Blood Donor Matching Information Systems and Determining Tools for Blood Cluster and Human Rhesus Based on IoT

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ABSTRACT
Until now, the process of testing human blood groups is still done manually by mixing blood and antisera. Testing is done by observing the agglutination reaction of blood samples. Then the testing process takes a long time, without storing donor data. this is less effective if the blood is tested a lot and in an emergency. This study aims to create a system that can provide blood donor match information and can determine the blood type and rhesus of humans automatically. This research uses the ABO system method and the rhesus system. The data input of this study uses the LDR voltage values illuminated by LEDs. Furthermore, the voltage value is processed by Arduino Uno. The data output is displayed on the LCD and android smartphone application, using the NodeMCU Wi-Fi module ESP8266. The application comes with a data store called Microsoft Excel. Based on test results, the system is able to determine blood groups with a voltage range detecting agglutination LDR1 = 0-1,3345 Volts, LDR2 = 0-1,2955 Volts and LDR3 = 0-1,183 Volts. While the voltage range does not detect agglutination LDR1 = 1.3345-2.2 Volts, LDR2 = 1.2955-2.2 Volts and LDR3 = 1.183-2.2 Volts. The percentage of system accuracy is 97.5%, with an average detection time of 02.43 seconds for the instrument and 20.33 seconds for the application.

Keywords: *Blood Type, Blood Donor, Internet of Things*

1. INTRODUCTION

Blood is a complex fluid that is very vital for humans. Based on antigens in the blood, blood is grouped into A, B, O and AB blood groups. Based on the Rhesus factor in the blood, blood is grouped into Rh positive (rh+) and Rh negative (rh-) blood groups. Blood grouping is important for the blood donor process [1].

Testing human blood and rhesus is still done manually by taking blood around 5-10 ml. Retrieval is carried out by medical staff, so the level of accuracy of the data still relies on the accuracy of the eyes of the examiner and requires a long time. The results will appear 3 hours later [2].

Then, the testing process is only done once without data storage. So, every time a donor will be re-tested [3]. One of the methods used for checking blood groups manually is the Slide test. The procedure of using a slide test is to place 1 drop of anti-A, anti-B and anti-D each on a clean, dry glass object separately. Drop 1 drop of blood sample into each reagent. mixture of reagents and blood samples using a stirring rod, spread about 20 mm x 40 mm. Tilt the slide from side to side for ± 2 minutes. Read the test results and read reaction results [4]. Therefore, system automation is very needed to simplify and speed up the blood detection process so that it is more effective and efficient.

Based on references from previous studies, this study developed a system by adding an electronic digital display that is integrated directly with the application on an Android smartphone. For the application, it displays blood group data from the reading of the tool, equipped with blood donor match information and data storage in Microsoft Excel. So, the data can be used as needed.

2. METHOD

2.1. Software

Creation of a program script to run tools on the Arduino IDE Software. The flowchart system program as shown in Figure 1.

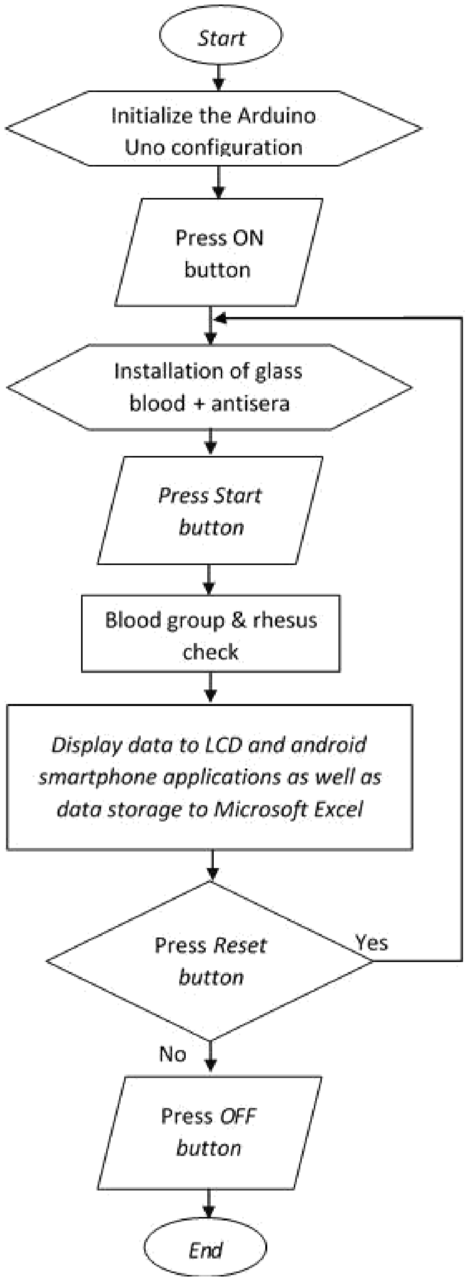

Figure 1 Software flowchart

Software consists of, (1) The system program in the Arduino IDE. (2) Thinkspeak Web server settings. (3) Applications on Smartphone Android using the MIT App Inventor web. The appearance of this application, shown in Figure 2.

2.2. Hardware

The tool is made in the form of a box using acrylic. Consists of 16x2 LCD, On/Off button, start button, reset button and drawer on the side of the tool as a place to put 3 Object glass. The tool display is shown in figure 3.

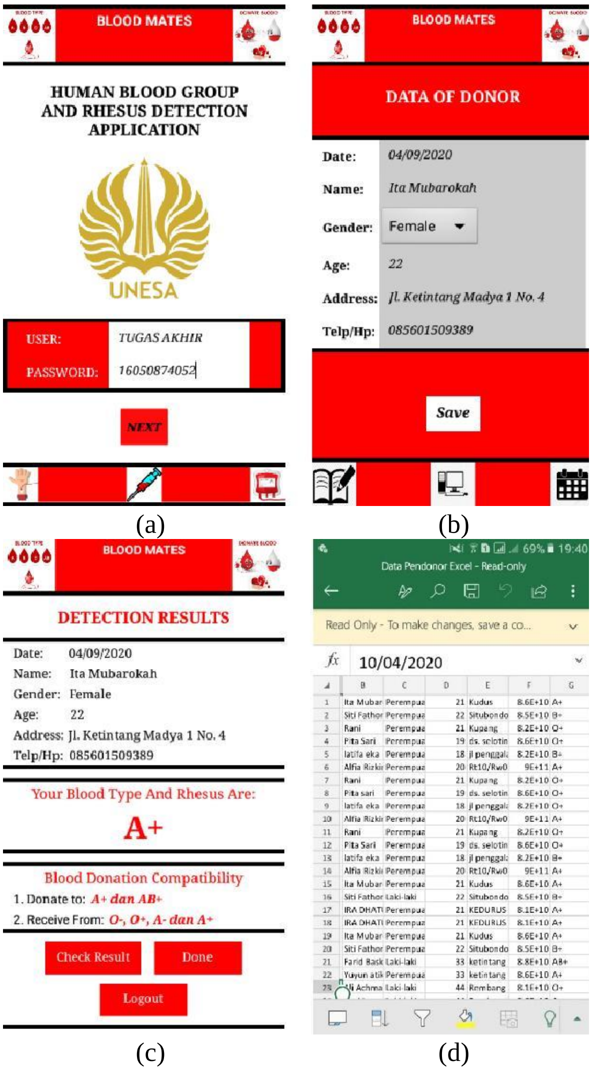

Figure 2 Application (a) Login menu (b) Data donator menu (c) Detection results menu (d) Data storage on Microsoft excel.

Figure 3 Hardware box

3. RESULTS AND DISCUSSIONS

3.1. Testing Preparation

Before conducting the test, prepare blood samples, reagents, tools and applications. Blood samples were dropped on 3 object glasses each of 1 drop. Next mixed with a reagent that is anti-A, anti-B and anti-D as much as 1 drop each. Then stir evenly and widen to a diameter of ± 1.1 cm. Then the object glass is inserted into the device between the LDR and the LED. The LDR output value will be processed by Arduino Uno. Then the data output will be displayed on LCD 16x2 and the application on an android smartphone using the Wi-Fi NodeMCU ESP8266 module.

3.1.1. System Testing

There are 2 tests, the first LDR sensor testing, LDR output value data in the form of voltage are presented as in Table 1.

Table 1. LDR sensor test results

No.	Blood Sample	Voltage (Volt)		
		LDR1	LDR2	LDR3
1.	O+	0,914 (T)	0,758 (T)	1,188 (TT)
		0,919 (T)	0,762 (T)	1,183 (TT)
2.	A+	1,466 (TT)	0,753 (T)	1,227 (TT)
		1,466 (TT)	0,758 (T)	1,222 (TT)
3.	B+	1,031 (T)	1,828 (TT)	1,461 (TT)
		1,036 (T)	1,833 (TT)	1,457 (TT)
4.	AB+	1,755 (TT)	1,637 (TT)	1,608 (TT)
		1,740 (TT)	1,745 (TT)	1,505 (TT)
		Min=0,914 Max=1,755	Min=0,758 Max=1,833	Min=1,183

* T = blocked TT = not blocked

Based on the data in Table 1, a threshold value can be determined using Equation 1.

$$Threshold\ Value = \frac{(Max\ Value + Min\ Value)}{2} \quad (1)$$

Obtained the value of the threshold value for the sensor LDR1 = 1.3345 Volts, LDR2 = 1.2955 Volts and LDR3 = 1.183 Volts. So that the voltage range can be determined for data learning programming.

The second is testing the whole system, aims to test the connection between the device and the application on an android smartphone. This test includes: determination of blood type and rhesus of humans. Inputting donor data on an android smartphone application. Appearance of donor data, human blood type and rhesus as well as blood donor match information. And the storage of detection data on Microsoft Excel.

3.2. Data

Data was collected on 17 donors, then blood samples were taken for 30 times. Data taken in the form of LDR output values for blood group A + in Figure 4, blood group B + in Figure 5, blood type O + in Figure 6, blood type AB + in Figure 7.

Based on the data, it is obtained the different voltage output values of each LDR sensor. LDR voltage value when detecting blood does not clot smaller. LDR voltage values when detecting blood clot greater.

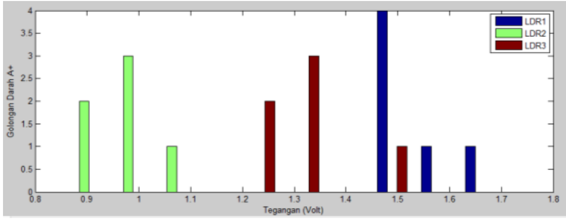

Figure 4. Graph of LDR Output (A+)

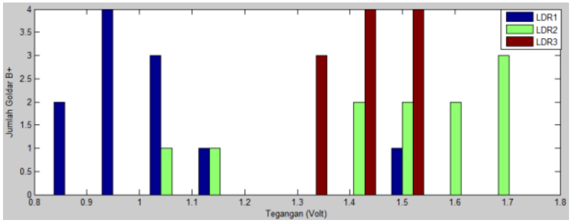

Figure 5. Graph of LDR Output (B+)

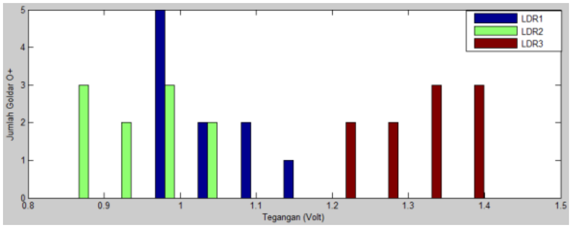

Figure 6. Graph of LDR Output (O+)

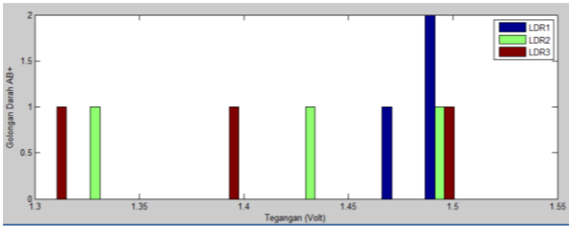

Figure 7. Graph of LDR Output (AB+)

3.2.1. LDR Data and System Detection Time

Device detection time data is shown in figure 8 and application detection time is shown in figure 9. Calculation of the average time of detection of tools and applications using the formula in Equation 2.

$$Average\ Time = \frac{Amount\ of\ Testing\ Time}{Number\ of\ Tests} \quad (2)$$

The average detection time of the device is 02.43 seconds. While the average time of application detection is 20.33 seconds. The system detection time is longer than manual testing. Because they have to wait for agglutination/non-agglutination reactions. However, the system is very effective at detecting large blood samples because it is more practical and automatic.

3.2.2. Tools Data Detection with Manual Test

Comparative data between the results of the detection of blood types and rhesus of humans based on the results of reading the instrument with proof of manual testing.

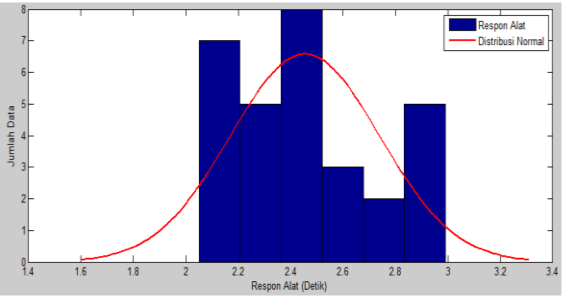

Figure 8 Graph of Tool Detection Time

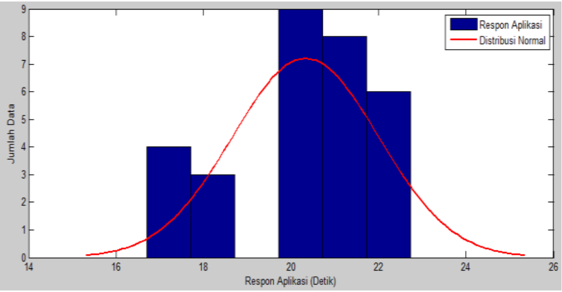

Figure 9 Graph of Application Detection Time

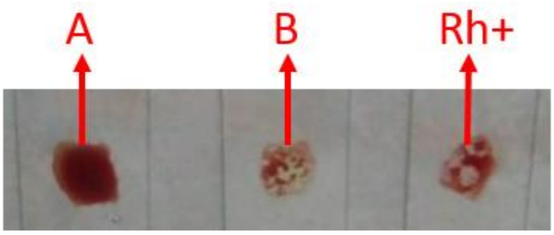

Figure 10. Manual Test Results

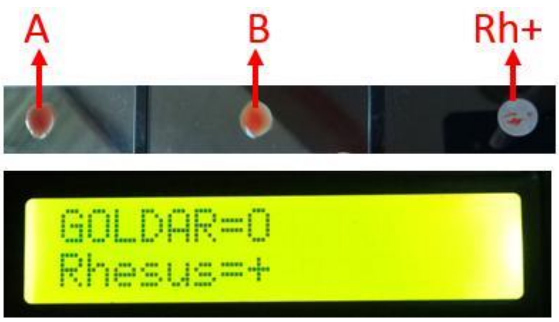

Figure 11. Tool Test Results

After the detection is done, there is one data which is not suitable between the results of reading the instrument with manual test evidence. Based on the manual test results detected B + as shown in Figure 10. While based on the results of reading the instrument, it was detected as O + as shown in Figure 11.

Detection error occurred, caused by, too much blood sample being dripped, so that blood clots cover the light from the LED. The uneven mixing of blood and reagents causes the LDR sensor to detect incorrectly. And the difference in voltage to detect blood groups and rhesus is very close. The calculation of the value of system accuracy uses the confusion matrix method. Presented in Table 2.

Table 2. Confusion matrix calculation results

		True value	
		True	***False***
Predicted	***True***	TP = 39	FP = 1
Value	***False***	FN = 0	TN =0

Calculation of the accuracy of the system using the formula in equation 3.

$$Percentage\ of\ Accuracy = \frac{TP+TN}{TP+TN+FP+FN} \times 100\% \qquad (3)$$

Thus, it can be seen that the percentage value of the system accuracy is 96.7%.

3.2.3. *Data Comparison of Accuracy Values*

Comparison of system accuracy with previous studies, presented in Table 3.

Table 3. Accuracy value comparison results

No.	Researcher	Accuracy
1.	Hidayat (2009)	90%
2.	Melati (2011)	100%
3.	Akmaliah (2013)	87,5%
4.	Iswahyudi (2015)	94,5%
5.	Fitryadi (2016)	80,25%
6.	Muhyanto (2017)	97%
7.	Retyanto (2018)	92,31%
8.	Putra(2018)	83%
9.	Hariri (2018)	98%
10.	Wewo (2018)	83,33%
11.	this Research (2020)	96,7%

Based on table 3 above the system accuracy of 96.7% was assessed to be accurate. Because blood samples used for programming (learning) are different from blood samples used for testing (testing), as well as reading blood samples in this study only done once.

4. CONCLUSION

Conclusions based on the results of research that has been done, (1) the system has been successfully made using an LDR sensor as a detector. The range of agglutination voltage is LDR1 = 0-1,3345 Volts, LDR2 = 0-1,2955 Volts and LDR3 = 0-1,183 Volts. While the voltage range is not agglutination LDR1 = 1.3345-2.2 Volts, LDR2 = 1.2955-2.2 Volts and LDR3 = 1.183-2.2 Volts. (2) The system can be used well with an average detection time of 02.43 seconds for the instrument and 20.33 seconds for the application. (3) Percentage of accuracy of instrument readings of 96.7%.

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