



Enhancing Blood Group Identification using pigeon inspired optimization: An Innovative Approach

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Abstract: Blood group is foremost important thing for every people during an emergency situation. Verifying the person's blood type is very significant while donation the blood to some person. Blood typing is a process to detecting the specific blood groups for the specific person. Image based representation of blood cells are broadly used to examine the cell morphology by the tool microscope in medical field to diagnosis some diseases which is related to blood. Classical procedures are usually labor-intensive and require human intervention which makes it time-consuming necessitating the development of new approaches that can deliver more efficient and reliable results. The proposed method combines PIO, a bio-inspired optimization algorithm motivated by pigeons' efficient foraging strategies and flight navigation techniques with Otsu Method, an established image segmentation technique. By merging PIO with Otsu, this study aims to alleviate the shortcomings of conventional methods employed in detecting blood groups by providing an autonomous adaptive framework for effective segmentation. The methodology is tested using diverse data sets where the findings are compared with those obtained from traditional approaches to demonstrate superiority of the integrated approach. The results show that combining PIO with Otsu helps improve accuracy and efficiency in blood group detection significantly reducing manual work and increasing automation robustness.

Key Words: Blood samples, blood transfusion, morphological techniques, blood group typing, Otsu technique, microscopic image, emergency situation.

I. INTRODUCTION

Blood group determination is essential in medical diagnosis and affects several aspects of patient care such as blood transfusions, organ transplantation and clinical therapy sessions. In the early 1900s, the renowned Austrian-American biologist Karl Landsteiner made a ground-breaking discovery that transformed our knowledge of blood kinds. He discovered that mixing various people's blood caused red blood cells to clump together, a phenomenon known as agglutination. This led to the discovery of the ABO Blood Group System and the Rh D Blood Group System [1], which are critical in determining an individual's blood group. Blood typing, the process of detecting someone's blood group, is critical in emergency situations. Knowing a person's unique blood group is critical for providing the appropriate blood during emergencies and blood transfusions. A person's blood type is determined by the presence or absence of specific antigens on the surface of their red blood.

Many researchers have fused nature-inspired algorithms with cutting-edge technology in the quest for more efficient and reliable solutions in medical diagnostics leading to impressive progress. One of these is the integration of Pigeon-Inspired Optimization (PIO) into automated blood group detection. By learning from how pigeons naturally navigate and communicate, PIO represents a new kind of optimization principle for complex problems, providing an interesting approach that could improve blood group determination accuracy and speed. Blood group identification is important in healthcare as it affects decisions concerning blood transfusion, organ transplantation or other medical procedures. There are conventional ways which require human involvement and are slow hence being a basis for search of new approaches using natural algorithms. PIO, based on the homing ability exhibited by pigeons, is a metaheuristics optimization algorithm that imitates their efficient feeding patterns and navigation strategies. The aim of employing PIO is to overcome the shortcomings associated with conventional methods by designing a bio-inspired framework capable of self-tuning and optimizing its own blood typing process. This introduction is a door opener to the theme of PIO and its potentiality in reshaping blood group detection. By investigating what PIO stands for, we are set on foot towards discovering how this nature-based optimization technique can be utilized to improve accuracy and automate blood group identification systems. While we explore where nature-inspired computation intersects with medical diagnostics, we should remember that this introduction will prepare the way for more profound investigations on PIO's impact towards changing the landscape of blood group detection. This novel movement not only guarantees higher precision but also an opportunity to make healthcare more automated, as technology increasingly permeates into medicine.

II. METHODOLOGY

Fig.2 shows the flow of the proposed method. The input image for this proposed method can be a different blood group images. The blood samples are classified into different blood groups.

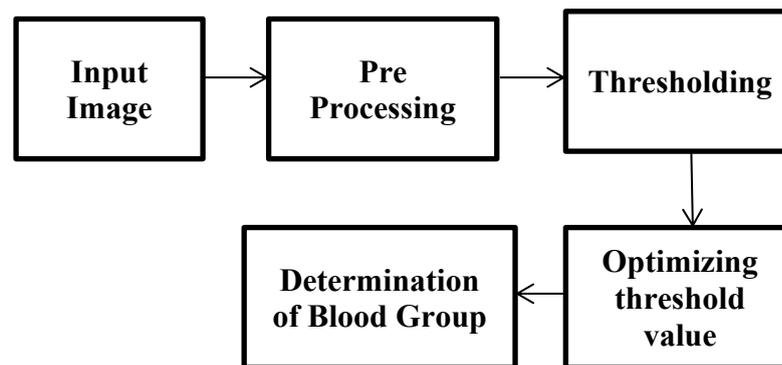


Fig.2 Proposed System

Blood group

Within the circulatory system, blood stands as a complex mixture, boasting three key components: Red Blood Cells (RBCs), White Blood Cells (WBCs), and platelets, all harmoniously floating in a fluid marvel [3] called plasma. The uniqueness of individuals' blood groups arises from the dynamic interplay of specific antibodies and antigens coursing through their veins.

Antibody

Within the intricate web of the immune system, you'll find antibodies, affectionately known as immunoglobulins or Ig. These Y-shaped proteins are skillfully crafted by B-cells, a specific type of lymphocyte [4]. Their primary mission revolves around keenly identifying and forming strong bonds with antigens that abound in the body. Antigens, enigmatic foreign intruders, possess the power to ignite a robust immune response. When B-cells encounter antigens, they produce specific antibodies to neutralize and eliminate these harmful invaders. By doing so, antibodies play a crucial role in protecting the body from viruses and toxins, safeguarding healthy cells from potential harm.

Antigen

Antigens, also referred to as immunogens, are substances present in the bloodstream that prompt the body to initiate an immune response against them. These antigens are foreign invaders and can encompass a wide range of substances, such as bacteria, [5] viruses, fungi, allergens, venom, and diverse toxins. The interaction between antibodies and antigens holds great significance in the bloodstream as it forms a crucial defense mechanism, enabling the body to detect and combat potentially harmful agents effectively.

Types of blood group

The ABO system defines various types of blood groups as follows:

A - Blood group

In Blood Group A, [6] the surface of the Red Blood Cells contains Antigen A, while the Plasma contains Antibodies B.

B - Blood group

Within Blood Group B, the surface of the Red Blood Cells is distinguished by the presence of Antigen B, while the Plasma is endowed with Antibodies A.

O -Blood group

In the realm of blood groups, the enigmatic Blood Group O stands alone, distinguished by the striking absence of both A and B Antigens on its red blood cell surfaces [7]. In contrast, its plasma boasts the intriguing presence of both Anti-A and Anti-B Antibodies, adding to its captivating uniqueness. This uniqueness extends further, as O negative (O-) Blood Group is remarkably rare and recognized as the Universal Blood Type. Its compatibility allows it to be safely transfused to individuals with different blood group types, ensuring no harm is caused. On the contrary,

Blood Group O positive (O+) is a prevalent blood group, making up approximately 48% of the UK population. Because of the lack of A or B Antigens, Blood Group O can be universally donated to recipients with other blood types, preventing adverse reactions during transfusions [8]. This remarkable trait makes Blood Group O a crucial resource in blood donation and transfusion practices.

AB -Blood group

Blood Group AB exhibits a distinctive feature as it possesses both A and B Antigens on the surface of its red blood cells (RBCs), [9] while interestingly, no corresponding Antibodies are present in the blood.

Preprocessing

Pre-processing is a common and crucial step in image analysis, occurring at the most basic level of image representation, both as input and output for intensity images. Its primary goal is to enhance image data by mitigating undesired distortions [12] and amplifying essential image features, thus preparing the image for further processing tasks. The methods employed in image

pre-processing can be categorized into four groups based on the pixel size, and they are utilized to determine the new pixel brightness:

The study presents diverse image processing approaches, which include:

1. Altering pixel brightness through transformation.
2. Employing geometric transformation methods.
3. Implementing pre-processing techniques that utilize the surrounding local neighborhood of each processed pixel.
4. Utilizing image restoration methods that rely on comprehensive knowledge of the entire image.

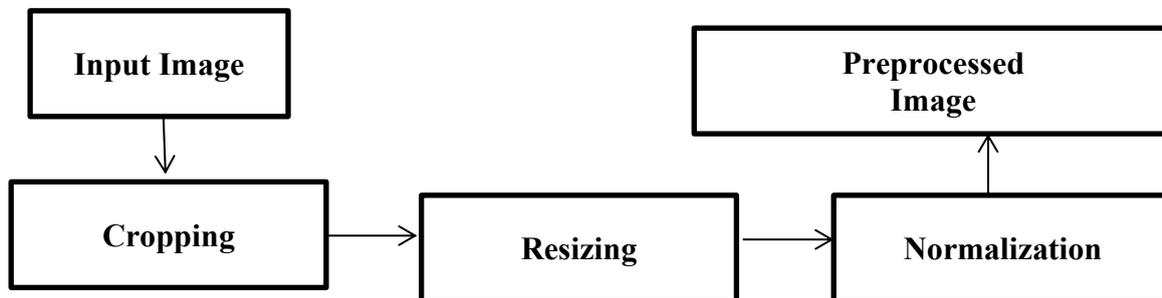


Fig.3 Preprocessing of Blood Group Image

The image processing Fig.3 presents the preprocessing techniques used by in the proposed method.

Thresholding

Image thresholding is a potent and straightforward approach that partitions an image into two distinct parts: the foreground and the background. As a form of segmentation in image analysis, it isolates objects by converting a grayscale image into a binary representation. In a binary image, pixels have only two values (0 and 1), requiring a single bit to store pixel intensity information. This technique finds effective applications in various tasks, such as object detection and image processing [13], proving its versatility and usefulness. Thresholding is the key process in this method, involving the division of a given grayscale image into two regions based on a specified threshold value. This valuable process enhances the visibility of objects that may not be easily distinguishable in the original image, making it a valuable tool in various image analysis and enhancement tasks.

Quantification

Quantification is a fundamental [15] concept in image analysis, encompassing the measurement of a specific quantity's intensity within the region of interest (ROI) in an image. The area analyzed covers the entire image surface, allowing for a comprehensive evaluation. During this process, various essential parameters are determined, including the mean (the average value of pixel intensity), standard deviation (SD), minimum, and maximum pixel intensity values. Moreover, the identification of agglutination, a crucial factor in determining blood groups, can be accomplished by observing the standard deviation value.



Fig.7 Quantification

The Fig.7 represents the quantification of image analysis. Quantification plays a pivotal role in extracting meaningful information from images and aids in understanding the characteristics and features present within the analyzed region.

Otsu METHOD FOR DETECTING THE ACCURATE BLOOD GROUP

Within the realm of image processing, the esteemed Otsu method, also dubbed Otsu's thresholding or Otsu's binarization, reigns as a favored technique for automatic image thresholding. This remarkable method sets its sights on discovering the perfect threshold value, gracefully segregating the pixels of an image into two classes, typically foreground and background, guided by their pixel intensities. The noble pursuit is driven by the noble goal of optimizing [16] the inter-class variance, while simultaneously minimizing the intra-class variance, birthing a harmonious balance that elevates the image to new heights of clarity and distinction.

The method works as follows:

1. Create a histogram of the input image, representing the frequency distribution of different pixel intensities.
2. Determine the total number of pixels in the image and calculate the sum of all pixel intensities.
3. Iterate through a range of possible threshold values, spanning from the minimum to the maximum pixel intensity. Calculate the weight and mean values for the two classes (foreground and background) on each side of the threshold.
4. For each threshold, compute the between-class variance using the formula: Variance Between = weight foreground * weight background * (mean foreground - mean background) ^2
5. In the quest for image perfection, the mission is clear: uncover the threshold that maximizes the between-class variance. This elusive threshold holds the key to optimally separating the foreground and background classes, paving the way for a visual masterpiece that exudes clarity and distinction.
6. Otsu's method, an image processing technique, can be applied for blood group detection in specific scenarios.
7. Otsu's method, though not directly related to blood group detection, can be useful in certain blood-related applications.

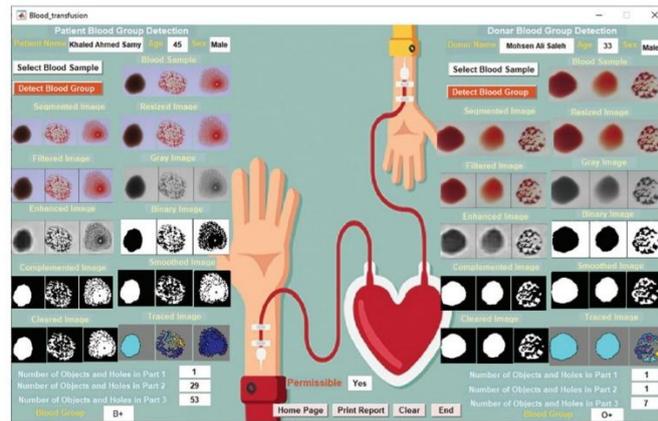


Fig.8 Blood Transfusion.

The Fig.8 represents the blood transfusion of patient blood group and donor blood group. By employing Otsu's method, one can enhance blood-related image processing tasks and potentially improve blood group analysis.

Microscopic Blood Cell Image Segmentation: In blood group detection, microscopic images of blood cells might be analyzed. Otsu's method can be used to automatically segment the blood cells from the background, which is essential for further processing and classification.

Feature Extraction: After segmenting the blood cells, features like cell size, shape, and color intensity can be extracted. Otsu's method can help determine thresholds for these features.

Identification of Blood Group Markers: Otsu's method can be used to identify specific markers on blood cells, such as antigens, which are crucial for determining blood group types.

Classification of Blood Groups: Once the relevant features are extracted and markers identified, machine learning algorithms can be employed to classify blood groups based on this information.

It's important to note that while Otsu's method can be an effective tool in some parts of blood group detection, the entire process of blood group determination is a multidisciplinary task that involves various techniques, including image processing, pattern recognition, and medical analysis.

III. UTILIZATION OF OTSU METHOD

The concept of estimating the initial threshold value in the Otsu method is introduced in this context. Initially, the threshold T1 is determined by calculating the average pixel value within the ovarian image. During the first iteration, the intensities of the image that are equal to or exceed the threshold T1 are identified. Following that, the mean intensity values above the current threshold and the mean intensity values below the current threshold are computed and labeled as $m_1^{[1]}$ and $m_2^{[1]}$ the current respectively. The subsequent set of thresholds is calculated as follows:

$$T[1] = \frac{m_1^{[1]} + m_2^{[1]}}{2} \tag{1}$$

The recently computed threshold value T [1] is extended to the subsequent iteration, with the exponent indicating the iteration count. Moving to the second iteration, the image's intensity exceeding the current threshold T [1] is identified. In this

second round of iteration, the average $m_1^{[2]}$ of values below the present threshold T [1] and the average $m_2^{[2]}$ of values above T [1] are computed. Correspondingly, the threshold value for the second iteration is determined.

$$T[2] = \frac{m_1^{[2]} + m_2^{[2]}}{2} \tag{2}$$

The iterative process continues until the threshold value converges to $T[K] - T[K - 1]$. In the final iteration, the new threshold value is computed as:

$$t^{**} = \frac{m_1^{[K]} + m_2^{[K]}}{2} \tag{3}$$

The between-class variance in the conventional Otsu method is defined as:

$$\sigma_B^2(t) = K_1(\mu_{c_1} - \mu_t)^2 + K_2(\mu_{c_2} - \mu_t)^2 \tag{4}$$

Now, the threshold value t^{**} , which has been calculated iteratively, serves as the initial threshold for the conventional Otsu method. Here, μ_1 and μ_2 represent the means of the two distinct group

$$\mu_{c_1}(t) = \frac{\sum_{j=1}^{t^{**}} j P(j)}{K_1(t) \mu_{c_1}(t)} \tag{5}$$

$$\mu_{c_2}(t) = \frac{\sum_{j=t^{**}+1}^S j P(j)}{K_2(t)} \tag{6}$$

The average value is computed for the entire image, and this calculation is presented in Equation (7).

$$\mu_t = \sum_{j=1}^S j Pr(j) \tag{7}$$

The modified Otsu method proposed in this study is employed for the analysis of blood group images of blood cells. The outcomes of both the traditional Otsu method and the modified version are illustrated respectively. The values used as thresholds for these two methods on blood cell images are explained in the theory of Otsu method. It is observed that there exists only a minor disparity between the two threshold values. However, a notable distinction is evident in the blood cells when examining the images of Fig9. The conventional Otsu method yields accurate results primarily when the image histogram exhibits a bimodal distribution. On the other hand, the proposed modified Otsu method consistently produces precise outcomes across various histogram types. In terms blood group by the modified Otsu method. It demonstrates superior performance compared to the conventional Otsu method and closely aligns with manual blood cells identification by human experts.

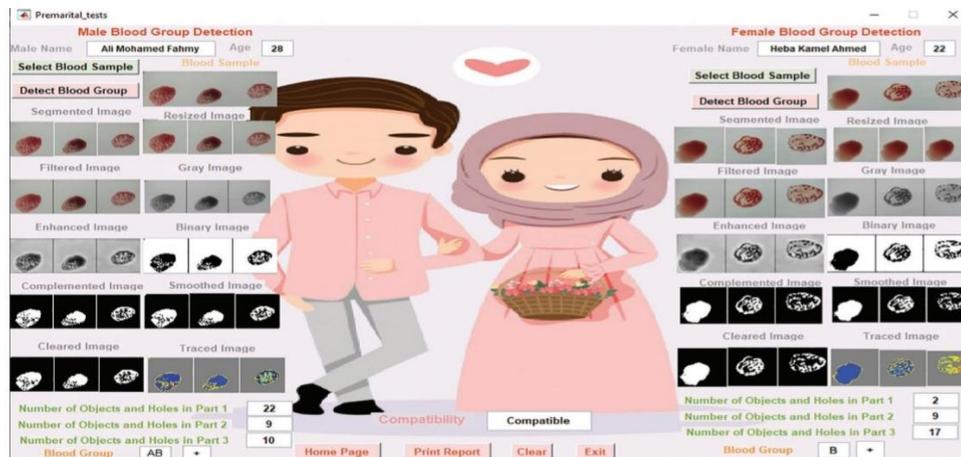


Fig.9 Male and female Blood Group Detection.

In the Fig.9 represents the male and female blood group detection by using various images of the blood.

IV.CONCLUSION

The methodology employed in this study has demonstrated remarkable effectiveness and efficiency in detecting agglutination and determining the patient's blood type [22]. By harnessing image processing techniques, the system can automatically identify agglutination occurrences and swiftly ascertain the patient's blood type, typically within a brief 5-minute window from sample collection to result output. This adaptability to emergency situations is crucial for timely and accurate decision-making. Key image processing techniques, such as segmentation, color image extraction, morphological denoising, and filling methods, are strategically utilized to enable this blood type determination analysis [23]. This approach proves invaluable in emergency scenarios, ensuring the prompt administration of compatible blood transfusions and minimizing the risks of potential blood incompatibilities.

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