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Framework for Automatic Blood Group Identification and Notification Alert System

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Abstract

Image Processing has assisted researchers in a variety of ways, especially in the areas of security and medicine fields. Identifying blood types in emergencies or far-off places and regions where experts have not been available is a present-day challenge. Therefore, we have developed an automatic system that will detect the blood group and notify an alert system using GSM and various image processing methods. Prior to any treatment or operation, it is necessary to determine the blood type for a transfusion of blood, even in an emergency. Currently, technicians manually conduct these tests, which can cause human mistakes. Different systems have been created to automate these tests; none have been successful in completing the analysis in time for emergencies. This project intends to create an automated system to do these tests quickly, adjusting to urgent circumstances. Initially, the slide test is performed to collect the blood images. Furthermore, various image processing methods have been performed for processing images using the PI camera. Subsequently, an alert with the patient's blood group is then generated and sent to the concerned patient or the hospital to immediately consult the patient. Unit testing and load testing were performed on 950 images at a time which yielded 97% accuracy.

Index Terms: *Blood Group Identification, Gray Level Co-occurrence Matrix, Global Positioning System, Image Processing, Raspberry Pi.*

I. INTRODUCTION

Blood group classification is the mandatory step to make sure blood transfusion is safe. The fastest identification/classification of the blood group of a person is extremely important in emergency Blood transfusion [1].

In an accident situation, the ambulance should reach the accident location at the right time and is related to the survival of the person. In a blood laboratory or an emergency blood transfusion, there is a need for a skilled person to identify the blood group because the blood type identification process needs the mixing of anti-oxides with the blood sample the person/patient possesses, and if the skilled person is not available at the right time, so identification of blood type of the person cannot be done at the right time which is also related to the survival of the person. So, there is a need for a system that should not need any skilled person to identify the blood type that is related to the person's survival. Blood Group Identification and Notification Alert System is basically used to determine the blood group that the human possesses and also sends the location of the accident place to the nearest ambulance so that the ambulance can reach the accident place at the right time also the system sends the Blood type information to the nearest hospital so that the blood of the particular type can be arranged at the right time and fast which can play an important role in the person’s survival.

Blood types are categorized into four types i.e. A, B, AB, and O. Blood type identification follows the agglutination procedure, and then after this process, it comes to the machine so that the machine can clarify the blood type. Interaction/Combination of an antibody and a particular antigen gives visible clumping termed as ‘Agglutination’. Blood type A has only the Antigen-A in the blood cells. Blood type B has only Antigen-B in the Blood cells. Blood type AB has Antigen-A and Antigen-B in the blood cells and Group Type O has neither A-Antigen nor B-Antigen in the blood cells. Blood transfusion is performed based on the compatibility of Blood types. The compatibility of different blood types varies. Determining blood type is therefore necessary for safe blood transfer. The manual blood group identification process still used today by lab personnel has certain disadvantages, such as the longer process time. Additionally, in rare circumstances, if the proper blood type is not found at the right time, it may cause the person to pass away.

II. LITERATURE REVIEW

Blood group identification is crucial in the medical industry for any type of treatment. Blood transfusion errors might result in several consequences. This technique offers a quick and simple way to identify blood types. To classify the blood groups, the variation in the quantity of absorption by each blood type is used. The blood sample is illuminated by the pulsing IR LED light [2], which is then detected, cleaned up, and transformed into a voltage signal. In order to categorize the blood groups, the received signal's fluctuations in strength caused by blood absorption are converted into matching voltage changes.

Prior to giving a blood transfusion in an emergency circumstance, blood type determination is crucial. Currently, these tests are conducted manually by laboratory professionals. When many samples are involved, this can get repetitive and can result in mistakes [3]. The suggested system attempts to provide an embedded system that uses an image processing algorithm to conduct blood tests using Rh and ABO blood type systems. The suggested method reduces the need for human interaction and conducts the whole test automatically, from the addition of antigens through the creation of the results. The suggested system seeks to provide results as quickly and accurately as feasible while also storing the findings for future use as references. Therefore, the method eliminates traditional transfusions based on the universal donor concept, lowers the danger of transfusion responses, and stores the results accurately and without human mistakes. Consequently, manual identification might allow for human mistakes. The present paper's central thesis tends to employ deep learning approaches, to resolve human mistakes [4]. The suggested technique minimizes human error while identifying each person's blood type. This would cut down on testing time and produce effective findings with high levels of precision and accuracy. Deep learning uses a trained model to anticipate the supplied picture and takes a blood sample from blood donation apps. The blood samples are found using the most recent image processing methods. A collection of blood samples that are grouped is the end result of the suggested system. As a result, the suggested approach enhances society while effectively influencing medical diagnosis.

III. METHODOLOGY

The proposed strategy to identify blood group initiates by acquiring various real-time blood group images and forming a dataset as shown in figure I.

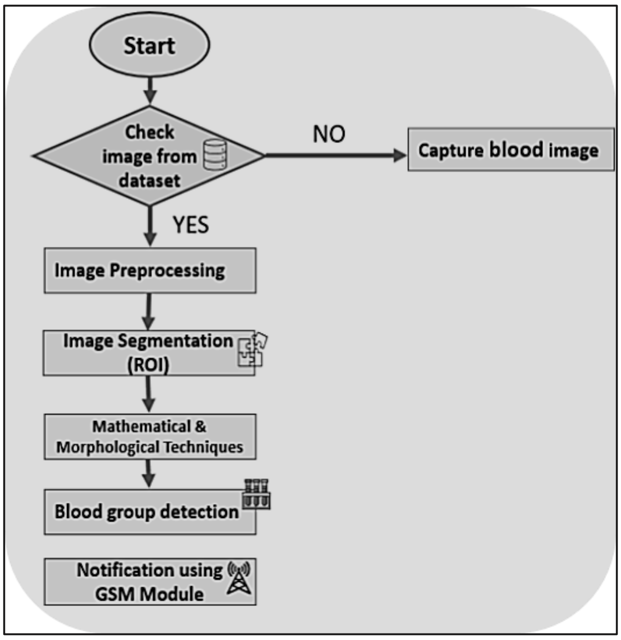

Figure I: Basic Flowchart for Research Methodology

After dataset collection, the second step is to preprocess the images to enhance the features of blood. The third step is to segregate the region of interest. Successively, mathematical, and morphological operations are performed in order to find the particular blood group. Finally, after successful blood group detection message is sent to the patient using the GSM Module.

A. Hardware Module of Raspberry Pi

A Pi camera attached to the Raspberry Pi uses a color picture made up of four blood samples and reagent samples to record the findings of the slide test. This image will be processed using image processing methods created with OpenCV [5].

The process involves installing putty which is an SSH client. Basically, what it does is that it provides remote-controlled access over the Raspberry Pi and displays the command line interface on the computer screen of the user who is trying to access it from their laptop or desktop. All they must do is open the putty, write the IP address to which the Raspberry Pi is connected on their corresponding router, and hit enter.

Once that’s done the software will then ask the user for authorization or verification to make sure that the Raspberry Pi computer board is being accessed by the right person. By default, the username of the Raspberry Pi is “Pi”, and the authorization password is “Raspberry”, but the user can change this any time they want to. Move on, once the user enters the correct username and password for authorization, the putty software then shows the command line interface of the Raspberry Pi computer board on the desktop screen of the user, this way without having any separate display for the Raspberry Pi (since it is a full-fledged computer it requires a display to be worked with) we can still work with it [6], and [7].

B. Global Positioning System Module

GPS stands for Global Positioning System, which allows anybody to acquire accurate position and time information from any location in the entire world with the help of different satellites [8]. The GPS measures the distance from every satellite by subtracting the time signal which parallelly broadcast from the time it was received.

C. Integration of GSM/GPRS SIM800A to Raspberry Pi

Following are the steps needed for integration of GSM/GPRS SIM800A to Raspberry Pi:

1. Put the SIM card into the phone's slot.
2. Connect the Pi's GPIO pins to the SIM800A.
3. Set up the Pi's PPP daemon.
4. To access the device, use software like Minicom.

After that, install and configure, the Point to Point Protocol (PPP) in Raspberry Pi.

D. PI Camera (8MP)

The newest camera attachment from Raspberry Pi is the High-Quality Camera. In comparison to the current Camera Module v2, it provides increased resolution (12 megapixels compared to 8 megapixels), and sensitivity (about 50% more area per pixel for enhanced low-light performance) [9]. It is made to work with interchangeable lenses in both

C-mount and CS-mount form factors. Third-party lens adapters may handle various lens form factors.

E. Real-Time Dataset Collection

Initially, image processing techniques are performed in the module including the PI 8MP camera which records the slide test findings as a color picture made up of four blood samples and reagent samples for the training and testing dataset. After acquiring around 950 images various image processing techniques were performed to get the desired segment.

a) Image Buffer:

The basic technique is undertaken to store the array of pixels on which the processing is to be held so that the comparison can be performed between the processed images as shown in figure II.

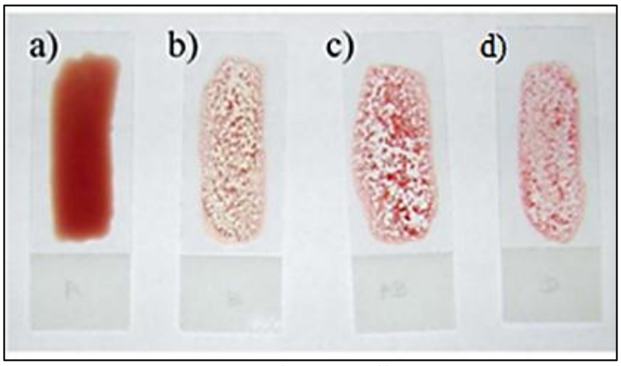

Figure II: The Application of Image Buffer on Image Sample; (a) Reagent Anti-A, (b) Reagent Anti-B, (c) Reagent Anti-AB, and (d) Reagent Anti-D

b) Color Plane Extraction:

It extracts the entire details of the pixels in one single color plane and removes the remaining details about the original image [10]. Therefore, as a result, the image is converted from RGB color to grayscale as represented in figure III.

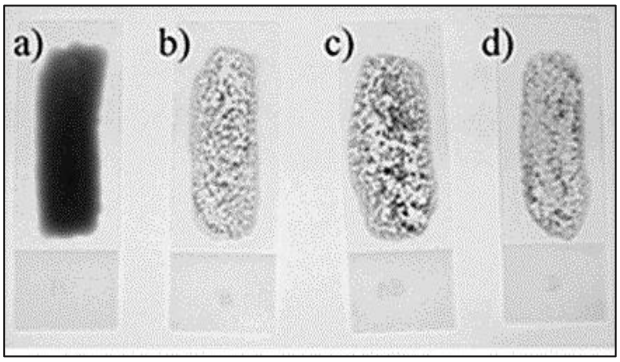

Figure III: The Color Plane Extraction

c) Auto Threshold (Clustering):

Auto thresholding is also known as automatic thresholding used for segmenting which automatically selects the maximum (optimal) threshold of gray levels which results in segregating the region/object of interest in the complete image. Therefore, it segregated the blood pattern as represented in figure IV.

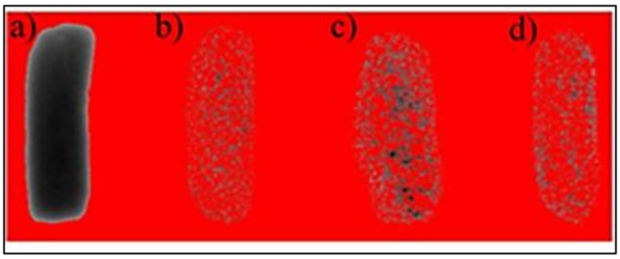

Figure IV: The Image Produced by using the Auto Threshold

d) Local Threshold (Niblack):

The 'Niblack' method moves a rectangle window over the grey-level image to determine a pixel-wise threshold [9]. The equation for computing the threshold is based on the local means and standard deviations of all the pixels in the window.

$$T_{Niblack} = m + (k \times s) \tag{1}$$

Where;

k is set to -0.2, s is the standard deviation, and m is the average value of the pixel in eq. (1). Local thresholding is used when the threshold T depends on both f (x, y) and p (x, y). Using this technique, a primary image is divided into multiple smaller sections as shown in figure IV and figure V.

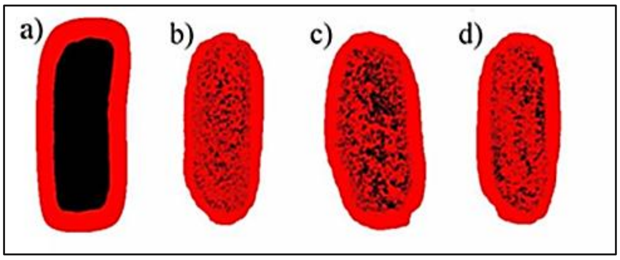

Figure V: Application of Local Threshold: Niblack Function to Generate an Image

e) Advanced Morphology (Fill Holes):

It involves pre- or post-processing procedures like Granulometry, Dilation, Erosion, and Morphological Filtering. Dilation and erosion are the basic processes. The erosion process consistently shrinks the objects' size with respect to dilatation increasing the size of the object relative to its surroundings and objects [10]. Using secondary procedures like erosion and dilation opening and closure are possible. Morphological procedures are used to get rid of ragged and spiked noise edges. To close the openings and gaps, utilize closing operations. It is the dilatation process, which is then followed by erosion [11], and [12].

f) Advanced Morphology (Remove Small Objects):

The technique is used to automate the blood type determination procedure. Make sure that the analysis is performed automatically together with another function later, but that the particle analysis function includes just four particles that correspond to combined blood and reagent as shown in figure VI and figure VII [13], and [14].

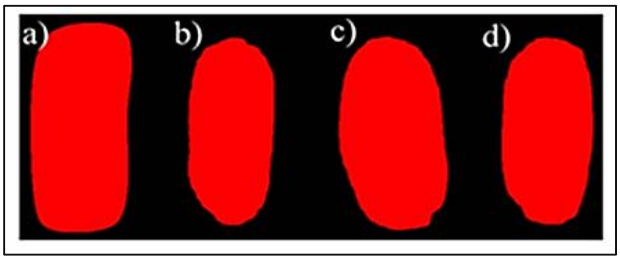

Figure VI: Application of Advanced Morphology to an Image using the Image's Function to Remove Small Objects

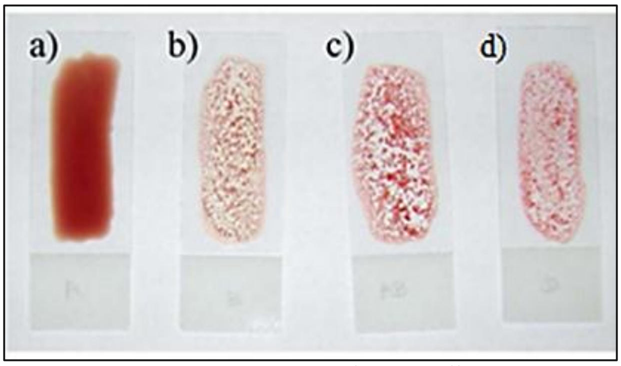

Figure VII: Retrieval of Image Buffer

g) Color Plane Extraction (HSL Luminance Plane and Set Coordinate System):

It represents color, saturation, and brightness. Points in the RGB color space are represented by cylindrical coordinates in this illustration as shown in figure VIII [15], and [16].

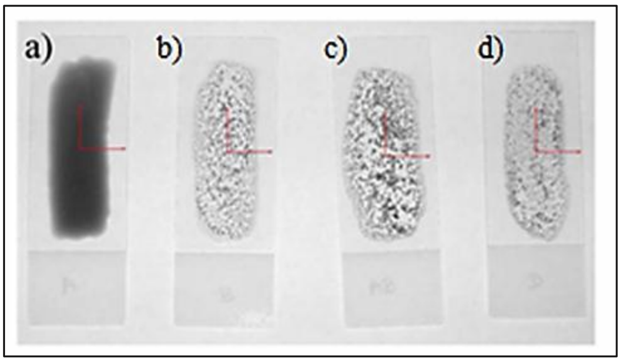

Figure VIII: Image Produced by Applying Set Coordinate System functions to each of the Image's Particles

IV. RESULTS AND PERFORMANCE

The output interface of our system is a graphical user interface implemented in the 'PyCharm' editor which first implements the blood group identification part.

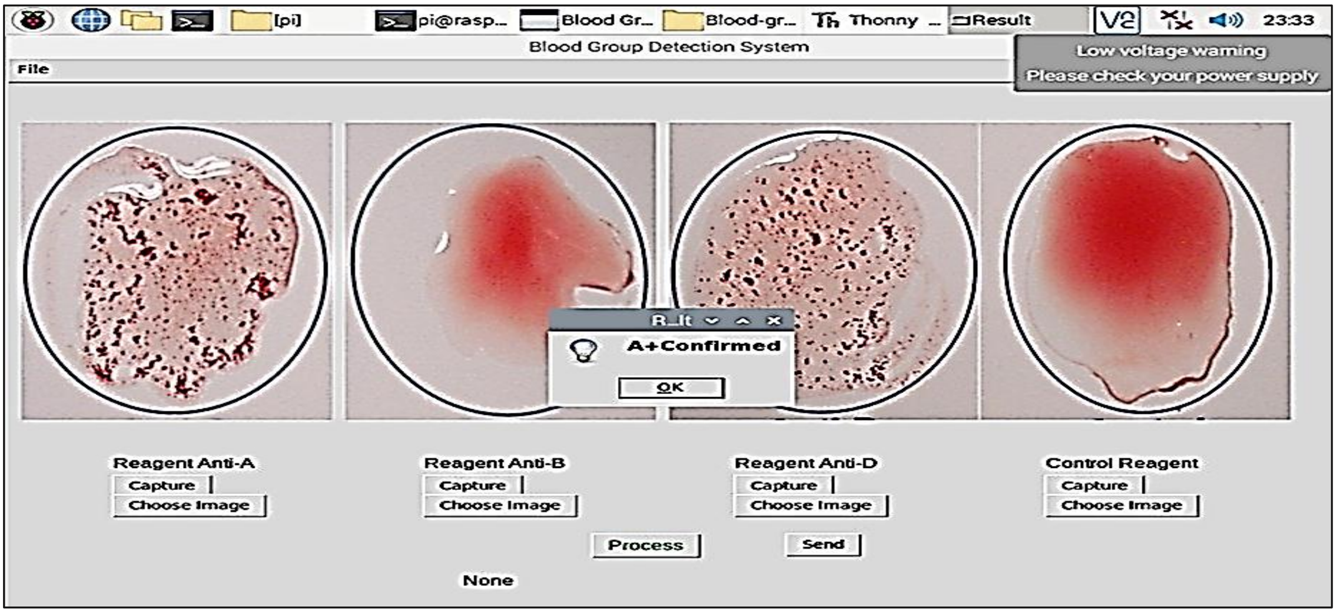

Figure IX: The Output after Performing all Steps of Image Processing

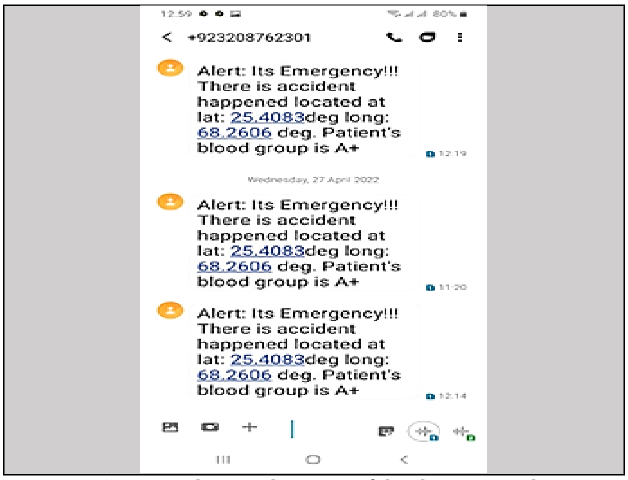

Figure X: Showing the output of the alert generated

On successfully detecting the correct blood group, the device will automatically search the nearest ambulance system/hospital and send the blood group and location of that place using the GSM and GPS to the nearest hospital as well as the hospital system.

This is an output of our device when it identifies the blood group it will generate an alert about that location and blood group to an emergency contact number, in the above image we can see that it will show a message as well as coordinates of the location of that place where is currently our device working, so this a prototype model but we can make it much advance as get more budget on this. See figure IX and figure X for a better understanding.

The experimental findings from this work are presented in this section. By observing figure XI, we can see agglutination occurred in samples (a) and, (c) and in samples (b) and, (d) there was no agglutination. In Anti-D there is agglutination, so it confirms the presence of antigens Rh in the blood sample which makes the blood group polarity positive. Thus, it can be concluded that the blood group is A Positive. The information about blood group and location (Latitude and Longitude) is being sent to the saved number.

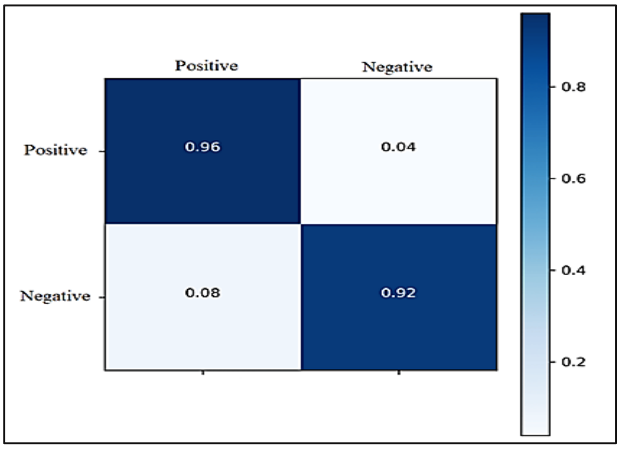

Figure XI: Normalized Predicted Values of Confusion Matrix for Blood Group Identification

The normalized confusion matrix shows the normalized values of true positive, true negative, false positive, and false negative of blood group images. Thus, achieved 90% of precision and 91% of recall using the below formulae:

$$Precision = \frac{True_{Positive}}{(True_{Positive} + False_{Positive})} \quad (1)$$

$$Recall = \frac{True_{Positive}}{(True_{Positive} + False_{Negative})} \quad (1)$$

V. CONCLUSION

The previous experiment's findings provide a reliable method for determining blood type. Such a method of blood type testing is quite useful in an emergency. Arrangement of blood at the right time can also be possible with this system because it notifies the blood group information to the person's family and the hospital. Additionally, it aids the administrator in avoiding potential blood incompatibilities by selecting appropriate blood for transfusion. It can be shrunk down in the future to make it more portable. It can be further automated by automating the mixing of reagents with the blood sample.

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Authors Contributions
The contribution of the authors was as follows: Madeha Memon``s contribution to this study was the concept, technical implementation, and correspondence. The methodology to conduct this research work was proposed by Boby Dewal. Data collection and supervision were performed by Mahaveer Rathi. The Yasra Memon facilitated the data compilation and validation. Knooz Fatima's contribution was project administration, and paper writing.

Conflict of Interest
The authors declare no conflict of interest.

Data Availability Statement
The testing data is available in this paper.

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