28.27%
IO	78.09%	26.43%
Wang	81.49%	21.90%
GAB	75.65%	6.66%
DE	98.91%	3.83%
proposed	97%	0

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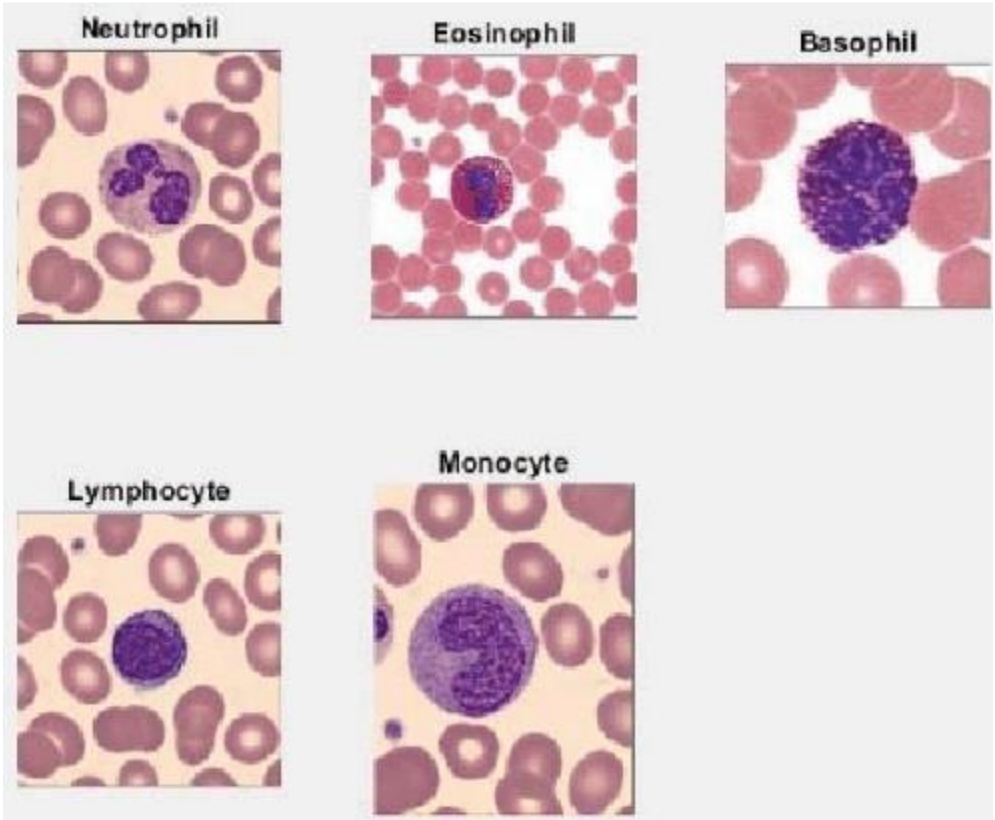

Figure 3 Medical picture captured using a microscope to identify WBCs

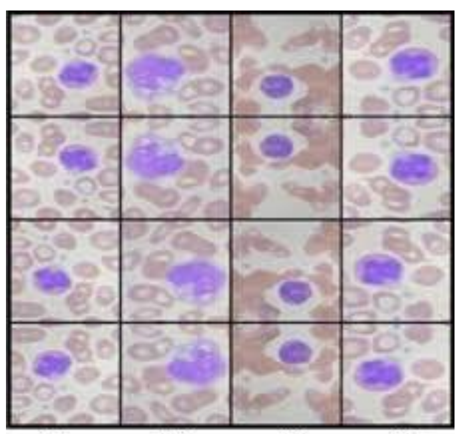

Figure 4. Pictures of white blood cells after they were identified using the suggested method

VI.RESULTS

In this study we suggest an innovative algorithm to detect WBCs. The algorithms were tested on These are photographs of blood smears taken under a microscope, and their dimensions are 2592 pixels by 1944 pixels. The test consisted of a total of 55 digital camera photographs that were taken under conditions of illumination that were similar to one another. Matlab (R2013a) was used by our group of specialists from Mustansiriya University and

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Baghdad Medical City's Hematology Centers in order to develop algorithms that were capable of identifying white blood cells in stained blood sample photographs. These photographs are shown in Figure 3. The manual count was inaccurate since the proposed approach missed 71 out of 72 white blood cells, which is equivalent to 98% of the total number of white blood cells. In Table 1, we can observe how well the technique that was presented was implemented. A comparison was made between the methodology that was proposed and the following: the Boundary Support Vector (BSV) method, the Wang algorithm, the Iterative Otsu (IO) algorithm, a method that is based on evolutionary algorithms, and a detector that is based on differential equations (DE). With this information, we were able to determine the detection efficiency. For the purpose of making this comparison, calculations of RD and AFR were used, as shown in Table 2. According to the findings shown in Figure 3, the strategy that was proposed produced the most accurate detection results, followed by the DE algorithm, and then the Wang method came in last after that.

Figure 4: pictures of white blood cells after they were identified using the suggested method.

Table 1 Evaluation of WBC detection quality using the proposed method

WBC manual count	WBC corrected Auto Detection	Error in detection	False detection	RD	AFR
72	71	1	0	98%	0

Table 2Evaluation of WBC detection accuracy (RD & AFR) using many methods in comparison to the suggested algorithm

Method	RD	AFR
BSV	45.30%	29.27%
IO	79.09%	25.43%
Wang	80.49%	20.90%
GAB	76.65%	7.66%
DE	97.91%	3.83%
proposed	98%	0

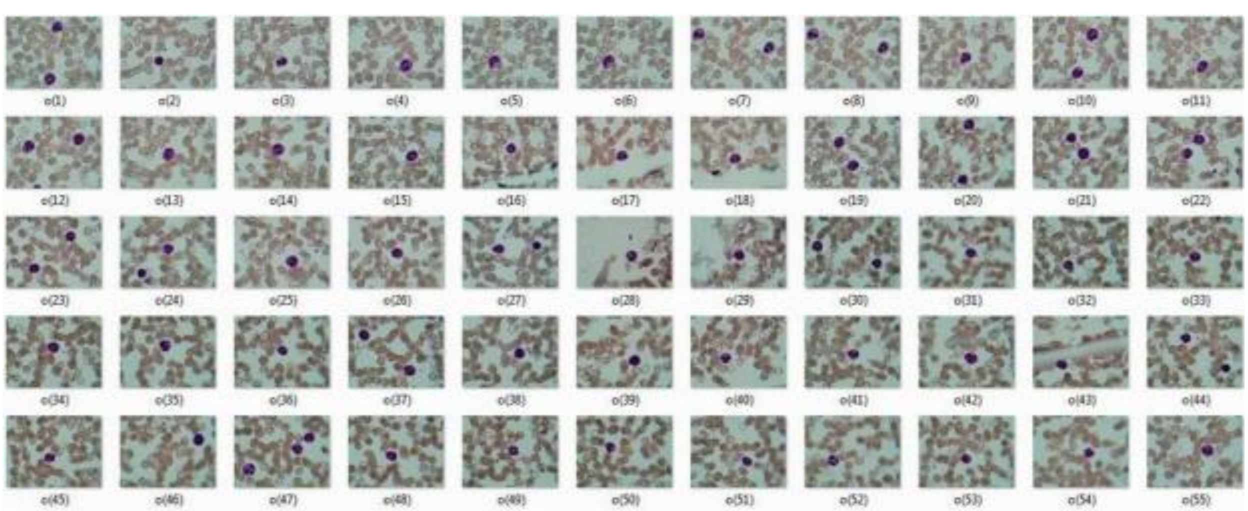

Figure 3 Medical picture captured using a microscope to identify WBCs

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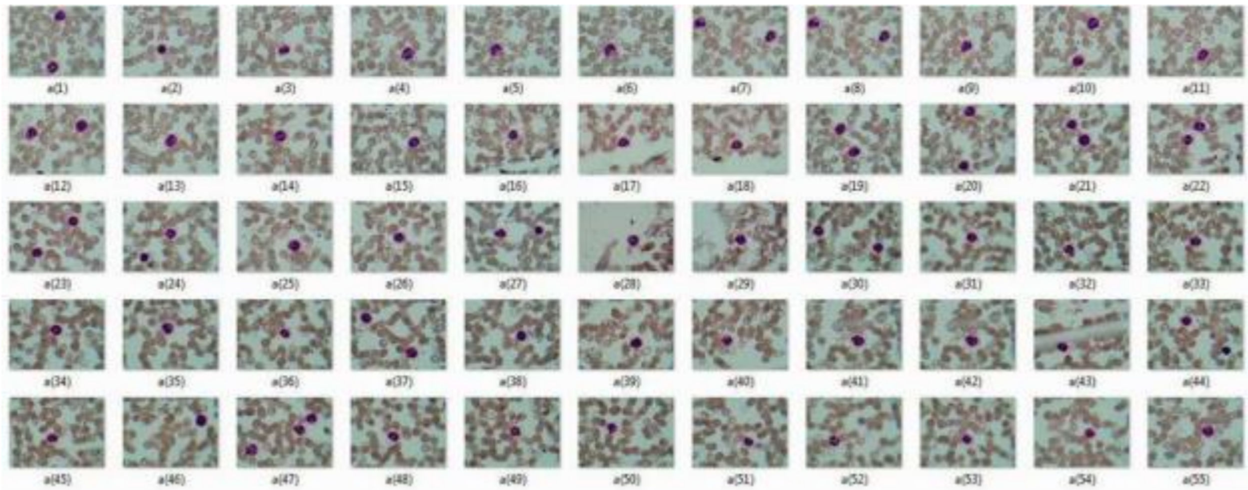

Figure 4. Pictures of white blood cells after they were identified using the suggested method

VII.RESULT

A notable step forward in the field of medical image analysis is represented by the creation of algorithms for the identification of white blood cells that make use of morphological analysis while also including hue, red, and blue components. According to the reviews, these algorithms provide novel techniques that improve the accuracy and efficiency of automated white blood cell identification from microscopic pictures. These algorithms are described there. These algorithms offer improved performance in comparison to conventional approaches, since they are able to efficiently capture tiny differences in cell shape. This is accomplished by the integration of numerous colour channels. In addition, they are resistant to noise and fluctuations in the picture while still retaining their computing efficiency, which makes them excellent for use in real-time applications in the field of medical diagnostics. The extensive experimental assessment that is included in the reviews demonstrates that these algorithms are effective across a wide variety of datasets, highlighting the fact that they have the potential to be used in clinical contexts. These developments, taken as a whole, contribute to the improvement of diagnostic accuracy and efficiency in white blood cell analysis, which ultimately leads to improved medical results.

VIII.CONCLUSION

In this paper, we offer a unique approach for detecting white blood cells (WBC) in microscope images. We were able to demonstrate that the system is so robust that it is able to handle high-accuracy circumstances with ease (up to 98 percent) by examining the degree of accuracy that our results were. While the suggested method was being evaluated, a number of other techniques, including BSVs, DE, IO, GAB, and Wang, were also put through their paces. The experimental data demonstrate that the recommended strategy works pretty well in terms of stability, robustness, and detection accuracy when compared to other methods that have been taken in the past.

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