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# Real Time Blood Type Determination by Gel Test Method on an Embedded System

**Enes Ayan *[1], Erdem Kamil Yıldırım [2]**

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***Abstract:*** This Determination of a blood type has a crucial importance for blood transfusion. Therefore it is mandatory doing tests to determine blood type before the transfusion. In order to prevent the errors in determining blood type and to save time these tests are carried out by the automatic devices. However these devices are very expensive and it is necessary to develop cheaper alternative systems. In this study, we designed a basic device which will be a first step for a cheap and fast prototype. It utilizes the image processing techniques and gel test method for real time blood type determination on embedded system. During the tests, fifty gel test cards data were used and, it is found that the proposed system can process each gel test card in 2 seconds with 99% accuracy on average.

***Keywords:*** *Image Processing, Blood Types, Embedded Systems, OpenCv, Gel Test Method*.

## 1. Introduction

Determination of blood type is a vital process before the blood transfusion. Otherwise fatal consequences may occur. It must mandatory doing blood type determination tests to avoid this situation. International Society of Blood Transfusion (ISBT) had recognized a total number of 30 human blood group systems, with ABO and Rh as the two most common groups [1]. The most important blood group is the ABO group. The ABO group system has A, B, AB and O blood types. Type A, B and AB have A, B and AB antigens respectively on the surface of the red blood cells (RBCs), whereas type O has none of these antigens [2]. The second most significant blood-group system is the Rh system. The Rh system determines blood type from the presence or absence of a ‘‘Rhesus factor’’ surface on red blood cells. If Rh factor is present on surface of the RBC it is positive otherwise it is called negative. According to the ABO and Rh grouping systems there are 8 blood groups. These are A Rh+, A Rh-, B Rh+, B Rh-, AB Rh+, AB Rh- , O Rh+, O Rh- . A, B, D (Rh) antigens tests are carried out for determination of blood type [3].

Until recently different methods have been developed to determine the blood group types. Most of the techniques applied today are based on the principle of interaction between antigen and antibody. As a result of this interaction, results are interpreted as positive if agglutination of RBCs occurs and negative if otherwise. The first method used for determination of blood type is called Slide method in which three blood drops are dripped on separate lams then A, B, D antigens are dripped respectively on lams and blood type is determined by angulation [3].
In this study gel test method is used for determination of blood type which is widely used in Tukey. The gel card used in this method is shown in Fig 1. Gel card has a special gel and blood cells which don’t agglutinate passes through this gel and accumulate at the bottom of the tuple [4].
Looking at literature there are several studies for determination of blood type. Zarifi and co-workers used plate method for detection of blood type on FPGA [5]. Feraz developed a prototype system for emergency situations and used slide method in this system [6]. Fatima determined blood type using slide method microscope images by using image processing technics [7]. Dolmashk and colleagues using laser light radiation and image processing techniques together have shown that the detection of blood group is possible [8]. Swarp and colleagues compared conventional tube method and gel test method [9]. Toz and colleagues developed a software for reading gel test cards by using image processing techniques [10]. Also there are several devices for blood type determination. Some of them are Technicon Auto Analyzer [11-13], Auto-Grouper [12], Technicon Auto Analyzer II [14, 15].

Gel test method needs three devices. These are gel test centrifuge, gel test incubator and gel test reader. These devices are very expensive. In general, technicians in hospitals are detecting blood type visually instead of gel test reader. Therefore errors in reading or interpreting cause hundreds of fatal blood transfusions over a year. Furthermore, analysing a large number of samples consumes a lot of time and requires special care for the sampler. In this study, our aim is to develop a cheap, fast and efficient system for gel test reader device. For this purpose a system is designed on Beagle Bone Black (BBB) which is a mini computer card which can run Linux operating systems. It is useful, stronger and cheaper alternative for image processing applications. Using an USB web cam gel card images were taken and image processing techniques are applied on BBB for detection of blood type.

## 2. Materials and Methods

Designed system is consist of BBB and an USB camera connected to it, a fix background and a moving belt.

### 2.1. Gel Card Test Method

Gel card used for gel testing method is manufactured by company DiaPro. Fig 1 shows an example of gel card. The size of gel card is 5x35 cm and it has 8 tubes in total but first 5 tuples are necessary for detection. Fig 5 shows the required area for detection. Every tube has a special gel which allows the passage to the bottom of the tube for non-agglutinated blood cells. If blood cells don’t agglutinate they move to bottom of the tube. This situation reveals a negative result (Fig 2). 25 ul of blood was added drop wise into

*[1] Computer Engineering Department, Engineering Faculty, Kırıkkale University, Campus, Kırıkkale/Turkey*
** Corresponding Author: Email: enesayan@kku.edu.tr*
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each tube and centrifugation was performed for the detection of blood group. After this process gel card image is taken. Fig 4 shows a B Rh + gel card, ready for determination of blood type.

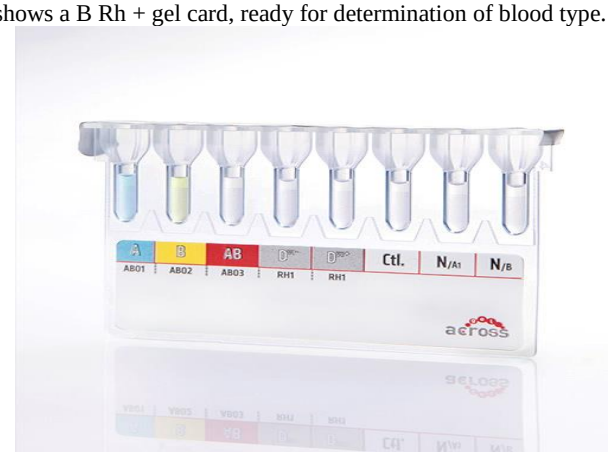


**Figure 1.** Gel card

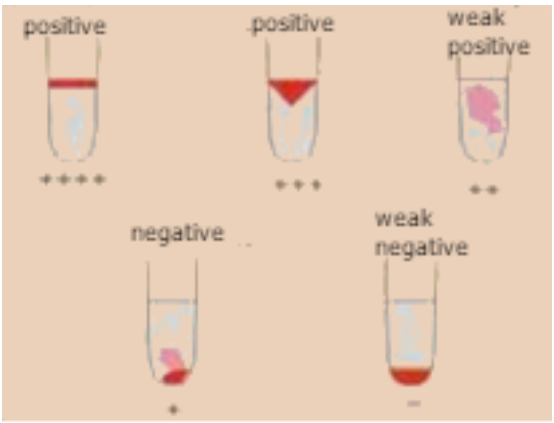


**Figure 2.** Gel card agglutination

### 2.2. Image processing techniques and Embedded System

OpenCv library and python programing language is used for image processing techniques. On the hardware side BBB minicomputer card and an USB web cam is used. USB can take 640x480 resolution image. BBB has Angstrom Linux operating system. The system has been tested in closed environment and constant intensity of light used to stop the effects of external factors. In this way, the problems of intensity of light and light angle have been removed

## 3. Results

Fig 3 shows image processing algorithms used in this study.

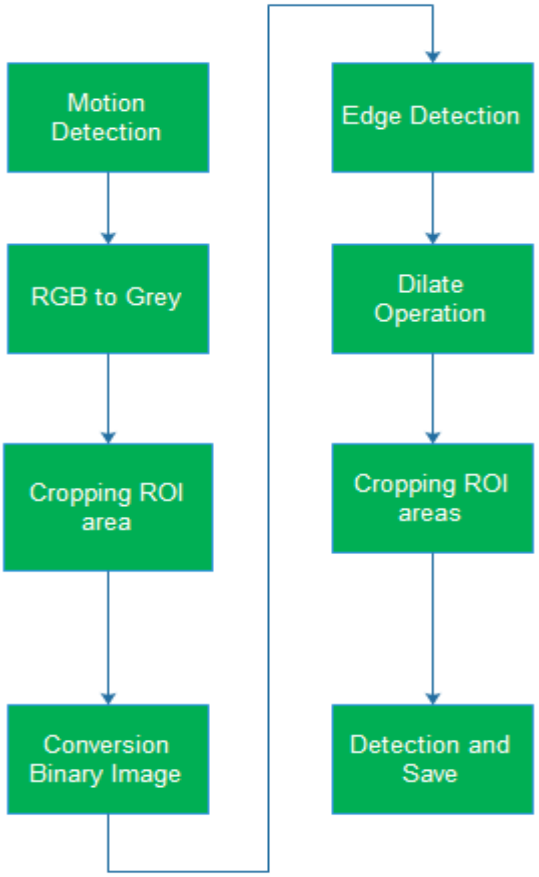


**Figure 3.** Algorithm steps

### 3.1. Detection of motion in System

Static background motion detection algorithm is used for detection of motion in the system. This algorithm is based on subtraction of static background image taken at the (t-1) time from the image taken at (t) time principle. A threshold value is set and after subtraction every pixel is compared with this threshold (Th) value. If pixel value is bigger than threshold value it is counted by counter. When the counter value reached to a predetermined value (Th2) motion is detected. The formulization of this process is given below.

$| It(x) – It-1(x)| > Th \Rightarrow c=c+1$ and if $c > Th2$ motion is detected.

### 3.2. Conversion of grey level image

Fig 4 shows an example of a gel card image taken after motion detection. RGB (Red, Green, Blue) image was converted grey image by using formula given below. Fig 5 shows grey level gel card image example.

$$Y= 0.299*R + 0.587*G + 0.114*B$$

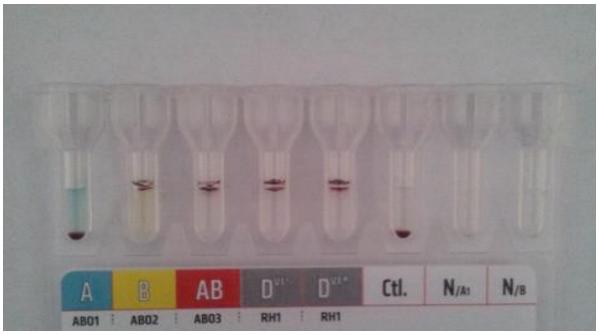


**Figure 4**. BRH+ gel card example

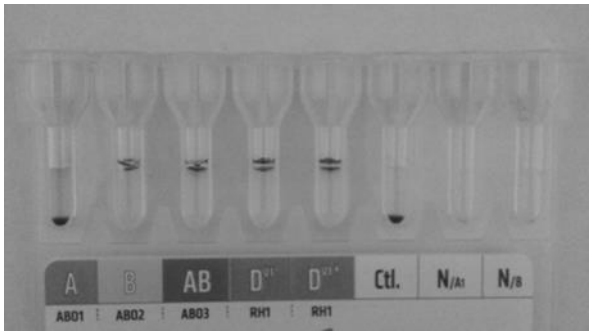


**Figure 5.** Grey level gel card

### 3.3. Detection of ROI (Region of Interests) and conversion binary image

In this process ROI area was cropped from the grey level image for detection of blood type. In this system since each gel card has a static location in front of the camera, ROI was obtained by cropping the gel card image from specified points. In order to obtain binary image, the adaptive threshold algorithm was applied on ROI

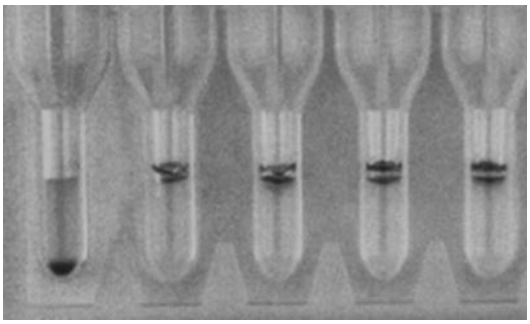

**Figure 6**. Cropping ROI area

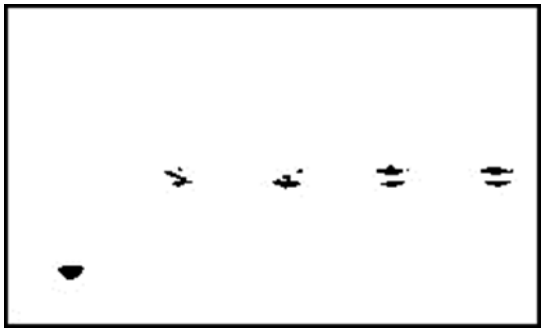

**Figure 7**. Binary image

### 3.4. Edge detection and Dilation

After the binary conversion the Canny algorithm was applied for edge detection. Furthermore to enhance the image dilation operation was performed. Fig 8 and Fig 9 shows results respectively.

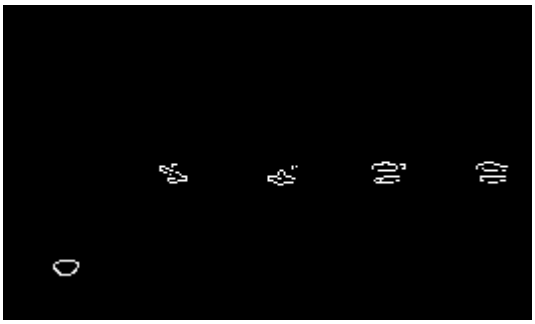

**Figure 8**. Edge detection

**Figure 9**. Dilation

### 3.5. Cropping ROI areas for detection

A, B, AB, RH1, RH2 ROI areas was cropped from the image for determination of blood type. First white areas was detected and then this areas was cropped from the image. FindCounters function in OpenCv library was utilized for this purpose. Fig 10 shows results respectively.

After cropping operation y coordinates of white areas was detected and compared with each other. According to this comparison blood type is determined and saved in a txt file in BBB. After saving blood type, the system is ready for another gel card. All process explained above is taken 2 second. This time is very efficient value for a real time system [5].

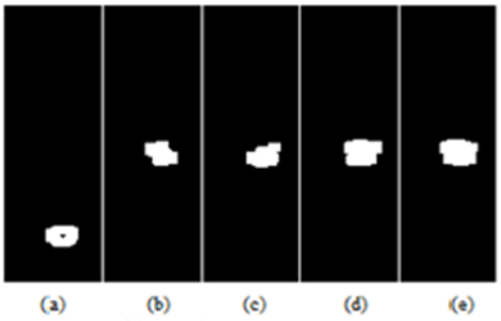


**Figure 10.** Cropped gel card tubes

## 4. Conclusions and Discussions

The Blood type determination test is one of the most important test performed in hospitals, blood banks, and other health organizations. Gel test method is one of the blood type determination methods which is widely used in Turkey. In this study our aim is to develop a cheaper and efficient alternative system for blood type determination. During the tests, fifty gel test cards data were used and, it is found that the proposed system can process each gel test card in 2 seconds with 99% accuracy on average.

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