Image Processing Based Detection & Classification of Blood Group Using Color Images

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Abstract: - Domain **of image processing is progressing a lot and has achieved tremendous milestones. Image processing is helping in many ways for the researchers to achieve their goals especially in security and medical fields. Detection of blood group in disaster or remote areas where expert is unavailable is challenge. In this paper we have proposed a system which will detect blood group using image processing techniques. Steps to detect the type of blood group using image processing techniques are discussed. Successful results have been obtained and accuracy of the proposed system is optimal**

Keywords-component; Blood Group detection ; blood group type identifier ; Image processing; Histogram; Segmentation;

I. INTRODUCTION

The field of Image processing has gone through tremendous useful changes in the recent few years. Medical imaging plays a vital component these days in various application used in the field of medical and is providing a great relief to the people associated to this field in terms of time and the efforts used. Various diseases have been identified using image processing techniques [1-3] and thus have provided early phase detection and helped the doctors to cure the disease. In [1] Alireza, et al have worked on Automated identification of diabetic retinal exudates in digital color images, in [2] Veropoulos, K., et al have worked on The automated identification of tubercle bacilli using image processing and neural computing techniques and in [3] authors Yun, Wong Li, et al have Identified different stages of diabetic retinopathy using retinal optical images. A lot of time is saved by the using image processing technique.

II. LITERATURE REVIEW

Blood is one of the important fluid in human body, which transport oxygen and nutrition to body. However, beside this blood performs pH regulations, different immunological function. Any form of blood is composed of three major types, red blood cells (RBC) oxygen carrier and (WBS) which helps fight infection and aid in the immune process. Third important component is Platelets which is yet another important substance in blood composition. It helps to clot the bleeding if any injury occurs. In the case of emergency if patient suffers from critical injury and large part of blood is loss, a blood transfusion is required. In some cases, a fluid like substance known as Saline solution is replacement of blood. However, in some cases RBC have to be restored, and transfusion is the correct procedure which should be performed. In this advance 21st century more than 30 blood groups have been discovered so far. The scientist has given different categories to them. Among 30 blood groups ABO is the most important blood group. It is classified by the presence and absence of A and B antigens in the blood of human.

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 [4]. There are different viruses in blood which encounter life threatening disease which can be spread by blood transfusion, diseases such as HIV/AIDS, anemia, HBV & HCV etc. [5]. However, there are different emergency situation around the globe round the clock in which patient's life is in danger and they need blood transfusion immediately. Before any blood transfusion, the exact determination of the blood type is important. Collecting the blood sample at that time and getting to known the correct blood type of patient is impossible when they are in remote or disastrous areas where access to the hospital will take time. In such critical situation it is impossible for doctors or paramedical staff to carry blood in ambulances. It is important to manage the correct blood and transfuse to the patient in right time. The current system requires blood to be tested in laboratories [6]. Mismatch of the blood type can lead to the agglutination, and the reaction of the blood can cause sudden death of the patient. Despite this risk can be covered by transfusing 2 units of universal donor's O negative blood only in emergencies to any different blood group humans. Since small human error can be fatal in case of blood transfusion. So it is very important to get automate these blood group identification procedures and get accurate results in case of emergency. [7].

Several systems have been developed Auto-Grouper [8], Olympus PK 7200 [9, 10], Ortho Auto value Innova System [11], Tango Automated Blood Bank [12]. Technicon Auto Analyzer II [13], Techno Twin Station [14], Immucor Galileo [15] and many others but so far, there is no such system which will tell the blood type without delay and delivers result in time [16]. Thus in this paper we have proposed a system which will identify the blood type, give accurate result in short interval of time. Traditional medical lab procedure concludes the result by looking at a reaction's output comprising of the following steps

- Place the blood samples on a white plate
- Place anti-serums and blood samples with a stick
- Mix both anti-serums and blood samples
- Wait until the reaction takes place
- Conclude the results by looking at the output

This process takes time and an expert to perform this procedure. Thus in disasters it is difficult to perform the task as experts are hard to find, thus in that situation an application based on image processing technique will be very useful and will provide accurate results.

III. PROPOSED SYSTEM

In this paper automated blood-group detection is discussed using image processing techniques that may be used by a lab technician or a novice user with no prior knowledge to blood group detection technique. All they need to do is to put the blood on the white plate and mix it properly with anti-serum and finally take an image. The system will be able to process the image and gives the final result in no time that is the exact blood-group. The main steps involved in this application will be as follow

1. Image Acquisition
2. Image Pre-Processing and Segmentation
3. Detection of Blood Group Type

A. Image Acquisition

We acquired images of test slides by using a digital camera as shown in figure 1. Slides contains blood sample mixed with antiserum. The image is loaded in our proposed system in MATLAB for further processing.

Fig. 1. Image acquired using digital camera during blood test at laboratory

B. Pre-Processing

Preprocessing step includes resizing of the image to bring it into a specific format. It includes conversion of image from RGB to HSV, HSV to gray scale, gray scale to binary image and then segmentation of processed image into region for post-processing by using advanced morphological operations as discussed below.

1) HSV conversion

HSV conversion is based on color characteristics as purity, family and intensity (or tint, shade and tone). The coordinate system is cylindrical, and the colors are defined inside a hex cone. The hue value ID between 0 to 360º. The saturation S is the degree of strength or purity and is from 0 to 1. Purity is how much white is added to the color, so S=1 makes the purest color in which there is no white color. Brightness V also ranges from 0 to 1, where 0 is the black. So Converting image in HSV space is for the better visualization. V channel is used to convert this image as shown in the figure 2 because it gives more precise picture for segmentation and take us closer to our goal.

Fig. 2. Conversion of RGB image into HSV and taking 1st frame of HSV sapce image

2) Binary Conversion

Then this HSV image is converted to binary image. We are calculating a global threshold level which we are using to convert the grayscale image into binary image. The result of conversion is shown in figure 3(A)

3) Morphological opening operation

We applied some basic morphological operation on the binary image to remove any imperfection and reform the image for better further processing.

At this stage we are performing morphological opening operation, which will remove the small components like (spurs, noise and outliners) from the processed image. The morphological open operation is an erosion followed by a dilation, using the same structuring element for both operations and is defines by equation 1

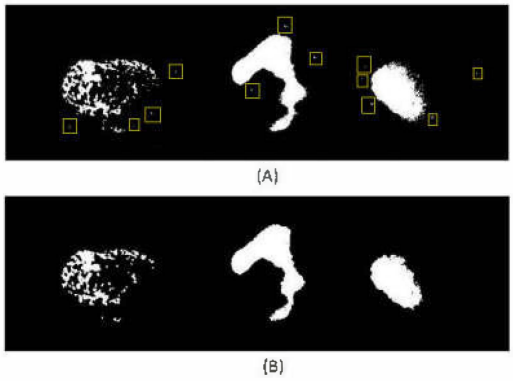

Fig. 3. (A) Converting HSV 1st frame into binary (B) Applying morpholoigal opeations to remove small components

$$A \circ B = (A \ominus B) \oplus B \qquad (1)$$

Where θ and $\oplus$ denote erosion and dilation respectively and A represent the image and B is the structuring element. Result of these morphological operations are shown in figure 3(B)

4) Histogram

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. Vertical Histogram is drawn by the following equation. Method of calculating vertical histogram is as followed

$$h(img) = \sum_{i=1}^{c} \sum_{j=1}^{r} whitepixel_j \qquad (2)$$

According to equation 2, for each column *"i"* and each row *"j"* of that column, we calculated total number of white pixel. After calculation a histogram will be generated as depicted in figure 4(A). Then we will smooth this histogram by using a dilation function which is defined by equation 3.

$$A \oplus B = \bigcup_{b \in B} A_b \qquad (3)$$

Where A is the array (Histogram array) being processed and B is the structuring element. This operation in result will give us the smooth edges of the histogram as show in figure 4(B). This histogram will be used for cropping the region of each blood mixture.

a) Derivative of Histogram

To get the information regarding the coordinates of the edges of histogram, we will take the first derivative of the histogram shown in figure 4(B). According to the definition of first derivative it gives zero value in flat segments, nonzero values at the onset of pixel values step or ramp and nonzero value along ramps. Formula of first derivative forward difference is depicted in equation 4

$$\frac{\partial f}{\partial x} = f(x+1) - f(x) \qquad (4)$$

According to equation 4 we are subtracting the next pixel value from the current pixel value. This method will give us a sharp edge where the value of pixels is changing rapidly. So, by using this method we will get the information of starting coordinates and ending coordinates of each spike in the histogram. It actually shows the area of blood sample regions in the processed image. Interpretation of this step is showed in figure 4(C). We can clearly see that where region is starting there we are getting a positive spike which shows all value of pixels changing from 0 to 1. Where region is ending, we are getting a negative peak which shows the ending point of region as shown in figure 4(C)

5) Segmentation

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 figure 5.

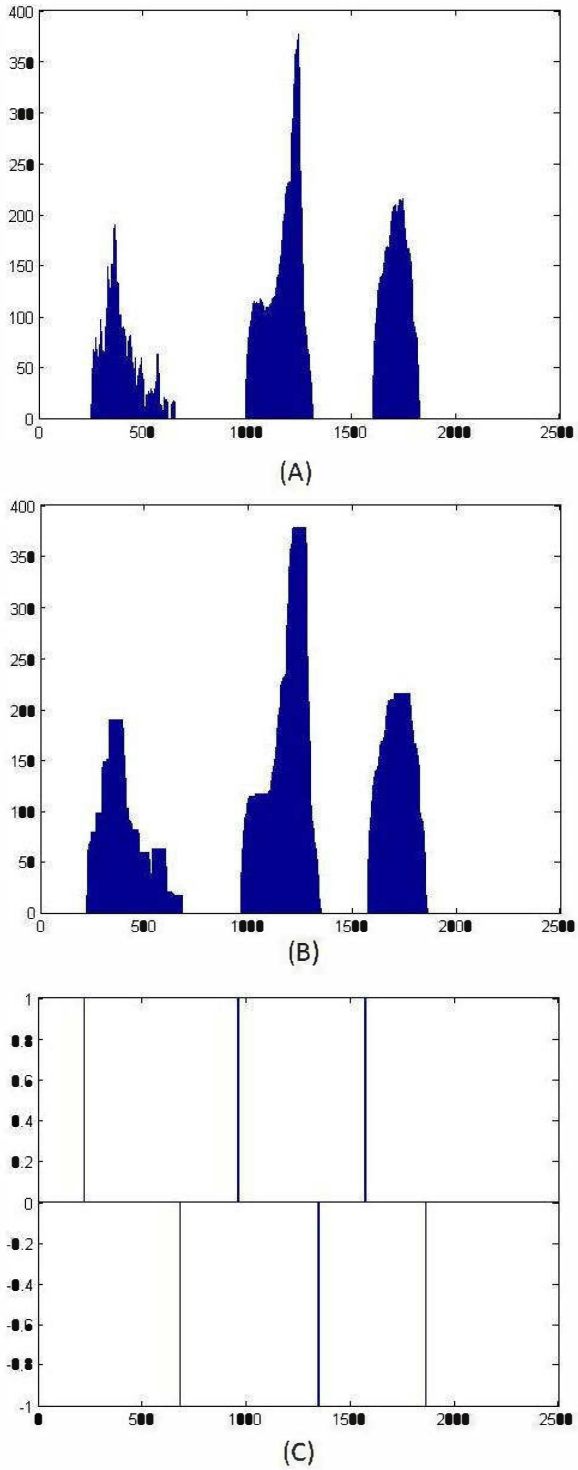

Fig. 4. (A). Developed Histograms of Processed B/W Image. (B). Smooth Curves Histrogram after performing dilation (C). Derivative of Histogram which will give the information of starting and ending position

Fig. 5. Segmented Image using the derivative information of developed histogram

C. *Blood Group Detection*

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

These two properties clearly define that blood region which is distorted must have less white pixels (means less red components) and should have more number of elements in the image. By the using these two properties we can easily detect the distorted part in the segmented image. Figure 6 to figure 8 shows original captured images and segmented images of all blood group types.

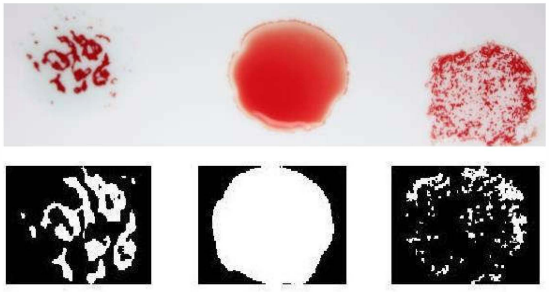

Fig. 6. Original and Segmented Image of A Positive Blood Group type

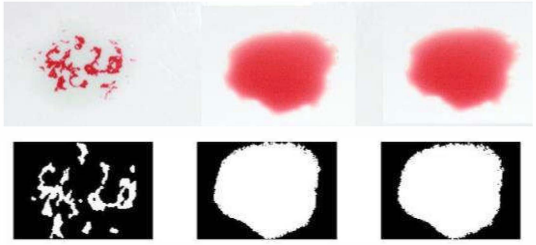

Fig. 7. Original and Segmented Image of A Negative Blood Group type

Table I shows the density (No. of white pixels) in each of the above given segmented part of the images and table II shows the number of objects (Red blood cell regions) in the

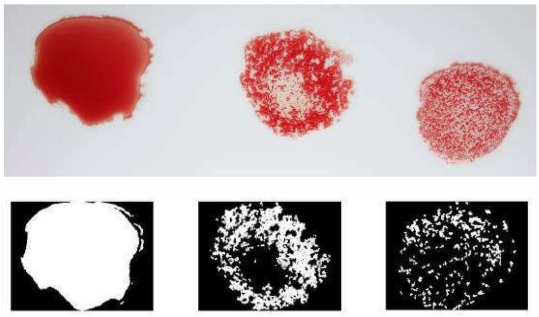

Fig. 8. Original and Segmented Image of B Positive Blood Group type

each segmented part of testing image. By doing a careful examination we can set a threshold values on these two properties which can help us to detect the region as distorted or non-distorted. From our experimental result we have set the density threshold value of 13000 and number of objects threshold value of 5. 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 I. DENSITY OF WHITE PIXELS IN TESTED IMAGES

	Density of White pixels in Region One	Density of White pixels in Region Two	Density of White pixels in Region Three
Figure 6 (A+)	7202	43092	5359
Figure 7 (A-)	3011	21140	19126
Figure 8(B+)	36798	12654	9452
(B-)	48953	9021	47659
(AB-)	5961	6978	35725
(AB+)	6544	7545	6268
(O+)	41758	42565	8785
(O-)	33758	33720	32656

TABLE II. DENSITY OF WHITE PIXELS IN TESTED IMAGES

	No. of objects in Region One	No. of objects in Region Two	No. of objects in Region Three
Figure 6 (A+)	18	1	145
Figure 7 (A-)	29	4	4
Figure 8(B+)	4	122	312
(B-)	3	59	4
(AB-)	19	126	3
(AB+)	20	130	125
(O+)	4	4	77
(O-)	1	1	3

TABLE III. BLOOD GROUP IDENTIFICATION CRITERION

Anti-A	Anti-B	Anti-C	Blood Type
0	0	1	O – Positive
0	0	0	O – Negative
1	0	1	A – Positive
1	0	0	A – Negative
0	1	1	B – Positive
0	1	0	B – Negative
1	1	1	AB – positive
1	1	0	AB – negative
1	1	1	Not Valid

After the detection of the distorted parts basic procedure of blood detection is further used. If first part is distorted and other two are complete then it is A- and if first part is distorted along with the third image, then it is A+ as shown in Table III (1 represent distorted & 0 represent complete). The algorithm of proposed system is stated below:

Algorithm 1 Classification of blood groups algorithm

Input: Image I.
Output: Classification of Blood Group using color images I .
$I \leftarrow 1$
$I_1' \leftarrow$ 1Complement of the image
$hsv = rgbhsv(I)$
$I_1 = Im2bw(I, value)$
$I_1 = hsv(value)$
$I_2 = Im2bw(I, value)$
$I_3 = bwareaopen(imopen(I_2, strel('disk', Value)), value)$
$I_3 = calculatinghistogram$
$[rc] = size(value)$
for $i = 1 \leftarrow 1 : c$ **do**
  for $j = 1 \leftarrow 1 : r$ **do**
    if I_3(j,i)==1 **then**
      $ForeachRandCitiscountingthenumberofwhitepixel$
      $ver_hist_value(i) = vertical_hist_value(i) + 1$
    end if
  end for
end for
histrogram smoothining is being performed to I_3
$Structuralelement = strel('Line', Length, angulardegree)$
$Takingderivativeoffinalhistogram$
for $i = 1 \leftarrow length$ **do**
  if $Vert_hist_value$(i)==0 **then**
    $x = x + 1$
    $flag = 1$
  else if Flag=1 **then**
    $zero_index = zero_index + 1$
    $array_zero(zero_index) = x$
    $x = 0$
    $flag = 0$
  end if
end for
$Eachbloodsampleimagewillbecroptheresultantimage willbestoreinnewtag$
for $I \leftarrow 1 : 1 : 3$ **do**
  $Inew(:,:,i) = imcrop(I_6, [area_start(i)1(area_end(i) - area_start(i))r]$
  $subplot(1,3,i), imshow(:,:,i))$
end for

The algorithm 2 is reflecting the feature extraction and blood group classification methodology which we have adopted for blood group classification.

Algorithm 2 Blood classification

Require: Resultant imageI_3
$Calculatingdensityofwhitepixels$
$area_1 = bwarea(I_3new1)$
Same will be done for each Image
$area_1 = bwarea(I_3new11)$
it will calculate the number of high pixels in resultant image
for $i \leftarrow 1 : 3$ **do**
  if num(i)>=5 AND area(i)<13000 **then**
    $anti(i) = 1$
  else
    $anti(i) = 0$
  end if
end for
if anti(1)==0 AND anti(2)==0 AND anti(3)==0 **then**
  $Bloodgroupis0-$
else if anti(1)==0 AND anti(2)==0 AND anti(3)==1 **then**
  $BloodgroupisO+$
else if anti(1)==1 AND anti(2)==0 AND anti(3)==1 **then**
  $BloodgroupisA+$
else if anti(1)==1 AND anti(2)==0 AND anti(3)==0 **then**
  $BloodgroupisA-$
else if anti(1)==0 AND anti(2)==1 AND anti(3)==1 **then**
  $BloodgroupisB+$
else if anti(1)==0 AND anti(2)==1 AND anti(3)==0 **then**
  $BloodgroupisB-$
else if anti(1)==1 AND anti(2)==1 AND anti(3)==1 **then**
  $BloodgroupisAB+$
else if anti(1)==1 AND anti(2)==1 AND anti(3)==0 **then**
  $BloodgroupisAB-$
end if

IV. EXPERIMENTAL RESULTS

The evaluation of proposed system is performed on a locally gathered dataset of patients. These images are captured using a simple digital camera. These images are manually labeled. The dataset contains a total 80 images obtained from the blood samples that have already been tested manually and blood group of all these images are known already. In this dataset 10 images from each blood group type are taken. Images are processed through the application and checked if the results match with manually generated results or not.

Different performance measures like sensitivity (true positive rate), specificity (true negative rate) and overall accuracy are used to determine the validity of the proposed system. equations 5-7 can be used to validate the parameters.

$$Sensitivity = \frac{TP}{(TP + FN)} \quad (5)$$

$$Specificity = \frac{TN}{(TN + FP)} \quad (6)$$

$$Accuracy = \frac{(TP + TN)}{(\mathrm{TP} + TN + FP + FN)} \quad (7)$$

Where

- TP are true positives, meaning blood group belonged to that group and is correctly classified.
- TN are true negatives, meaning blood group did not belong to that group and is correctly classified.
- FP are false positives; blood group did not belong to that group but is wrongly classified to that group.
- FN are false negatives; blood group belong to that group but is not classified to that group.

Table IV shows the confusion matrix for the whole dataset and the performance parameters calculated through these values are given in table V.

TABLE IV. CONFUSION MATRIX

	Blood Group Match	Blood Group Mismatch
Correct Blood Group	79 (TP)	1 (FP)
Incorrect Blood Group	1 (FN)	79 (TN)

TABLE V. EVALUATION RESULTS OF THE PROPOSED SYSTEM

Total Images	Correctly Classified	Sen	Spec	Accuracy
80	79	0.9875	0.9875	0.98

V. CONCLUSION

In this paper a system is proposed capable of detecting the type of blood group using MATLAB algorithms. Colored image taken from a digital camera was uploaded in to MATLAB application and was converted to HSV format V channel was used for the conversion. Then threshold technique was applied and image was rendered leading to the development of histogram then taking the derivative and focusing the area of the blood image. And then using this processed image blood group was classified.

In future a small hardware device can be made like diabetes checking machine that we see in our daily life and that small machine could be used by novice users in disaster or other remote areas where expert staff is not available.

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