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A Survey on the Human Blood Group Detection Using Image Processing

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Abstract: Identification of blood groups plays a vital role in the medical field for any treatment, ensuring compatibility in transfusions and other procedures. Currently, this task is typically performed manually in laboratories, a time-consuming process that requires skilled experts. To address the constraints and limitations of conventional blood group prediction methods, MATLAB techniques have been developed. These techniques incorporate image processing, including segmentation processes, to classify blood groups efficiently. By collecting blood samples and processing them through image classification with feature extraction, the variety of blood types based on ABO and Rh systems can be accurately identified. This advanced methodology mitigates the drawbacks associated with traditional methods, primarily reducing manual errors and enhancing speed and accuracy. The implementation of these techniques allows for the rapid and precise classification of blood groups, which is crucial in medical emergencies and routine diagnostics. The integration of image processing with artificial intelligence significantly enhances the reliability and efficiency of blood group determination. This technological advancement not only ensures faster results but also reduces the dependency on human expertise, minimizing the risk of errors. Consequently, this innovative approach represents a significant improvement over conventional methods, providing a robust solution for the timely and accurate identification of blood groups. This development is particularly beneficial in critical situations where time is of the essence, ensuring that patients receive the correct blood type promptly, ultimately saving lives and improving healthcare outcomes.

Keywords: Blood group type, feature extraction, Histogram, Image processing, MATLAB, Segmentation.

I. INTRODUCTION

Image processing involves using computer algorithms to analyse and interpret visual data from medical images. This technology has revolutionized the medical field by enhancing the accuracy and efficiency of diagnostic procedures. Through the application of sophisticated image processing techniques, medical professionals can extract detailed information from various imaging modalities, such as X-rays, MRI scans, CT scans, and microscopic images of biological samples. Blood group determination is crucial for various medical procedures, including transfusions, surgeries, and treatment of certain medical conditions. Blood is a complex fluid composed of several components, each playing vital roles in maintaining bodily functions. Red blood cells (RBCs) carry oxygen from the lungs to tissues and return carbon dioxide for exhalation. White blood cells (WBCs) are essential for the immune response, fighting infections and foreign invaders. Platelets are involved in blood clotting and wound healing. Given these critical functions, before performing any transfusion, it is necessary to collect the blood safely and get it matched accurately with the patient, so that the blood type of receiver donor is same as of donating donor ensuring the correct blood type is matched during transfusions to avoid potentially life-threatening reactions [1].

Traditional blood typing methods involve mixing a patient's blood sample with antibodies that react with A, B, and Rh antigens on the surface of red blood cells. Observing the reactions (agglutination or clumping) allows technicians to determine the blood type [2]. This method, while reliable, is labour-intensive and time-consuming, requiring skilled personnel and laboratory facilities. In emergency situations or remote locations, these constraints can delay critical care, risking patient health.

Automating blood group determination using image processing techniques can overcome the limitations of traditional methods [3]. These techniques utilize advanced algorithms to analyse images of blood samples, providing rapid and accurate results. The process typically involves several steps where Blood samples are prepared on slides, often treated with specific reagents to highlight relevant antigens. High-resolution cameras capture detailed images of the prepared samples. Microscopy techniques, such as phase contrast or fluorescence microscopy, can enhance the visibility of blood cell components and reactions. Advanced image processing algorithms analyse the captured images. These algorithms can detect patterns, identify cell types, and quantify the extent of agglutination.

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Machine learning techniques can further enhance the accuracy by learning from large datasets of previously analysed samples. The system interprets the analysis results, determining the blood type with high precision and reliability.

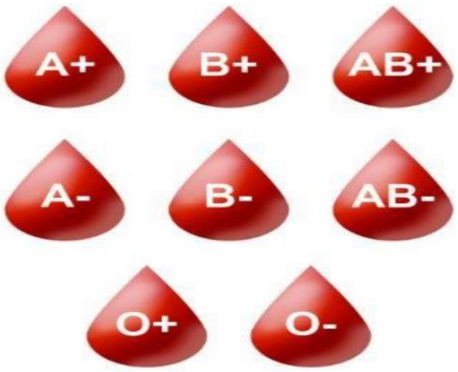

Fig.1 Classification of human blood group

The integration of image processing in blood group determination offers several significant benefits where an Automated systems can process blood samples and provide results much faster than manual methods, crucial in emergency situations by reducing human error ensures more reliable and consistent results, enhancing patient safety. Portable and automated systems can be deployed in remote or disaster-stricken areas, providing vital support where traditional laboratory facilities are unavailable. Automating the process frees up medical professionals to focus on other critical tasks, improving overall workflow in healthcare settings.

II. PROPOSED SYSTEM

The classification and detection of the blood group are done accurately through the image processing techniques with deep learning. This is followed through the MATLAB techniques. These innovative technology helps in the detection of human blood group to aid the doctors and medical practitioners to save time and obtain results accurately. The detection of blood group includes several stages. The advanced technology helps to detect the blood sample as soon as possible. This in turn saves time. It includes the collection of raw blood images and process them in MATLAB to obtain the images like the predefined images. This helps in the classification of blood samples.

In our proposed system, reagents are mixed with three samples of blood. After sometime, agglutination may or may not occur. After the formation of agglutination, the slide is captured as an image and allowed to process in MATLAB image processing toolbox. By using this system, more chances of human errors can be reduced. Image processing techniques used for blood group identification are:

- Image Acquisition.
- Pre-processing techniques.
- Thresholding and morphological operation.
- Histogram Equalization.
- Detection of Blood group.

Image Acquisition:
The first stage involves capturing high-quality images of blood samples using digital camera as shown in Figure 2. In our proposed system, reagents are mixed with three samples of blood. After a period, agglutination (clumping) may or may not occur. The formation of agglutination is an essential indicator used in blood typing.

Fig.2 Image Acquisition using digital camera

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Pre-Processing:

The pre-processing stage is a crucial step in the image processing pipeline for blood group detection. This stage involves several techniques aimed at enhancing the quality of the acquired images and preparing them for further analysis. The first step in pre-processing is resizing the acquired image to a specific format. Resizing is essential because smaller image sizes can significantly reduce processing time without compromising the important features needed for analysis.

By resizing the image, we ensure that the computational load is manageable, allowing for faster and more efficient processing. During the image acquisition process, various types of noise can be introduced, which may affect the clarity and quality of the image. To address this, image filter methods are applied to remove noise. Colour image processing is computationally intensive due to the additional information in colour channels. It includes conversion of image from RGB to HSV, HSV to Gray scale. The Grayscale image is shown in Figure 3. Therefore, most applications, including our system, convert images to grayscale.

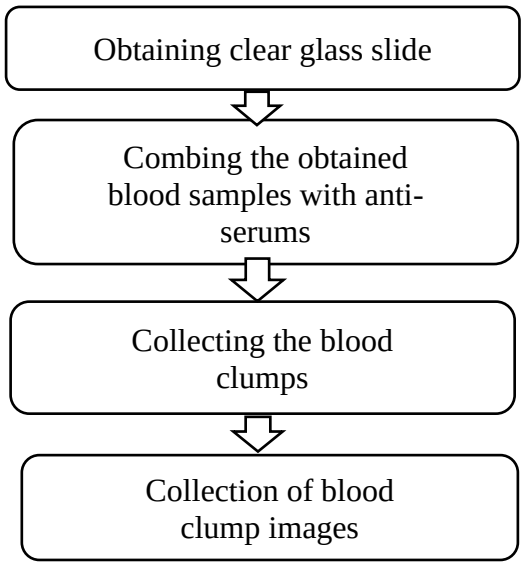

Fig.3 Grayscale Image

Thresholding:

The next step in the pre-processing stage is converting the grayscale image to a binary image. This conversion simplifies the image data further, making it easier to identify and process specific features relevant to blood group detection. To achieve this, a global threshold level is calculated.

This threshold is used to differentiate between the foreground (blood cells and relevant features) and the background. Pixels with intensity values above the threshold are set to white (value 1), while those below the threshold are set to black (value 0). This process results in a binary image, where the essential features stand out clearly against the background.

On applying some basic Morphological operation like erosion and dilation on the binary image to remove any imperfection and reform the image for better further processing.

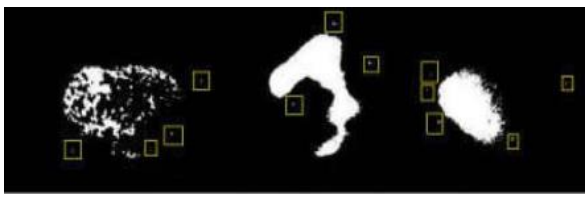

Fig.4.a Converting Gray frame into binary

Fig.4.b Applying Morphological operation to remove all the small components

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Histogram Equalization:

Image enhancement is a widely used technique to enhancing certain characteristics of an image in order to increase its visual quality and to aid in further image analysis. CLAHE (Contrast Limited Adaptive Histogram Equalization) is the tool used in the proposed system for contrast enhancement.

We will now take the vertical histogram of the image being processed. This histogram will give us the information regarding the regions of blood samples in the image. By Using this information of region starting and ending coordinates we can easily crop the region of interest (Blood mixture region) by using simple loop operation and we can segment our processed image for further processing. The segmented images are shown in Fig 5.

Fig.5 Segmented Image using derivative information of developed Histogram.

Detection of Blood Group:

White Pixel and Object count: We are detecting blood group by using two properties from the segmented image which are mentioned as

• By calculating the density of white pixel of each segmented region (area consist of white pixels) in the first place.

• And then calculating the total number of objects (elements) in each segmented image.

If there are more than 13000 white pixels and less than 5 number of objects in a region, then that region will be detected as non-distorted region and if there are less than 13000 number of white pixels and more than 5 objects in a region then it will be detected as distorted region.

Table.1 Criteria of human blood group

Blood type	Antigens	Antibodies	Rh factor
AB+ve	A and B antigen	no antibodies	D antigen
AB-ve	A and B antigen	no antibodies	no antigen
A+ve	A antigen	B antibodies	D antigen
A-ve	A antigen	B antibodies	no antigen
B+ve	B antigen	A antibodies	D antigen
B-ve	B antigen	A antibodies	no antigen
O+ve	no antigen	A and B antibodies	D antigen
O-ve	no antigen	A and B antibodies	no antibodies

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Table2. Comparison Between Different Techniques

Author Name	Year	Techniques	Description
Abubakar Yamin, FaisalIrnran, UsmanAkbar, Syed Hassan Tanvir[4].	2017	HSV format V channel and threshold technique	Use of MATLAB application and converting to HSV format V channel, then threshold technique was applied, and image was rendered leading to the development of histogram.
Mrs.G.SangeethaLakshmi, Ms.M.Jayashree [5].	2019	Local Binary Pattern (LBP) and Canny Edge Detection Techniques.	The paper presents an efficient blood group detection model using image processing, including grayscale conversion, Canny edge detection, and morphological operations. The method demonstrates promising accuracy.
Sree Vatshav, K. Sai Karthik, Akash C H, Sumanth P, Dr. M.S.Pradeep Kumar Patnaik [6]'	2021	Canny Edge Detection Technique.	The system captures blood sample images using MATLAB's GUI, processes them with grayscale conversion, thresholding, and complemented image techniques, uses Canny edge detection for feature identification, and quantifies results to determine the blood group.
S. A. Shaban, D. L. Elsheweikh [7].	2022	BWboundaries and GUI system.	It traces the outlines of objects, as well as the boundaries of holes within these objects, in the binary images .
Tannmay Gupta [8].	2024	Logistic regression optimization techniques and use of feedforward neural network.	They are efficient in modelling and data processing for non-linear interrelationships.
Ana Ferraz [9].	2024	Advanced Morphology and Quantify techniques.	The process captures blood and reagent images with a CCD camera, applies image processing for colour extraction and thresholding, uses morphological operations, and performs statistical analysis to determine agglutination and classify blood type based on standard deviation. The system automates this for quick and accurate blood typing.

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