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Centrifuge Design at STIKES Semarang

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Abstract *. Centrifuge is a laboratory equipment that is widely used to separate compounds that have different molecular weights by using centrifugal force. The principle of centrifugal force is based on the phenomenon that particles suspended in a container (tube or other form) will settle into a cuvette due to the influence of gravitational force. Centrifuge design using applied methods aims to make a tool equipped with LCD as a display of a setting, RPM and Timer, switch as a safety and Arduino Mega 2560 as a microcontroller. The results obtained in the design of this Centrifuge are that it has speed parameters, namely 3000 RPM, 3500 RPM, and 4000 RPM. Measurement data on 3000 RPM parameters with a percentage error of 2.43%, 3500 RPM with a percentage error of 4.2%, and 4000 RPM with a percentage error of 7.2%. The percentage value of the 3 parameters is still within the tolerance limit so that this tool can be used properly.*

Keywords *: Centrifuge, Switch,* Arduino Mega 2560, LCD

BACKGROUND

In hospitals the use of medical equipment is very important, one of the uses of medical equipment is use in the laboratory. The use of medical equipment in the laboratory is very necessary to see the results of a disease. In the laboratory there are many medical equipment, one of which is *the Centrifuge*.

A centrifuge is clinical laboratory equipment that is widely used to separate compounds that have different molecular weights by utilizing centrifugal force. The principle of centrifugal force is based on the phenomenon that particles suspended in a container (tube or other shape) will settle into a cuvette, due to the influence of gravity (Alfian, 2022).

So the settling rate of a suspended particle can be regulated by increasing or decreasing the gravitational influence on the particle. Setting the settling rate can be done by placing a container containing liquid into the *centrifuge machine* precisely on the rotor which will then rotate at a certain speed. Thus, the working principle *of a centrifuge* is to utilize centrifugal force so that the material can be separated. This is done by rotating the mixture very quickly and focusing on a central point (Panjaitan, 2021).

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In order to produce good examination fluid or *specimens, the equipment must always be in good condition and maintained.* So that the tool can always be used and operate as it should. Maintenance and incompatibility of functions so that it cannot be operated. As a result, the examination becomes hampered and can cause losses for the hospital. The working principle *of a centrifuge* uses the principle of rotation or rotation of the tube containing the solution so that it can be separated based on its density. Manufacturing *centrifuge* equipment includes several factors, for example in terms of weight, cost and ease of manufacture (Setyadi, 2021).

Because of the importance of *centrifuges* in hospital laboratories, centrifuges are needed *that* are equipped with an LCD display and a safety *switch*. The LCD display aims to provide speed and *timer information*. Meanwhile, *the switch* is used as a safety device, where if the device is open or not closed tightly, the device cannot operate.

When the author *reviewed* a number of studies, there were several studies that were relevant to the research being carried out by researchers writing this journal based on references from several previous studies that had been made.

A centrifuge is a tool used to separate organelles based on their density through a settling process. In this research, a *Centrifuge* design was created which has a motor speed selection of 1000-4000 rpm, *a digital* timer*,* a tool tilt position indicator is added, and the tool will *error* if the tool position is tilted. Motor speed settings, *digital timers* and tilt position indicators use an Arduino nano microcontroller which can be displayed on an LCD *display* and can be easily *set* by the user. This research is an *experimental observational research*. The method of observation is by direct measurement on the tool by observing using an observation guide. In this case, the rotation speed, measurement of the tilt system and time on *the centrifuge* will be measured using existing measuring instruments at the Bali International University Laboratory by repeatedly measuring the values indicated by the tool with existing measuring instruments. The results of time measurements from the design *centrifuge, in testing times of 1 minute, 2 minutes, 3 minutes, 4 minutes and 5 minutes, had an overall error* of 0%. The results of speed measurements in *Revolutions Per Minute* (RPM) from the design *centrifuge, in the Speed Test (RPM) 1000 rpm had an error* of 1.7%, 2000 rpm had *an error* of 0.75%, 3000 RPM had *an error* of 0.6%, and 4000 RPM, has *an error* of 0.2%. Results of sediment testing from the *centrifuge* design using the UNBI laboratory *centrifuge.* In the overall sediment testing results from *the centrifuge* design with the UNBI laboratory *centrifuge*, there were deposits in each screening process (Putra, 2022).

Infrared centrifuge is intended to add technological improvements to radio frequency systems that work based on *infrared* and store RPM and time combined in a *sample name*. The *infrared centrifuge* consists of 2 microcontroller circuits, namely as a signal receiver and sender, LCD circuit, pipette and *buzzer*. When the tool is running, the *tachometer block* will measure the motor rotation speed, and the speed value is given to the microcontroller to compare with the speed *setting* used. The results of the comparison will be given to the DAC circuit section which will later be combined with the output of *the oscillator section* and will ultimately influence the vibration speed of the motor so that an appropriate speed value can be obtained. A series *of displays* will show how long the tool has been working and how fast it is. These values will be given from the microcontroller circuit. The microcontroller circuit also receives data from the *sample receiving block* which indicates that the blood *sample* being processed has been separated from substances with the highest density to the lowest. The *infrared* circuit will read the condition of the blood *sample* when centrifugal force occurs, and if the blood sample is well separated it will send a signal to the second microcontroller circuit and the second microcontroller will provide information to the first microcontroller circuit that the blood sample has been separated. If the test accuracy is 99.92% and the time is 99.99% in the RPM and time accuracy test results based on data from *the tachometer* and *stopwatch* , with the results of this research the *infrared centrifuge tool* has worked according to the design of the tool, so it can be used in the laboratory as a basic *sample test* in blood, urine and sediment (Fauzi, 2015).

A centrifuge is a medical equipment used to separate particles in a solution that have different weights and types. *Centrifuge* repair at Panti Rahayu Yakkum Purwodadi hospital. Because this *centrifuge* plays a very important role in the laboratory, especially analysts who often use it. This centrifuge repair was carried out by identifying the motor, *dimmer* circuit *board,* damage was found to the tool, namely the disconnection of all the circuits on *the dimmer board and then the entire dimmer* circuit was replaced so that it could be used again. After repairing the tool, a function test of the tool will be carried out using *a tachometer* and *stopwatch* to test speed and time. Once the data taken is appropriate, the tool is ready to be used again (Balan, 2023).

THEORETICAL STUDY

The following is a supporting theory used by the author to fulfill the research that will be used:

1. *Centrifuge*

A centrifuge is clinical laboratory equipment used to separate a compound based on its density through a particle settling process using centrifugal force (Indrawati, 2023). To separate the solution, *the centrifuge* has a rotor as a place to place the solution. Then this rotor will rotate at high speed so that the solution will separate into two phases, namely the denser particles will migrate away from the *centrifuge axis,* called *pellets* or organelles that settle. Meanwhile, the solution that remains and is separated from the precipitate liquid is called supernatant liquid. The faster the rotation is carried out, the more *organelles* that settle, and vice versa (Setyadi, 2021).

2. Arduino Mega 2560

Arduino 2560 *board is an Arduino board* that uses the ATmega 2560 microcontroller IC. This *board has relatively many* I/O pins , 54 digital *inputs/outputs* , 15 of which can be used as PWM (*Pulse Width Modulation*), 16 analog inputs, 4 UART (*Universal Asynchronous Receiver – Transmitter*). The Arduino Mega 2560 is also equipped with 16 Mhz for the simplest use, just connect *power* from USB to a PC or Laptop via a DC Jack using a 7-12 VDC adapter (Kartiria, 2021).

3. LCD 20 x 4 (*Liquid Crystal Display*)

Liquid Crystal Display (LCD) is a device that functions as a display medium by utilizing liquid crystals as the main display object, a 20 x 4 LCD, namely an LCD consisting of 20 characters and 4 lines (Permatasari, 2023). LCDs are of course very widely used for purposes such as television electronic media, calculators or even computer screens (Nirwan, 2020).

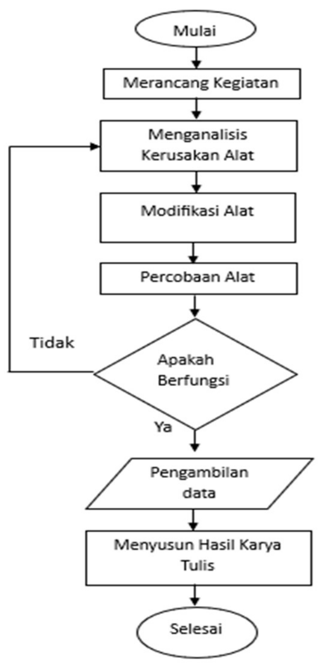
4. *Magnetic Door Switch* Sensor

The MC-38 magnetic sensor is a sensor for detecting door opening/closing which works based on electromagnetic principles (Siswanto, 2018). Under normal conditions the sensor and magnet are not close together, that is, the switch is in an open condition (*open circuit*), while in the active condition the sensor and magnet are in the closed door position and the switch is in a closed condition (*closed circuit*) with a resistance value of ±4Ω (ohm) (Virgiawan, 2021).

RESEARCH METHODS

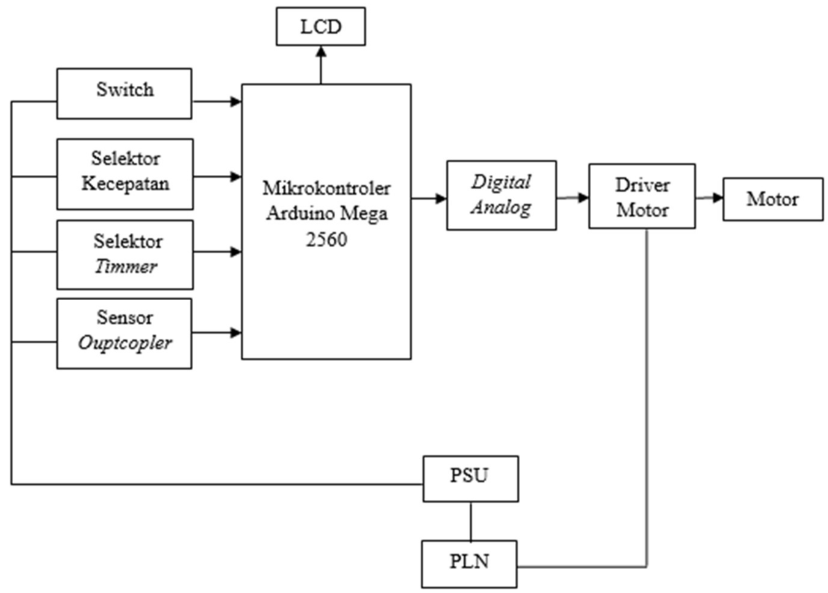
The type of research carried out by the author is applied research. Applied research is research carried out by applying the theories obtained by the author into direct practice with the stages of literature study, field study and data analysis. When the author conducted research from February 2024 to June 2024. Research on *Centrifuge Design and Construction* took place at the Semarang College of Health Sciences (STIKES) Laboratory.

In this research the author made *a Centrifuge*, this tool uses an Arduino Mega 2560 *board* which functions as a microcontroller and as *programming*, the Arduino Mega 2560 functions as a command giver to run components on *the centrifuge,* namely running the motor and calculating *the timer*.



Gambar 1. *Flowchart* Penelitian

1. Hardware Manufacturing

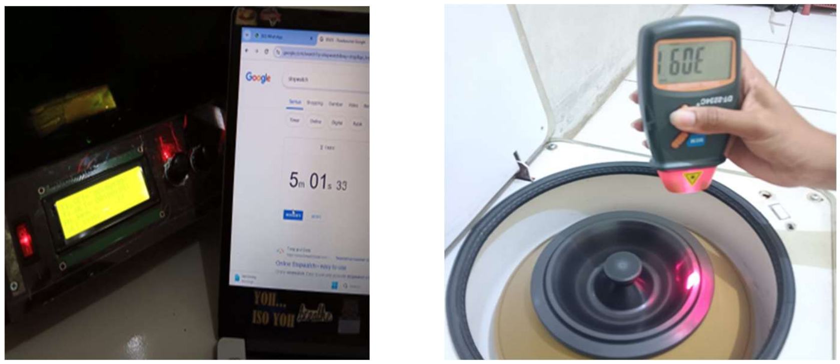


Gambar 2. Blok Diagram Alat

The PLN voltage originating from 220V enters *the power supply* to be converted from AC voltage to DC voltage. When the voltage is entered, the LCD will light up to display the motor speed control and *timer*, select the motor rotation speed using the speed selector, *set the timer* using the *timer selector* Once all settings have been completed press the *start button*. Then the microcontroller will send *analog digital data* to the motor driver and the voltage from PLN to the motor driver will regulate the motor rotation according to the set settings, then the motor will move *the sample* so that it can separate the particles in *the sample* according to their molecular weight.

2. Tool Function Test

In the process of collecting data, the step taken by the author is to test the function of the tool. The purpose of carrying out a functional test is to ensure that the tool can operate normally. This function test is carried out on two tool parameters, namely speed parameters and time parameters. Tool speed measurements are carried out using *a tachometer* and time parameters using *a stopwatch*.



Gambar 3. Pengujian Alat

In the picture, tests are carried out on the motor and *timer rotation* . The first picture shows *the settings Timmer* is in good condition, while the second picture shows the condition of the motor rotation in good condition.

RESULTS AND DISCUSSION

1. RPM (*Revolution Per Minute*) Testing

The RPM (*Revolution Per Minute) test* aims to determine the performance of the AC motor, to ensure that the motor rotation matches the set *settings.* Data collection was carried out 3 times with tool settings of 3000 RPM, 3500 RPM, 4000 RPM. The measurement results can be seen in Table.

In the table you can see the results of speed measurements on *the centrifuge.* This measurement was carried out at 3000 RPM, 3500 RPM and 4000 RPM using a tolerance value of ±10%.

Table 1. RPM Test Results

No	RPM Speed	RPM measurement			Average	*Error*	Tolerance
		1	2	3			
1.	3000	2965	3164	3091	3073	2.43%	±10%
2.	3500	3640	3669	3642	3650	4.2%	
3.	4000	4313	4273	4278	4288	7.2%	

2. *Timer* Testing

The measurement results in the tool *timer performance test were carried out using a stopwatch* by taking data 5 times at *the timer settings of* 5 minutes, 10 minutes, 15 minutes, 20 minutes and 30 minutes. The following in Table 3 are the data and calculation results.

Table 3. *Timer* Test Results

No	*Centrifuge Timer Settings*		Measurement Results 1	Measurement Results 2	Measurement Results 3	*Error*	Tolerance
1.	5 minutes	300 Sec	4 Minutes 59 Sec	5 minutes 0 Sec	4 Minutes 59 Sec	0.03%	±10%
2.	10 minutes	600 Sec	10 minutes 2 Sec	10 minutes 0 Sec	9 Minutes 59 Sec	0%	
3.	15 minutes	900 Sec	15 minutes 0 Sec	15 minutes 1 second	15 minutes 0 Sec	0%	
4.	20 minutes	1200 Sec	20 minutes 1 second	20 minutes 0 Sec	20 minutes 2 Sec	0.01%	
5.	30 minutes	1800 Sec	30 minutes 2 Sec	30 minutes 0 Sec	30 minutes 1 second	0.01%	

CONCLUSIONS AND RECOMMENDATIONS

Centrifuge Design, starting from literature study, design, tool making and data collection and data analysis, the author can make the following conclusions.

Centrifuge function test was carried out using *a Tachometer* and *Stopwatch measuring instrument* by testing speed and time parameters. For the time parameters, measurements were made *for the settings of* 5 minutes, 10 minutes, 15 minutes, 20 minutes and 30 minutes in 3 trials. *Setting* 5 minutes (300 seconds) with measurement results of 299 seconds % *error* = 0.03%, 300 seconds % *error* = 0%, 299 seconds % *error* = 0.03%. *Setting* 10 minutes (600 seconds) with measurement results of 602 seconds % *error* = 0.03%, 600 seconds % *error* = 0%, 599 seconds % *error* = 0.03%. %. *Setting* 15 minutes (900 seconds) with measurement results of 900 seconds % *error* = 0%, 900 seconds % *error* = 0.01%, 900 seconds % *error* = 0%. %. *Setting* 20 minutes (1200 seconds) with measurement results of 1201 seconds % *error* = 0.01%, 1200 seconds % *error* = 0%, 1202 seconds % *error* = 0.02%. %. *Setting* 30 minutes (1800 seconds) with measurement results of 1801 seconds % *error* = 0.01%, 1800 seconds % *error* = 0%, 1802 seconds % *error* = 0.02%. Speed parameter testing was also carried out using *a Tcahometer* with three stages and three repetitions. The measurement results with the Low *setting (3000 RPM) obtained values of 2965 RPM % error* = 1.16%, 3164 RPM % *error* = 5.46%, 3091 RPM % *error* = 3.03%. The measurement results with *the Medium setting* (3500

RPM) obtained values of 3640 RPM % *error* = 4%, 3669 RPM % *error* = 4.82%, 3642 RPM % *error* = 4.05%. The measurement results with *the High setting* (4000 RPM) obtained a value of 4313 RPM % *error* = 7.82%, 4273 RPM % *error* = 6.82%, 4278 RPM % *error* = 6.95%. With the measurement data that has been obtained, it can be seen that the tool is still within the tolerance limit of 10%. Based on the functional tests that have been carried out, it can be concluded that the tool is back to normal condition and can be used as before.

From the design and research that has been carried out, there is a suggestion from the author, namely to maintain the condition of the tool in good condition and avoid damage, the user of the tool should comply with the SOP in *the Manual book.* If damage occurs to the equipment, damage analysis, *troubleshooting*, repairs and speed suitability testing should be guided by *the manual book* on *the centrifuge*.

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