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Design of a Rotary Blood Mixer Based on Arduino Uno to Prevent Blood Clotting

Roy Rizki Maulana[1], Bayu Wahyudi[2], Florentinus Budi Setiawan[3]
Engineering, Faculty of Electromedicine, Sekolah Tinggi Ilmu Kesehatan Semarang, Indonesia

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Corresponding author*:
roymaulana191221@gmail.com

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Abstract: One of the examinations in the laboratory related to blood is a hematology examination. In a hematology examination, the patient's blood is first taken before being examined or processed by a Hematology Analyzer. The blood that will be processed for examination will clot quickly. This tool uses an input voltage from PLN 220 V which is then converted by using a power supply to DC current using a power supply and to reduce the voltage to supply the microcontroller. Arduino Uno as a microcontroller which contains a program sends commands to the optocoupler sensor to regulate the rpm speed of the dc motor.

Keywords: Homogenization. Rotary Blood Mixer, Arduino Uno Microcontroller, Optocoupler Sensor, DC Motor

INTRODUCTION

In the laboratory there is one of the tests related to blood, namely the hematology examination. In the hematology examination, the patient's blood is previously taken first before being examined or processed by a device. Hematology AnalyzerBlood that will be processed for examination will clot quickly, in this case because blood contains blood-clotting substances. To avoid this, the blood must be mixed with anticogulant substances. Blood consists of complex plasma essence including erythrocytes, leukocytes and platelets. Erythrocytes or red blood cells function to transport hemoglobin and then transport oxygen from the lungs to the tissues (Annanisa, 2015). This Rotary Blood Mixer is a laboratory tool that functions to mix blood samples with anticogulant substances by rotating. hematology analyzer who have been given anticoagulants as substances that can prevent blood clotting (Nugraha, 2010).

Several previous studies have been made by Apriyulida and Elfiansyah with the title the effect of modifying the timer on the Roller Mixer controller from the Mutiara Elektromedik Journal. Research on this tool has been equipped with time settings along with display time, the method used in this research is the experimental method, namely tool design Roller Mixer by modifying the power motor circuit based on the ATM8535 microcontroller. Overall, this research can be concluded that the blood mixer can be designed to be equipped with time and speed settings using the ATMEGA 8535 microcontroller as the main controller in the circuit. Based on the results of motor speed measurements, a tolerance range of 10% is given at 1 to 5 minutes at speeds of 35 and 45 rpm (Fitri Apriyulida, 2017).

Research by Era Faidatunnadia with the title rotary blood mixer based on Arduino from the Department of Electromedical Engineering at Widya Husada University. This research created a Rotary blood Mixer as a replacement for manual homogenizing methods. This tool works at a voltage of 220VAC, the components that the author uses consist of a stepper motor, push button, motor driver, LCD, speed sensor, and microcontroller. This tool can be used for various types of liquid samples. The movement that can be done with this tool is rotating. And you can set the time for how long this tool moves based on sample mixing needs. Tool Rotary blood Mixer This has succeeded in achieving its main goal, namely mixing blood samples evenly and consistently. When testing the tool, it shows that this tool can produce more accurate and reliable results in various types of clinical blood tests. Apart from that, this tool is easy to use and reliable in a laboratory environment (Era Faidatunnadia, 2023).

RESEARCH METHOD

Type of research

The type of research carried out is design and construction planning. This research is to design and build a rotary blood mixer. The type of research used in this research is the experimental method. The experimental or experimental method is a means of conducting learning by carrying out a trial or experiment, making observations, then making conclusions on the data obtained during these observations. With this experimental method, the tool that will be tested is first designed, namely the Arduino Uno Based Rotary Blood Mixer Design.

Tools and Materials

To support the process of making this rotary blood mixer, several equipment and materials are needed, which can be seen in table 1 below.

Table 1. Tools and materials

No	Materials/Components	Equipment
1	Arduino Uno	Solder
2	Motor DC	Tachometer
3	Resistor	Screwdriver +
4	LCD i2 c 20 x 4	Boron PCB
5	Sensor Optocoupler	Scissors
6	PushButton	Toolkit Set
7	Swicth ON/OFF	Laptop
8	IC IRFZ44N	Multimeter
9	Capacitor	Stopwatch

Research stages

This research stage explains the initial steps to start planning the manufacture of a rotary blood mixer. The flow diagram in the following image explains the research stages in detail and in stages.

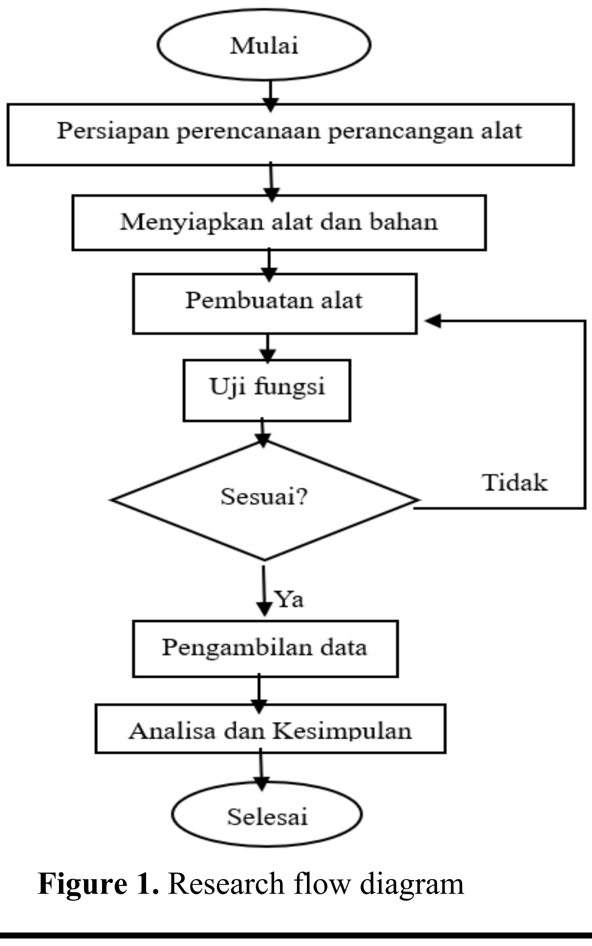

Figure 1. Research flow diagram

The flow diagram of this research depicts the stages taken to design a rotary blood mixer, starting from preparation for designing the device to analysis and conclusions with a complete explanation below:

1. Start

   Research begins according to a predetermined schedule and plan.
2. Prepare a tool planning design

   Prepare or create a planning design for the tool later, such as the working system of the tool.
3. Prepare tools and material

   Prepare the equipment that will be used and the materials that will be used in carrying out the design and construction activities of the equipment.
4. Making tool

   At this stage the researcher has started to assemble the tool according to the initial design by paying attention to all the supporting components in this assembly in order to get results according to the researcher's design.
5. Test the function of the tool

   Test the function of the tool to see whether the system's working function is as it should be. At this stage, the tool that has been made by the researcher will be carried out.
6. Data collection

   Data collection was carried out to prepare reports on research results
7. Analysis and conclusions

   Analyze the overall data, test the function of the tool to see if it is in accordance with what was planned, if it is appropriate then draw conclusions.
8. Done

   End of the research carried out

Hardware planning

When designing a tool, it is necessary to design hardware in the form of a block diagram. A block diagram is a diagram created in such a way as to map the work process of the tool with the aim of clarifying the work flow in the tool. Block diagrams are formed in the form of images so that they are easy to understand and understand. The following Figure 2 is a block diagram of the design of a rotary blood mixer.

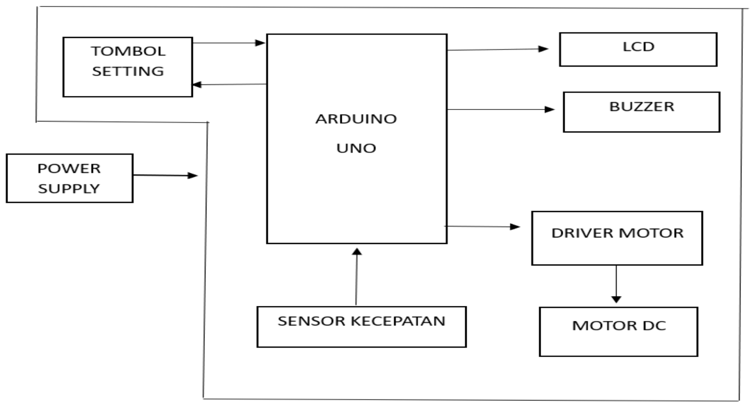

Figure 2. Tool Block Diagram

The explanatory information for the block diagram starts from PLN 220 V to the power supply. The voltage is lowered to be used to supply the Arduino microcontroller. Then the setting button gives a speed setting command or timer setting on the microcontroller and the speed sensor will regulate the rotation of the DC motor according to the command and then processed on the Arduino which will be displayed on the 20 x 4 LCD. After the command is sent to the DC motor the tool starts working according to the settings and the buzzer will sound when the process is complete.

Then, to make a rotary blood mixer, a whole circuit is needed, starting with a PLN 220 VAC network input, then entering the 2A transformer and lowering the voltage through the power supply circuit to 18 VDC, then the voltage is lowered again by stepdown LM2596 to 12 V which is used to supply the Arduino Uno and DC motor, for the voltage entering the optocoupler sensor, namely 5V, the voltage is lowered by the 7805 regulator IC. For buzzer, keypad and LCD 20 x 4 voltage taken from Arduino Uno. Below is a picture of the entire circuit in figure 3.

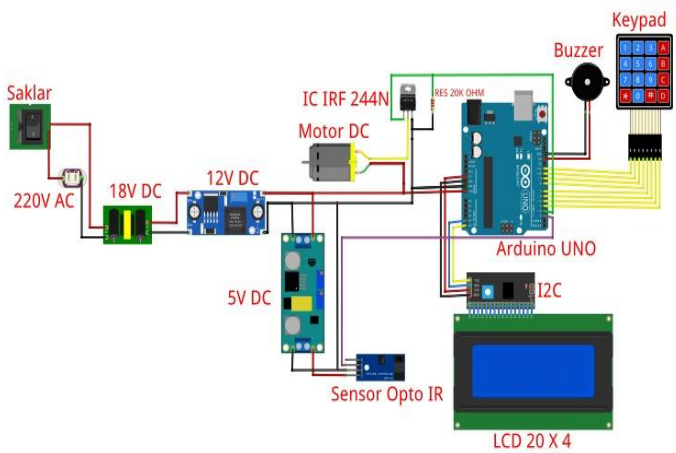

Figure 3. Whole Network

In designing the tool, a tool design is needed to ensure that the tool is made according to its function and use to prevent blood from clotting. The following is a design drawing for a rotary blood mixer.

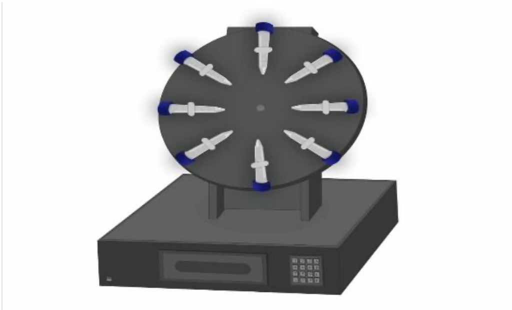

Figure 4. Tool Design

Data Retrieval

Data collection on the rotary blood mixer is carried out by monitoring several important measurement points to ensure the overall performance and efficiency of the device. These measurement points include: power supply input to determine the electrical power used by the tool as a whole, power supply output to monitor the efficiency of power distribution to the components, motor voltage input to ensure the drive motor is working at the appropriate voltage, optocoupler sensor voltage input which functions to detect motor rotation movement, and LCD input which shows the rpm value and rotation duration of the tool. Data on each of these is used to find out optimal results on the tool.

Test the function of the tool

The function test of the tool is the stage for adjusting the tool made with a comparison tool. The function test of this tool uses three stages. The first is the speed or RPM function test by comparing the tachometer measuring tool, the second is the time duration or timer function test on the tool using a stopwatch comparison tool.

Analysis of tool function test calculations

The data analysis method obtained data from several measurement points (TP) that were found. The measurement results are in the form of data in the form of tables containing values or images showing the results of the measurements that have been carried out. According to wikiHow formally, the percentage error is the estimated value minus the exact value, and divided by the exact value per 100 cases (in percentage form). In this research, the approximate value is the value of the measured results, while the exact value is the value of the theoretical results (Wi kihow, 2017).

$$\% \, Error = \frac{Theory \, Result - Measured \, Result}{Measuring \, Result} \text{ x } 100 \, \%$$

From the calculation formula above, we can find the level of error/difference so that we can then find conclusions.

RESULT AND DISCUSSION

These results and discussion will explain in detail the results from the data collection measurement points and the results of the tool function tests.

Measurement results

The measurement results are measurement data from each measurement point that has been determined to determine whether the results of the series are in accordance with the plan. Data analysis aims to compare reference results with measurement results that have been obtained from measurement points and determine the percentage of error in the circuit.

Measurement Point 1 (TP1)

Measuring the input voltage on the PLN grid is carried out with a digital multimeter, with the red probe connected to the positive (+) voltage, and the black probe to the negative (–) voltage. The measurement results show an output of 221 VAC, which is still within the required input voltage range, so it is still within normal indicators.

Table 2. PLN Net Input Voltage

Measurement results	Output Voltage (V) Measurement	Rata-rata (V)	Datasheet (V)
1	221		
2	221	221	220 V
3	221		

Measurement Point 2 (TP2)

Power supply output voltage measurements are carried out with a digital multimeter, with the red probe connected to the positive voltage and the black probe to the negative voltage. The measurement results show the power supply output is 11.59 VDC, which is still within the required tolerance.

Table 3. Voltage Output Power Supply

Measurement results	Input Voltage (V) Measurement	Rata-rata (V)	Datasheet (V)
1	11,59		
2	11,59	11,59	12 V
3	11,59		

Measurement Point 3 (TP3)

When measuring the input voltage of the optocoupler sensor, the red probe is connected to the positive voltage and the black probe to the negative voltage. The measurement results show an input of 4.96 VDC, which is still within the range, so it is still within the normal indicator.

Table 4. Optocoupler Sensor Input Voltage

Measurement results	Input Voltage (V) Measurement	Rata-rata (V)	Datasheet (V)
1	4,96		
2	4,96	4,96	5V
3	4,96		

Measurement Point 4 (TP4)

Measuring the input voltage on a DC motor is carried out using a digital multimeter. The red probe is connected to the positive (+) voltage on the sensor and the black probe to the negative (–) voltage. The measurement results show an input of 11.55 VDC, so it is still within normal indicators according to the datasheet.

Table 5. Dc Motor Input Voltage

Measurement results	Input Voltage (V) Measurement	Rata-rata (V)	Datasheet (V)
1	11,55		
2	11,55	11,55	12 V
3	11,55		

Measurement Point 5 (TP5)

Measuring the input voltage on the LCD is carried out using a digital multimeter. The red probe is connected to the positive (+) voltage on the sensor and the black probe to the negative (–) voltage. The measurement results show an input of 4.95 VDC, so it is still within normal indicators according to the datasheet.

Table 6.LCD Input Voltage

Measurement results	Input Voltage (V) Measurement	Rata-rata (V)	Datasheet (V)
1	4,95		
2	4,95	4,95	5 V
3	4,95		

Function test results

The function test results are the result of a comparison of the speed function test using a tachometer comparator and the time function test using a stopwatch comparator as well as the results of the function test using a blood sample.

1. Speed measurement test results

From the results of the speed measurement test carried out by the author by comparing the tachometer measuring instrument. The results of the measurement test can be seen in table 7.

Table 7. Speed Measurement test results

No	**Tachometer (m/s)**			**Flat-Flat**	**Tool (m/s)**			**Flat-Flat**	**% Wrong**
1.	5.2	5.2	5.2	5.2	5	5	5	5	3,8%
2.	25.1	25.1	25.1	25.1	25	25	25	25	0,3%
3.	45.1	45.1	45.1	45.1	45	45	45	45	0,2%

From the speed measurement test results above, it can be seen that the first measurement shows the LCD display with an average value of 5 Rpm and the tachometer shows an average value of 5.2 Rpm with an error percentage of 3.8%. The second measurement shows the tool with an average value of 25 Rpm and the tachometer shows an average value of 25.1 Rpm with an error percentage of 0.3%. Rpm and the tachometer shows an average value of 45.1 Rpm with an error percentage of 0.2%. So the error percentage in the speed measurement test is 1.4%.

Time measurement test results

From the results of the timer measurement test which was carried out by comparing it to a stopwatch. The results of the measurement test can be seen in table 8.

Table 8. Time Measurement Test Results

No	**Stopwatch (minute)**			**Flat-Flat**	**Tool (minute)**			**Flat-Flat**	**% Wrong**
1.	01:00	01:00	01:00	01:00	01:00	01:00	01:00	01:00	0 %
2.	02:00	02:00	02:01	02:00	02:00	02:00	02:00	02:00	0 %
3.	03:00	03:00	03:00	03:00	03:00	03:00	03:00	03:00	0 %

From the results of the timer measurement test above, it can be seen that the first measurement shows the timer on the LCD display with an average value of 1 minute and the stopwatch shows an average value of 1 minute with an error percentage of 0%. The second measurement shows the timer on the device with an average value of 2 minutes and the stopwatch shows an average value of 1 minute with an error percentage of 0%. 3 minutes with an error percentage of 0%, so the error percentage in the timer measurement test is 0%.

Results of Functional Tests with Blood Samples

The results of the function test using blood samples mixed with anticoagulant substances by adjusting the rpm settings and time settings can be seen in table 9.

Table 9. Functional Test Results with Blood Samples

No	Speed (Rpm)	Duration (Minute)	Volume (ml)	Results Observation	Notes
1.	5	5	3	Homogeneous	Blood Doesn't Clot
2.	25	3	3	Homogeneous	Blood Doesn't Clot
3.	45	1	3	Homogeneous	Blood Doesn't Clot

From the results of the experimental function test using blood samples mixed with anticoagulant substances with the first test speed being 5 Rpm and a time duration of 1 minute, then the second test at a speed of 25 Rpm and a duration of 3 minutes and the third test at a speed of 45 Rpm and a time duration of 1 minute. The choice of Rpm and time duration must be appropriate so as not to damage the cells in the blood. lumpy.

CONCLUSION

After carrying out the manufacturing process, design the rotary blood mixer Based Arduino Uno, starting from literature studies, planning, experiments, to data collection and data analysis. So it can be concluded. The design of the rotary blood mixer was designed from collecting materials, making tools, carrying out functional tests and then collecting data. This tool can function well to mix blood and anticoagulants evenly so as to prevent blood clots. In this study, a function test was used with blood samples mixed with anticoagulants to provide homogeneous observation results, blood and anticoagulants were mixed well and Then carry out a test of the speed measurement function with a tachometer measuring instrument with the result of the error percentage level being 1.4%, then test the timer measurement function with a stopwatch with the result of the error percentage level being 0%. It can be concluded that this tool is functioning well.

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