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Blood group detection using ML classifier

Suresh Dannana
GMR Institute of Technology, Rajam, Andhra Pradesh, India,

DY Vara Prasad
GMR Institute of Technology, Rajam, Andhra Pradesh, India

***Abstract*---**Determining blood types is very important during emergency situations before giving a blood transfusion. Currently, tests that are performed manually by technicians can lead to human error. As the tests are performed manually, if an inappropriate blood group is detected it can result in the death of an individual. Blood type determination in a short time and without human error is very essential. Many methods are employed which aims at determining the type of blood. The first method developed is determination of blood type using fiber optics. In this method, optical signals are fed into blood sample depending upon the optical variations of different blood groups the corresponding blood group is detected. But, this method fails to find the Rh (positive and negative) type of blood group. The second method employed is classification of blood type by microscopic images. Initially image processing is performed by histogram equalization, and then corresponding blood group is analyzed by Quantification Techniques. In this Technique, the major disadvantage lies in the inaccurate detection of agglutination. In order to avoid these disadvantages a new method Blood group detection using an ML classifier, Support Vector Machine (SVM) is proposed. The proposed system provides accurate and precise without human error in emergencies. It is useful for automatic diagnosis of blood type with accurate and fast response.

***Keywords*---**Blood group, Rh type, Microscopic image, SVM, Histogram.

Introduction

Blood types were discovered in 1901 by Karl Landsteiner of Austria. The ABO blood type and the Rh D blood system [1]-[5] are the most important blood types used to determine a person's blood type, and the test used to determine that blood type is the blood typing. The blood groups are detected based on specific antigen (presence or absence) in the blood cells.

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***Corresponding author**: Dannana, S.; Email: suresh.d@gmrit.edu.in*
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There are four types of ABO blood groups: namely A, B, AB and O. Fig. 1 shows the different blood groups agglutinations. The Blood group 'O' means no antigen present on surface of the blood cells and antibodies namely A and B present in the blood cells[6][7]. The Blood group 'AB' means both antigens A and B present and no antibodies in the blood cells. The Blood group 'A' has antigen A and antibody B in the blood cells, while blood group B has antigen B and antibody A in the blood cells. Referring to Rh D blood group system, one more antigen called Rh D is involved while determining the blood group. If D antigen is present on the red blood cells of a person then he/she is Rh D positive, while one who does not have D antigen on the red blood cells is Rh negative while having a blood transfusion, blood grouping is very important. If there is any incompatibility while transfusing blood, it can be fatal causing intravenous clumping in the patient's blood. Antigens on the red blood cells in the blood of the person receiving blood can be attacked by the antibodies produced in the blood due to incompatibility.

A person with blood type O can safely donate blood to someone with another blood type because the blood does not contain naturally occurring antibodies. Similarly, People with blood type AB can safely accept blood from someone with another blood type because there are no antibodies in the blood. A person with a positive blood type can be given Rh D positive or Rh D negative blood, but a person with a negative blood type can only receive blood from someone with Rh D negative blood. Therefore, one person with O -ve blood type is a universal donor and AB + ve blood type is a universal receiver.

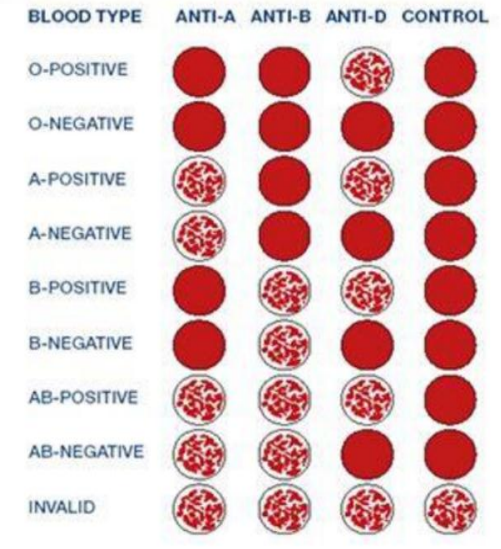

Fig. 1 Reaction of blood samples with different Reagents

Some tests may be needed before the transfusion. One of these tests is to determine the blood type. Some emergencies require immediate blood transfusions because of the risk to the patient's life.Currently available tests require relocation of the laboratory, it may not find time to get the blood type and is administered with blood type O-ve, because it is a universal donor and hence

incompatibility is less likely. However, although there are inconsistent risks, it is sometimes important to minimize the risk of mortality and avoid them.

Therefore, it may be helpful to determine the patient's blood type. Secondly, Pre-transfusion tests are performed by experts and can lead to human error. These human errors can be translated as lethal consequences. It is important to automate the procedure for these tests as it is one of the most common causes of fatal transfusions. Blood type can be determined by using morphological image processing techniques.

Image segmentation can be used to detect the blood group. Features of image such as color, texture, and shape can be analyzed [6][12][13]. By using image processing techniques less quality images and antibody agent analysis can be analyzed. There is a scope for determining blood types using image processing techniques. Image segmentation algorithm for blood type classification and various image processing parameters are analyzed. Image features, such as color, texture, shape are analyzed. Low quality ancient document images and antibody agent analysis using image processing is explained. The slide test is performed by mixing a drop of blood and a drop of reagent, which results in the formation of agglutination or not. Blood type is determined based on occurrence and nonoccurrence of agglutination. Therefore Software developed in imaging techniques can detect agglutination from a captured image after a slide test procedure and, as a result, determine the patient's blood type.

Literature survey

This literature survey gave us an idea about different methodologies, which helps us in keen and deep analysis of blood group detection. This survey helps in understanding advantages and disadvantages of other methodologies which are developed previously.

P. Sturgeon (2001) explains a new method on automatic area classification in peripheral blood smears. In this paper, system integrated algorithm is used for area classification and quality. Here, both cell spreading and cell clumping in terms of individual clumps and the occurrence probabilities of the group of clumps over the images are considered. The disadvantages of this process are observed in decreasing performance when more data is tested. A. Dada, Daniel Beck and Gerd Schimitz (2007) explained that that automated technologies reduce the impact of human error in the blood bank industry and improve the standardization and quality of successful results.

K. Satoh, Y. Itoh (2009) proposed a new approach to detect the blood group by using polymerase chain reaction (PCR)-based methods, such as sequence-specific primers with a positive control (PCR-SSPPC). P. A. Berlitz (2011) demonstrated an innovative automated analytical tool for reproducible, fast and recorded results can be produced in minutes. The disadvantage of this method is that to detect blood type, computers and software must be required. Chemicals and reagents are also needed to determine blood type, so it costs more.

T. M. Selvakumari (2011) illustrated that the blood group detection is made based on optical properties of optical such as absorption. Optical properties will be different for different blood groups. The advantage of this method is that due to the high brightness of the surface plasma, a smaller blood drop is enough for testing. The major disadvantage is that RH Positive and negative (+ve and –ve) cannot be predicted.

Gerda J. Edelman (2013) proposed a novel approach on the practical implementation of bloodstain age estimation using spectroscopy. SM. Nazia Fathima (2013) proposed a semi-automated system to classify blood types by using microscope color images. This paper deals with both ABO and Rh blood typing systems. T. Zarifi, Mahsa Malek (2014) demonstrated that a hardware implementation of image processing algorithm for determination of blood groups. By using edge and contrast of agglutination identify the blood group. This is reliable because it used FPGA based algorithms in combining with image processing techniques. Prof. R. A. Rathod, Rubeena A Pathan (2016) proposed SIFT (Scale Invariant Feature Transform) algorithm which converts an image into many local vectors. Each vector is invariant to the operations of image such as scaling, translation and rotation. A. Mujahid, F. L. Dickert (2016) states that the transfusion test is essential to verify the compatibility between the blood groups of the donor and the recipient. Overall, in all cross-matching tests, agglutination was observed to monitor the chemical reaction of antibodies containing erythrocyte antigens.Y. Dong, W. Fu, Z. Zhou, N. Chen, M. Liu and S. Chen (2017) illustrated a method based on image features to identify the blood group, it is a quick, accurate. J.C.D. Cruz, R.G. Garcia, A.V.C. Diaz, A.M.B. Dino, D.J.I. Nicdao, and C.S.S. Venancio (2019) proposed a device works on principles of image processing to identify blood group which is portable.

Methodology

Digital images of blood samples contain reagents that are mixed with blood cells. After a while, agglutination may or may not occur. After agglutination, the slide test is to taken place and allows it to be run in the MATLAB. Using this system, humans are more prone to making mistakes.

Initially, three drops of blood with added reagents on slide are captured by using a digital camera [10]. The picture which is stored in JPEG format. The steps involved in image processing [13]-[20] are shown in the Fig.2.

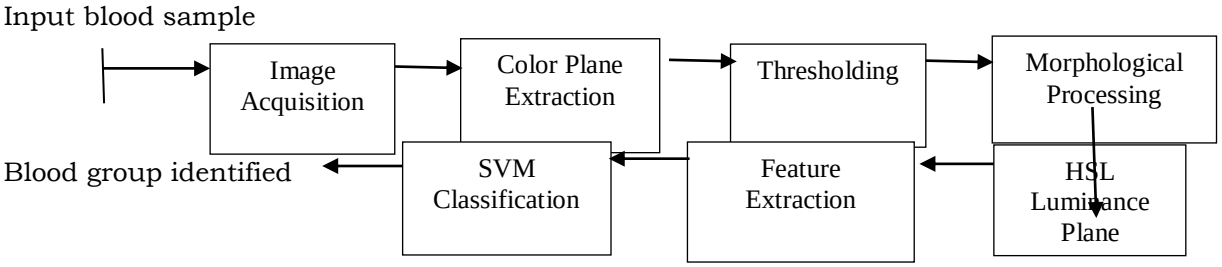

Fig. 2 Block diagram of the Blood group detection using SVM Classifier

Image acquisition

Three samples of blood are taken on a slide, each mixed with reagent anti-A, anti-B, anti-D respectively and images of slide are taken [8]. Fig. 3 shows the samples of different blood groups are collected from the laboratory. The following are the pictures of blood samples which are captured by the camera and stored in .JPEG format.

Fig. 3 Blood Samples of AB+ group

Image segmentation

In this process digital image is divided into different sub-images called image objects which reduce the size and complexity of the image so that analysis will become simple. Fig. 4 shows the output after segmentation.

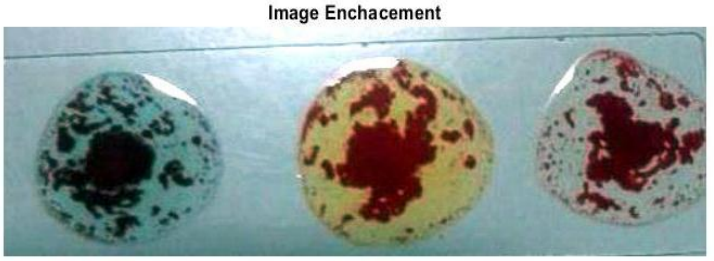

Fig. 4 Output after image segmentation

Gray conversion

A Grayscale image can be viewed as a single layered image. A grayscale image have only two colors white and black. Grayscale images makes algorithms simple and easy, in turn which reduces number of computations. Fig. 5 shows the grey colored image of blood.

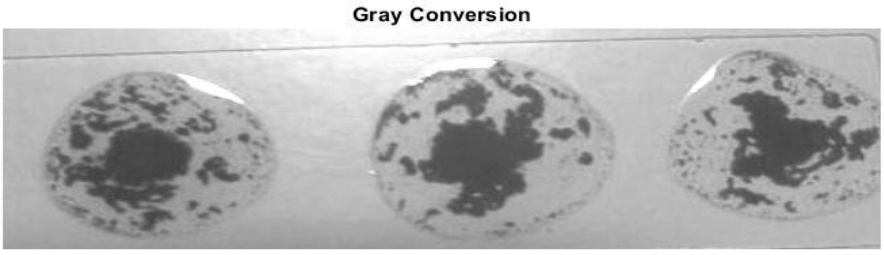

Fig. **5** Image after performing Gray Conversion

Thresholding

Thresholding converts color or greyscale image into binary image, which makes algorithms simple and thresholding is used to select the particular area of image which is needed and other parts can be ignored.

Fig. 6 Output after performing Thresholding

Here, Fig. 6 indicates the binary image, in which the pixels are made of one two colors namely black and white. The white pixels are those whose pixel intensity is greater than or equal to threshold and the black pixels are those whose pixel values are less then threshold.

Morphological processing

Morphological Operations on image is done based on their shapes. In a morphological operation, pixel and neighborhood pixel information is considered to estimate the shape of the image.

Fig. 7 Output after performing Morphological Processing

As shown in the Fig. 7 the edges, boundaries of an image are clearly visible to us after performing Morphological processing. The outline of the image got highlighted.

HSL luminance plane

HSL is a more intuitive and human way of understanding color as compared with RGB, which is more technical in the way colors are produced. Fig. 8 shows the Image after HSL extraction.

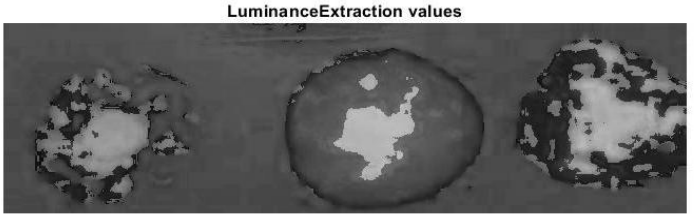

Fig. 8 Image after performing HSL extraction

Support Vector Machine (SVM) classifier

SVM classifier is one of the Machine Learning classifier, worked on the principle of hyperplanes that identifies the boundaries or features in input space. SVM finds linear vectors from data vectors which are trained by using supervised learning algorithms. Hyperplanes in SVM classifier splits the samples as positive and negative samples. Based on closest negative and positive samples linear separator is drawn in hyper planes. However, it draws a line based on training data, which is may be correct for the testing data. Multiclass SVM aims to assign indexes to models using reference vectors extracted from a very limited set of elements. An obvious approach to doing so is to reduce the multiclass problem to binary classification problems.SVM is machine learning algorithm under the category of supervised learning. SVM can be used in both classification and regression type problem statements. SVM finds the boundary which is optimum to classify the data. In other words, SVM uses the optimum and complex algorithms depending on the problems, and based on those algorithms, it tries to maximize the separation boundaries among data points.

Classification using SVM

In most of the cases SVM classifier [21] do the binary classification. In multi classification, data is divided into subgroups and do the binary classification. In other words we can say that SVM does not do the multi classification. The following are dominant methods to obtain multi- classification using SVM classifier.

- One vs One approach
- One vs All approach

One vs One (OVO) approach

Algorithm:

1. Divide the multiclass classification into sub problems i.e., binary classification

2. Perform binary classification for each pair of data points
3. By using majority voting and distance from margin get the confidence criterion.
4. Predict the classification for test data by using above steps.

This technique breaks down our multiclass classification problem into sub problems.

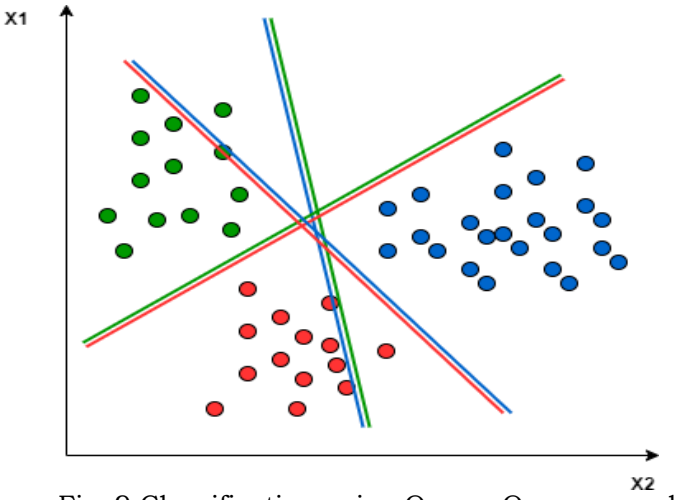

Fig. 9 Classification using One vs One approach

In this approach, separation is done between two pairs only. Other (third) points are omitted. This is the major problem in this approach. One more is that, it trains so many SVM's.

One vs All (OVA) approach

In one-vs-All approach, P number of binary classifiers are needed for P- class instances dataset. The number of labels in data set must be same as number of generated binary classifiers in problem statement.

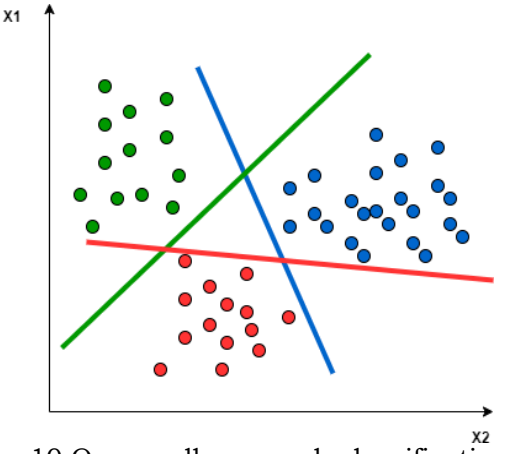

Fig. 10 One vs all approach classification

Results and Discussions

Initially training data is executed and the features are extracted using Grey Level Co-occurance Matrix (GLCM), Color histogram Techniques. The remaining images are then classified using Multiple SVM Classifier. The training data set consists of 20 images, and the testing data set consists of 4 images.

Detection of blood groups

Initially, the image is processed using image enhancement technique to resize the image to required size and then the green plane extraction is done. The green plane extracted image undergoes gray level conversion since in the gray level conversion only 8 bit is required to store a single pixel of the image. Now, thresholding is performed to convert the image into binary image which consists of white and black pixels and then dilation operation is done to expand the pixels in the image. Extracted first order features like Mean, standard deviation, variance, Entropy, skewness using GLCM, Color histogram techniques and stored them in the form of matrix. The features are extracted from the training data set which consists of 8 classes of different blood groups. Testing image is taken and using Multiple SVM classifier the features of testing image data is examined with the features obtained from training data set. Here, the different features of testing data set of A+ blood group like Mean, variance, skewness etc. as shown in the Table 1 matched with the extracted features of A+ blood group in the training data set. Hence, this can be concluded as A+ blood group. From the Fig. 11, if the blood sample forms agglutination with Anti A, Anti D then it is identified as A+ blood group.

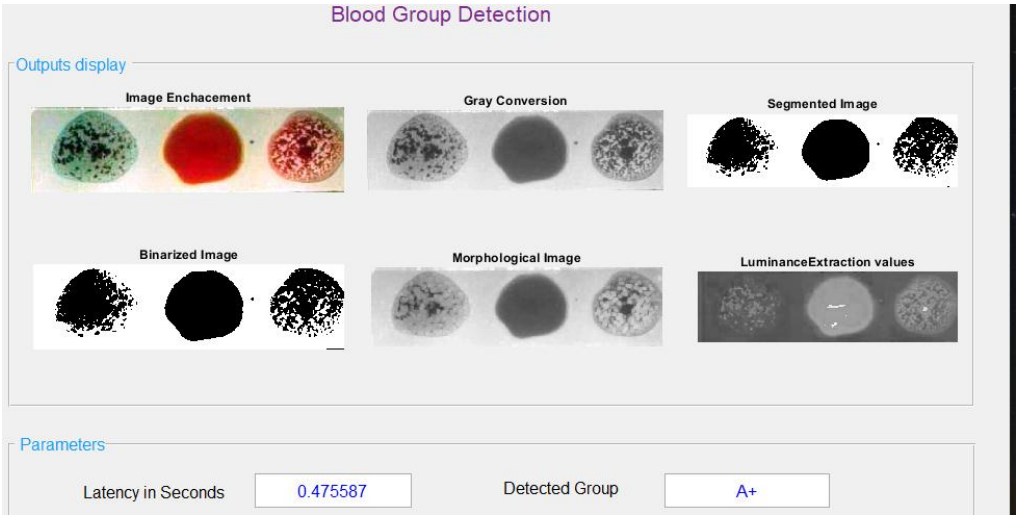

Fig. 11 Detection of A+ Blood group

From the Fig. 12, theoretically it can be confirmed that if the blood sample forms agglutination with Anti B then it is identified as B- blood group.

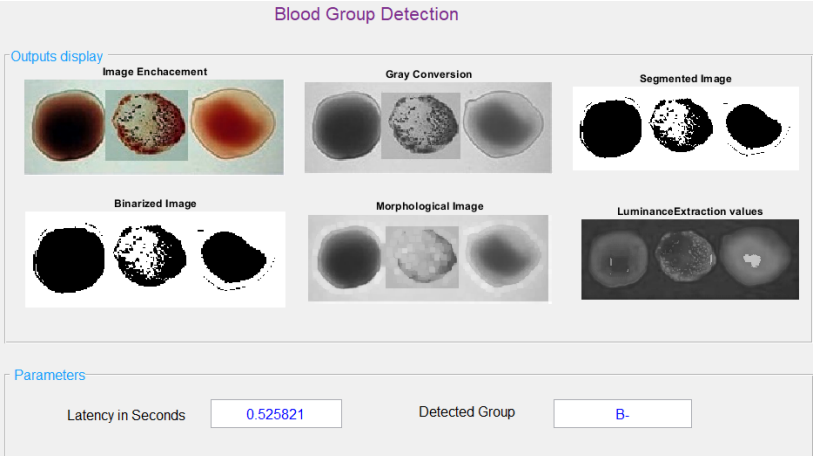

Fig. 12 Detection of B- Blood group

From the Fig. 13, theoretically it can be confirmed that if the blood sample forms agglutination with Anti A, Anti B, Anti D then it is identified as AB+ blood group.

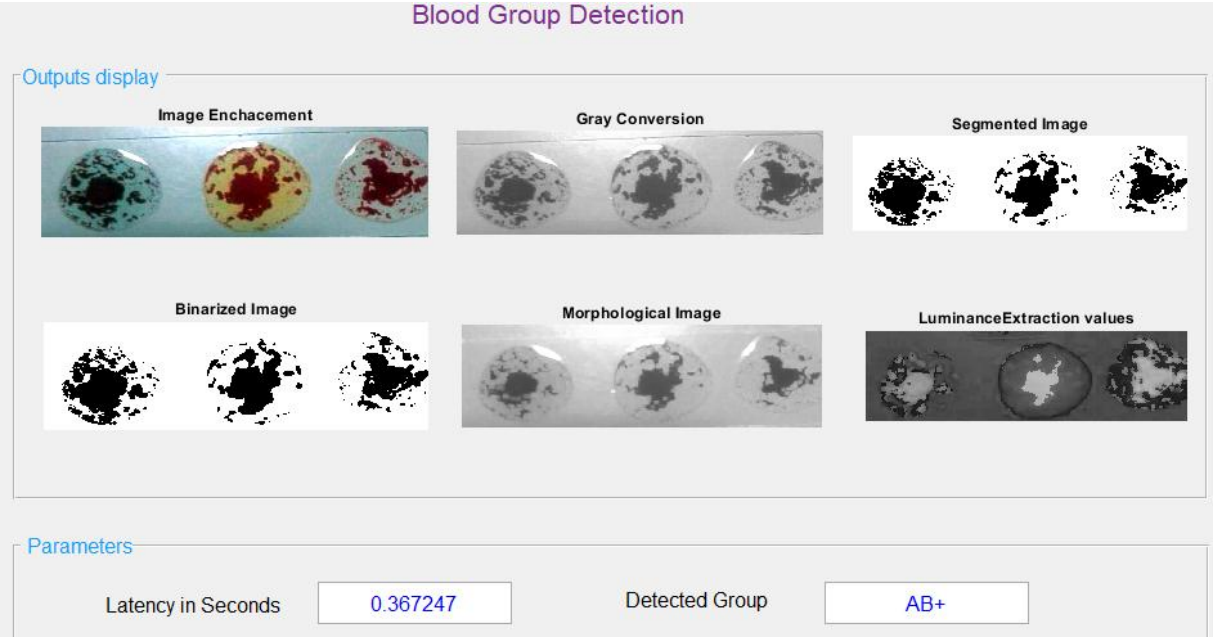

Fig. 13 Detection of AB+ Blood group

From the Fig. 4.7, theoretically it can be confirmed that if the blood sample forms agglutination with Anti D then it is identified as O- blood group.

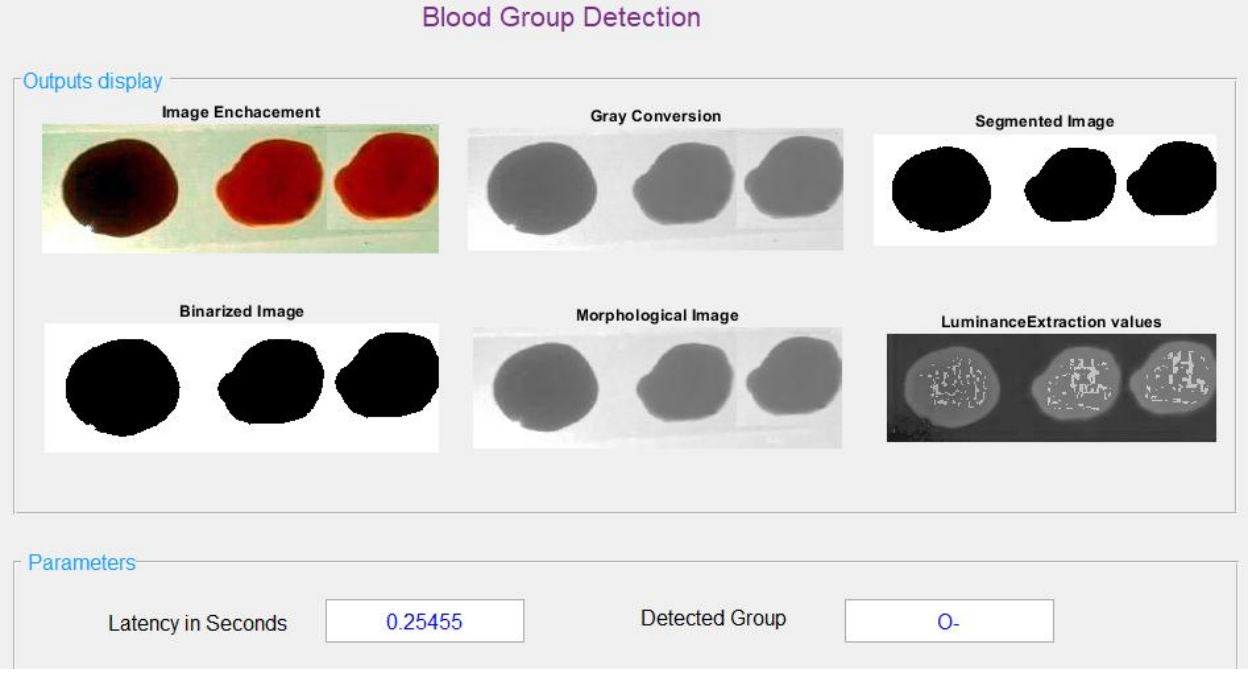

Fig. 14 Detection of O- Blood group

Table 1
Values of extracted Features for different Blood Groups

Blood Group	Mean	Standard Deviation	Entropy	Variance	Kurtosis
A +	0.494563	0.49997	0.999915	0.147778	1.00047
A -	0.483357	0.499723	0.999201	0.147757	1.00444
B+	0.35844	0.479542	0.941381	0.145501	1.34857
B-	0.502559	0.500007	0.999981	0.201589	1.0001
AB +	0.214934	0.410776	0.750808	0.14469	2.92637
AB -	0.35900	0.479707	0.94185	0.1458	1.34558
O +	0.388103	0.487318	0.963564	0.150247	1.2109
O -	0.541464	0.498278	0.995034	0.182798	1.0277

Table 1 shows the values of extracted features such as Mean, Standard deviation, Entropy, Variance, Kurtosis for different types of blood groups. These parameters are stored as a matrix in the training data and the values of obtained parameters are cross checked with the values of the testing data using Support vector Machine (SVM) classifier.

Table 2
Calculation of Parameters

Blood Group	No. of samples tested	No. of samples whose blood group is correctly identified	Recognition Rate (%)
A +	13	12	92
A -	20	18	90
B+	15	14	93
B-	11	10	91
AB +	5	5	100
AB -	9	8	89
O +	20	19	95
O -	9	8	89

Table 2 shows the no of blood samples which are taken for the detection and no of blood samples which are detected accurately**.** Here, Recognition or accuracy rate is calculated individually for individual blood groups.

Conclusion

The proposed methodology of "Blood group detection using ML classifier" involves image processing techniques like Color plane extraction, thresholding, morphological processing and HSL Luminance extraction. Due to the usage of image processing techniques, image is very well processed and is highly suitable for feature extraction. Here, the feature extraction techniques like gray level co-occurrence matrix, color histogram method are used. They aim in extracting features like mean, variance and standard deviation accurately. Since, eight classes of images are used in training data set, no of features extracted are high. The usage of SVM classifier makes the process of blood group detection much faster. From the results, it can conclude that this process is highly used in emergency situations as the time taken for blood group detection is less than one minute which in turn indicates high computational speed. Instead of going to the hospital for blood test, which is time consuming at the times of urgency, people can make use of this project and can detect their blood at the home itself. In future, it is intended to improve the system by incorporating GSM technology to send the message to the mobile of lab technician to avoid unnecessary travel.

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