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Design And Construction Of An Automatic Sluice Control System On Dams

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Abstract

A dam is a construction built to hold back the flow of water. At every dam there is usually a sluice gate guard. The floodgates are controlled by humans so that the water in the dam remains stable. The sluice gate guard must be ready at all times to control the water level in the dam. Water gates in dams generally use human power to open them and then close them again and this is done manually. For this reason, it is necessary to use technology that is useful as a substitute for human labor. With the development of sophisticated technology, an Automatic Sluice Gate Automation System was designed, with Aruduino nano as the control center. This sluice controller works automatically. The ultrasonic sensor functions as a water level detector and then the data is processed by Arduino nano and the results of the data reading will be displayed on the LCD. This tool also uses a DC motor to open and close the sluice gate.

Keywords: Water gate controller; Arduino nano; Ultrasonic sensor.

1. Introduction

A dam is a construction built to hold back the flow of water to become a reservoir, lake or recreation area. Often dams are also used to channel water to a hydroelectric power plant [1]. Dams are constructions built to hold back the flow of water. Dams can be used to generate electricity and to utilize all the needs of sectors involving water. Therefore, monitoring of dams needs to be carried out so that their use can be felt continuously [2]. Therefore, sluice gate officers must be ready at all times. But it is very unlikely that these officers will be available at all times to guard the flood gates [3]. Therefore, the author will design a system that can automatically control the flood gates in the dam. So it can make work easier and make it easier to monitor the water level in the dam. This tool is very useful as a substitute for the work of an operator in regulating the opening and closing of the sluice gate, so that the operator can control the sluice gate without having to be on standby at all times by setting a stable water level [4].

This tool is designed to measure the water level in the dam using an ultrasonic sensor. The sensor sends the measurement results to the Arduino Nano, which then processes the data. The sensor reading results are displayed on the LCD. If the water level is in the safe and normal category, the floodgates remain closed. However, if the water level is in the alert category, the DC motor will automatically open the flood gate and the buzzer will sound. The sluice gate will remain open until the water level returns to normal, and then automatically close the sluice gate again [5].

2. Material and methods

This tool was designed using experimental research methods (Experiment Research). This method includes creating and designing software and hardware as well as testing tools [6]. The design and manufacture of this tool explains block diagrams, tool working principles, mechanical design, tool circuit design and software design as a guide in the initial stages when building a tool.

2.1 Block diagram

Block diagrams are one method that can be used to describe in general how a tool works as a whole [7]. The general design of the "Design and Construction of an Automatic Sluice Control System On Dams" can be seen in the following picture.

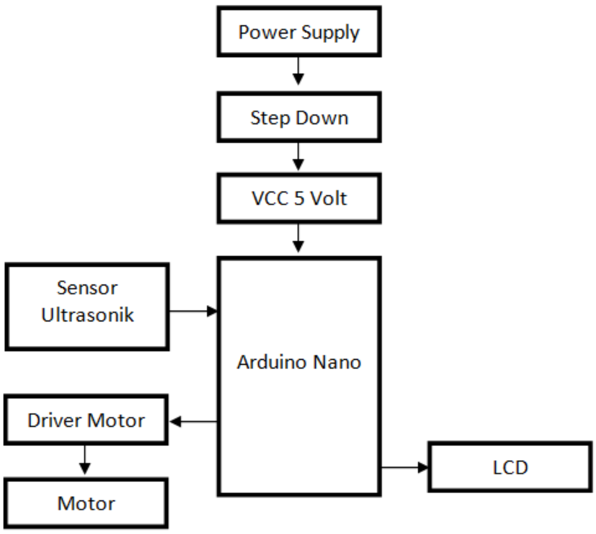

Figure 1: Block Diagram

The following is an explanation of each part in the block diagram:

1. Arduino Nano
   This module is the center for control and data processing [8]. Reads ultrasonic sensor data, controls the relay, displays the data to the LCD, and then forwards the data to Blyknk [9].
2. Ultrasonic Sensor (HCSR)
   Ultrasonic sensors/HCSR sensors are sensors that can read the distance from objects located in front of the sensor [10]. This ultrasonic sensor will be used as a water volume reader in hydroelectric dams [11].
3. Motor Driver
   The motor driver uses IC 298N where the motor driver functions as a controller for the movement of the motor which is controlled by Arduio nano [12].
4. Motorcycle
   The motor functions as a driver for the rise and fall of water gates in hydroelectric dams [13].
5. LCD
   The LCD functions to display the volume of water in the dam which is converted into percent units [14].

6. Power Supply
   The power source for the tool to be made is a 12 Volt power supply [15].
7. Stepdown
   Stepdown functions to reduce the voltage from the power supply [16].

2.2 Flow Chart

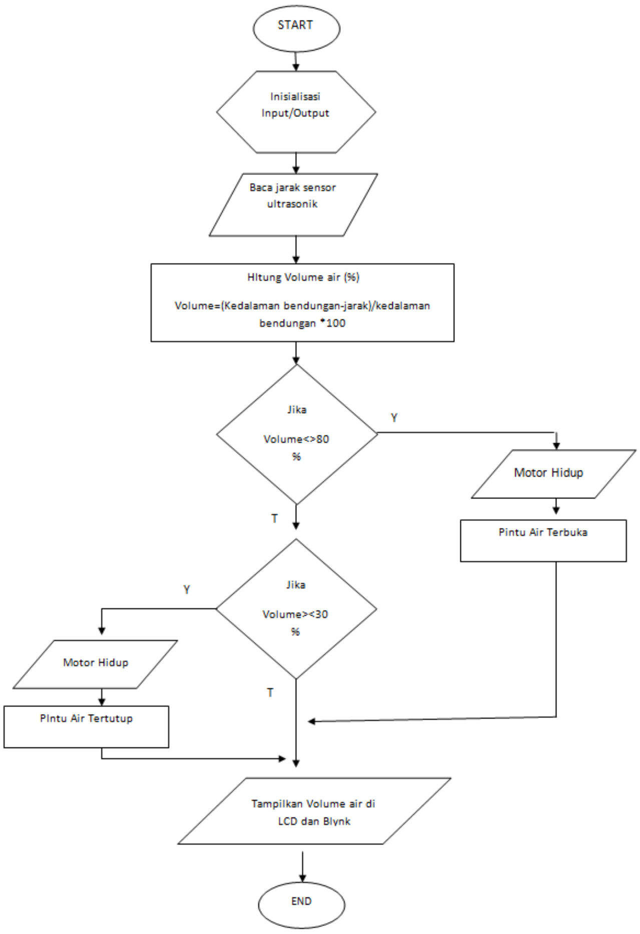

Figure 2: Flow Chart

2.3 Tool Design

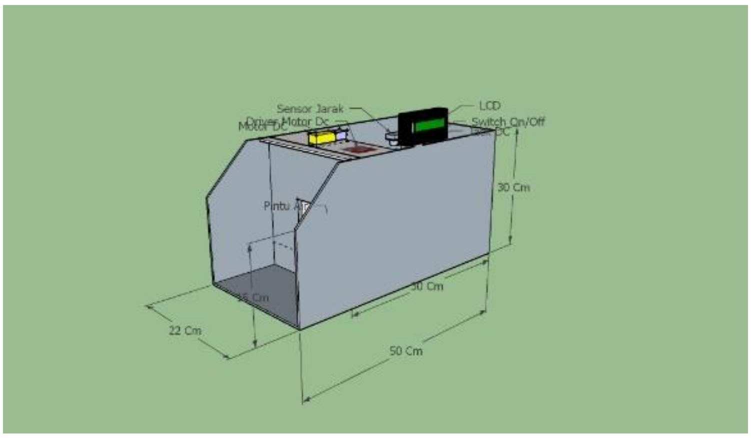

Figure 3: Tool design

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3. Results and discussion

The tool that will be made uses a 12 Volt 2 Amper adapter as the power source. For this reason, a stepdown module is used which functions to reduce the voltage from the adapter from 12 Volts to 5 Volts. In the picture you can see the measurement of the output voltage from the stepdown.

Figure 4: Stepdown output voltage

From the picture above you can see the results of measuring the voltage output from the stepdown module of 5.07 Volts.

The tool that will be made uses a 16x2 I2C LCD as a medium to display the volume of water in the hydropower dam. To be able to connect to Arduino, an I2C module is used so that the LCD can be connected to Arduino using I2C communication. In the image below you can see the output display from the LCD.

Figure 5: Water volume display on LCD

In this test, the results of the water level readings on the tool using a sensor are compared and measured with a ruler. The results of the tests carried out can be seen in table below:

Table 1: Water level reading results

NO	Jarak yang terukur (cm)	Level air yang terbaca	Lebel air secara perhitungan	Selisih	Error (%) (selisih/secara perhitungan)
1	5 cm	83,88	83,87	0,01	0,0001
2	10 cm	68,80	67,74	1,06	0,015
3	15 cm	52,00	51,61	0,39	0,007
4	20 cm	35,52	35,48	0,04	0,0011
5	25 cm	19,40	19,35	0,05	0,002
6	30 cm	3,25	3,22	0,03	0,009
Rata-rata Error					0,0057

From the table above, it can be seen that the error in the water level reading results by the sensor is 0.0057 percent. This error value is very small, this happens because the proximity sensor is an electronic device which also has a reading tolerance.

The tool made by the motor driver functions to control the rotation and direction of rotation of the motor. Where the motor will rotate and will lift the floodgate. The measurement results can be seen in the image below.

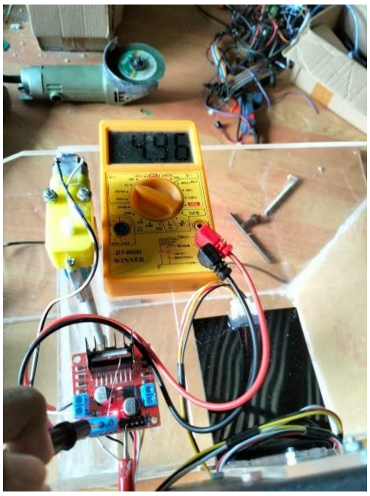

Figure 6: IN1 Measurement When the Sluice Gate Moves Open

Figure 7: IN2 Measurement When the Sluice Gate Moves Open

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In Figure 6 and Figure 7 you can see the IN1 and IN2 voltages on the motor driver at IN1 measured 4.96 Volts (HIGH) and IN2 measured 0.02 Volts (LOW).

To make the motor rotate to close the sluice gate, IN1 must be given a LOW input and IN2 must be given a HIGH input following the measurement results of the input pins on IN1 and IN2 when the motor is rotating to open the sluice gate. The measurement results can be seen in Figure 8 and Figure 9.

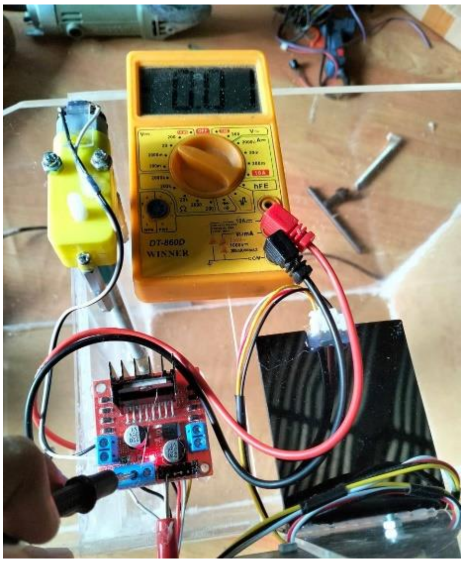

Figure 8: IN1 Measurement When the Sluice Gate Moves Closed

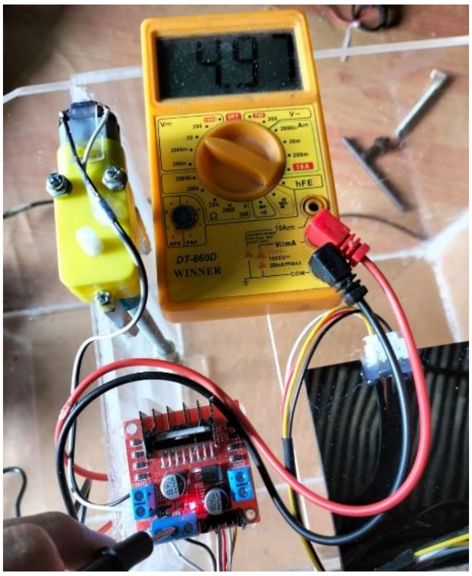

Figure 9: IN2 Measurement When the Sluice Gate Moves Closed

In figure 8 and figure 9 you can see the IN1 and IN2 voltages on the motor driver at IN1 measured 0.01 Volts (LOW) and IN2 measured 4.97 Volts (HIGH). To stop the motor rotation, the IN1 driver is given a LOW input and IN2 is given a LOW input so that the motor will not rotate.

The motor functions as a sluice gate driver, where the motor driver controls the rotation and the direction of rotation of the motor. When IN1 is HIGH and IN2 is LOW, the motor will rotate clockwise. The following motor voltage when rotating clockwise can be seen in Figure 10.

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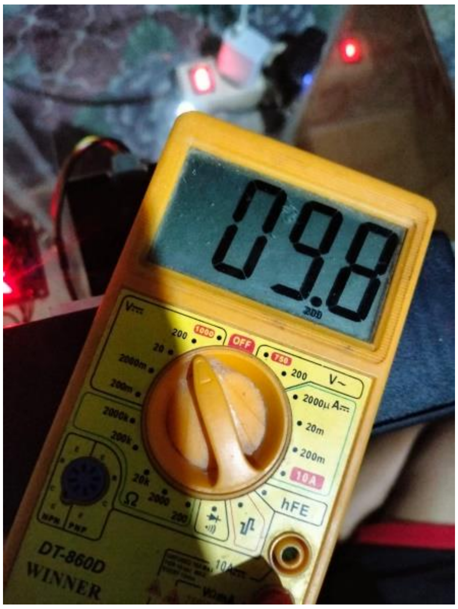

Figure 10: Motor Voltage Measurement When the Sluice Gate is Open

When IN 1 is LOW and IN2 is HIGH, the motor will rotate counterclockwise. The following is the motor voltage when rotating clockwise, which can be seen in the image below.

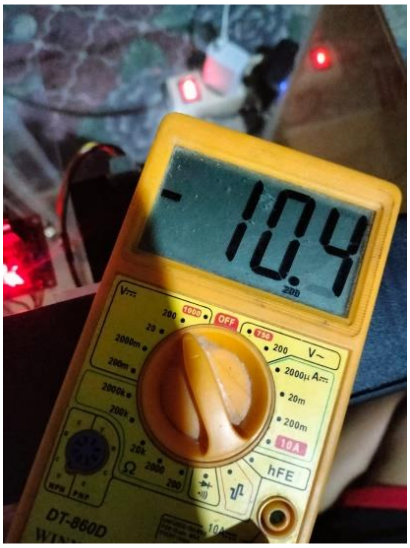

Figure 11: Motor Voltage Measurement When the Sluice Gate is Open

The motor voltage when the sluice gate is closed becomes minus because the motor rotation rotates in the opposite direction to the motor rotation when the sluice gate is open, so the positive and negative points are reversed. The measurement point is the same as the measurement point when the motor rotates to open the sluice gate.

The motor voltage when the sluice gate is closed becomes minus because the motor rotation rotates in the opposite direction to the motor rotation when the sluice gate is open, so the positive and negative points are reversed. The measurement point is the same as the measurement point when the motor rotates to open the sluice gate.

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Table 2: Overall Measurements

NO	Jarak yang terukur (cm)	Lever air yang terbaca (%)	IN1	IN2	Tegangan motor (Volt)	Tegangan buzzer (Volt)
1	5 cm	83,88	HIGH	LOW		HIGH
2	10 cm	68,80	LOW	LOW	0,0	LOW
3	15 cm	52,00	LOW	LOW	0,0	LOW
4	20 cm	35,52	LOW	LOW	0,0	LOW
5	25 cm	19,40	LOW	HIGH		LOW
6	30 cm	3,25	LOW	HIGH		LOW

From the component testing and measurements that have been carried out, the data obtained according to table 2 can be concluded that the tool being made is running normally. Where the reading results from the distance sensor are very accurate, where the reading error is 0.0057 percent. The sluice gate moves normally, where the sluice gate moves open if the water volume is >80 percent and will close again if the water volume is <30 percent. When the sluice door moves open the buzzer will sound.

4. Conclusion

After designing and testing the design of an automatic sluice control system for dams in hydroelectric power plants, the author can draw several conclusions, namely: The tool made works well, where the sluice gate opens when the water volume is >80 percent and the sluice gate will close again if the water volume <30 Percent. The tool created can read the volume of water using a distance sensor. The water volume can be monitored on the LCD screen on the tool.

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