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Prototype of Automatic Water Level Monitoring System and Flood Gate Control With IOT-Based Flood Warning Notification

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ABSTRACT

Indonesia is one of the countries with a fairly high rainfall rate. Indonesia is part of the tropical rainforest area around the equator up to 15 degrees north and south. This causes flooding disasters to often occur in Indonesia, directly impacting areas that are especially close to rivers, so that when the rainy season comes, many agricultural areas, housing, villages, and plantations are affected by floods. Therefore, this study aims to design a prototype system that can provide accurate and fast information to authorities and the wider community regarding the potential for flooding. The design of a prototype of a water level monitoring system and automatic floodgate control using several sensors such as an ultrasonic sensor that functions to measure water level, a DHT11 sensor to measure humidity and air temperature, and a rain sensor to detect rainfall intensity, and a stepper motor as a floodgate driver controlled via an ESP 32 microcontroller. The final results of this study are displayed on the LCD in the form of sensor reading data and flood warning notifications to smartphones via the MIT App Inventor.

INTRODUCTION

Indonesia is one of the countries with a fairly high rainfall rate. Indonesia is part of the tropical rainforest area around the equator up to 15 degrees north and south. This causes flooding to often occur in Indonesia, directly impacting areas that are especially close to rivers, so that when the rainy season comes, many agricultural, residential, rural, and plantation areas are affected by flooding. Dams are one solution to various problems related to water resources, utilization, management, and preservation. Dams also act as a flood control system. The dam building has a part called a water gate to regulate the water discharge that flows gradually or continuously.

Based on this topic, the importance of quickly knowing the water level in the dam is very necessary in dealing with uncertain rainfall. Until now, the dam water gate control system has been done manually so that it requires a development stage into an automatic system by considering several other aspects, so that decision making can take place quickly. At the water gate, a dam requires an android-based monitoring system that is useful for providing real-time information in providing warning information about the danger of water discharge that is starting to approach the maximum safety limit, making it easier for officers to get information in real time.

Automatic door monitoring and control tool with ESP 32 is a system designed to measure and monitor the water level in a container or a specific location. ESP 32 is a microcontroller used as the main brain in this system, which allows wireless data transmission and internet connectivity. This system consists of several components including ESP 32, ultrasonic sensor, DHT 11 sensor, and rain sensor. Ultrasonic sensor to measure water level, DHT 11 sensor to measure humidity and air temperature, and rain sensor to detect rainfall intensity. ESP32 acts as the main controller in this tool. It takes data from the sensor and then sends it via WiFi connection to a server or cloud platform. This module can also be programmed to send notifications or warnings if the water level reaches a specified threshold.

With this monitoring system, it can provide accurate and fast information to the authorities and the wider community regarding the potential for flooding. In addition, the integrated automatic water gate control system can help in regulating water discharge efficiently, so as to minimize the risk of flooding and there is an early warning that can inform the public if the water volume has exceeded the limit. Based on the background and problems regarding the potential for flooding, the author created a final project entitled "Prototype of Water Level Monitoring System and Automatic Water Gate Control with IoT-Based Flood Warning Notification."

LITERATURE REVIEW

In August to October 2024, the Indonesian region is generally predicted to experience low to medium rainfall. In August 2024, 17.63% of Indonesia's territory is predicted to experience low rainfall (0 - 100 mm/month), 73.69% is predicted to be medium (100 - 300 mm/month) and 8.68% is predicted to experience high to very high rainfall (>300 mm/month). In September 2024, 14.73% of Indonesia's territory is predicted to experience low rainfall, 75.33% is

predicted to be medium and 9.94% is predicted to be high to very high. Meanwhile, in October 2024, 7.50% of Indonesia's territory is predicted to experience low rainfall, 63.81% is predicted to be medium and 28.69% is predicted to be high to very high. From the weather predictions in Indonesia, the Internet of Things (IoT) plays an important role in facilitating various digital interactions, including in collecting and monitoring weather data such as rainfall.

Internet of things (IoT) is a network of physical objects. IoT can be categorized into three, namely people to people, people to machine, and machine to machine. The purpose of the Internet of Things is to enable everything to be connected anytime, anywhere, with anything and anyone who ideally uses any path or network and service. How IoT works by utilizing a programming argument, where each argument command can produce an interaction between machines that have been connected automatically without human intervention and without being limited by long distances. In this IoT system, several hardware components used include ultrasonic sensors, which are sensors that function to convert physical quantities (sound) into electrical quantities and vice versa. The way this sensor works is based on the principle of the reflection of a sound wave so that it can be used to interpret the existence (distance) of an object with a certain frequency. DHT11 is a digital sensor for detecting temperature and humidity. The DHT11 temperature and humidity sensor is available as a sensor and module. The rain sensor is a sensor that functions to detect rain or water hitting the sensor. The point is, if this sensor is exposed to water on the sensor board, its resistance will change, the more water that hits the sensor, the smaller it will be and vice versa. Audio signal devices such as beepers or buzzers can be electromechanical, piezoelectric, or mechanical types. Their main function is to convert signals from audio to sound. A stepper motor is an electromechanical device that converts electrical power into mechanical power. A stepper motor is also a brushless synchronous electric motor that can divide a full rotation into a large number of steps. LCD (Liquid Crystal Display) is a device that functions as a display media by utilizing liquid crystals as the main display object. A power supply is an electronic device or device that functions to convert AC current into DC current to power other hardware. LED stands for Light Emitting Diode which can emit monochromatic light when given a forward voltage bias. Step Down is a DC voltage reducer designed to convert a higher DC input voltage to a lower DC output voltage with a current of up to 3A. A DC water pump is an electric pump with low voltage. A relay is a switch device that is controlled by an electric current. A4988 is a micro stepping driver for controlling bipolar stepper motors that has a built-in translator for easier operation.

The software used includes Arduino IDE, which is software that provides an Integrated Development Environment (IDE) for creating programs on the Arduino board. Arduino IDE functions as software used to create, edit, and validate program code. Firebase is a Backend as a Service (BaaS) offered by Google to make it easier for application developers to develop applications (web and mobile). As a Backend as a Service (BaaS), Firebase is able to manage everything related to databases, authentication, hosting, APIs and the like. MIT App Inventor is an open web application originally developed by Google, and is currently managed by the Massachusetts Institute of Technology (MIT). App Inventor allows users to drag and drop visual objects to create applications that can be run on software for Android. App Inventor 2 is cloud-based and can be accessed using a browser.

METHOD

In the design and implementation of the system, it will be explained about how the system works which is contained in the outline of the system design and followed by an explanation of the hardware which consists of several parts that function to process data. Then followed by the design and creation of software and in the mechanical design in the form of the creation and design of the tool design.

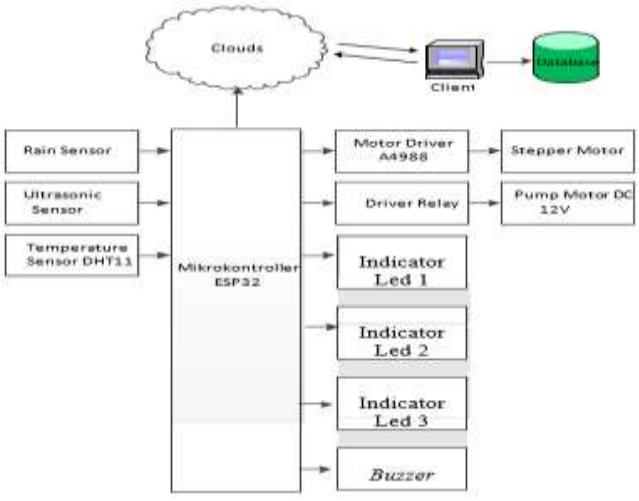

Fig. 1 Block Diagram

The overall system design consists of several integrated components to detect and control environmental conditions. First, the rain sensor functions to detect rainfall with a reading value between 0 and 1023. In addition, an ultrasonic sensor is used to measure the distance of the water level. To monitor the temperature, a DHT11 sensor is used to detect the temperature of the tool prototype. The ESP32 microcontroller acts as the brain of the system, reading data from sensor inputs and controlling outputs such as relays, stepper motor drivers, and LED indicators and buzzers. The A4988 motor driver is responsible for driving the stepper motor, while the relay driver controls the 12V DC pump which functions to automatically discharge and fill water. The LED indicator provides visual information about the water level through several indicator levels, while the buzzer functions as a sound indicator. Finally, the database stores data sent via a WiFi network to the cloud for access by clients.

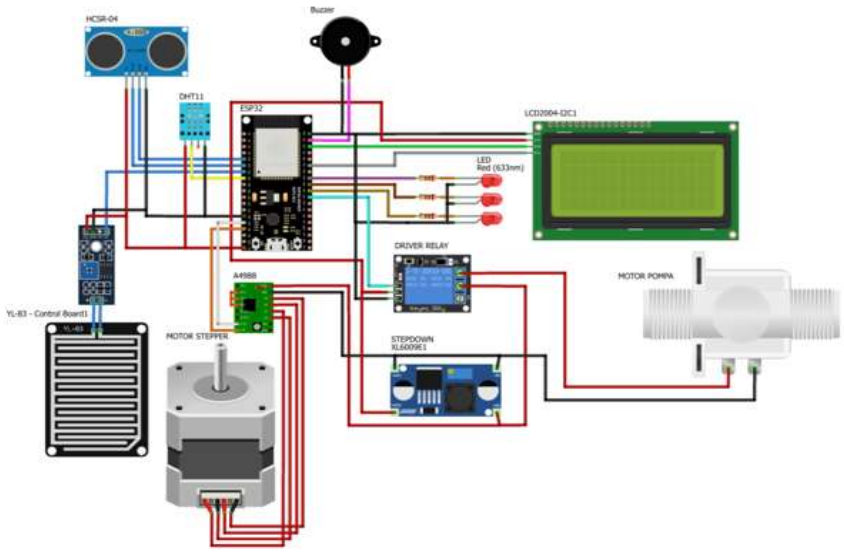

Fig. 2 Complete Tool Set

Hardware design consists of mechanical design and electronic design. Mechanical design, namely creating a design form for the mechanics of a tool system and electronic design, namely creating an electronic circuit that will be realized in the form of a PCB (Printed Circuit Board). The schematic of the entire tool is a circuit that functions to arrange all the circuits to work together to suit the needs of the tool used.

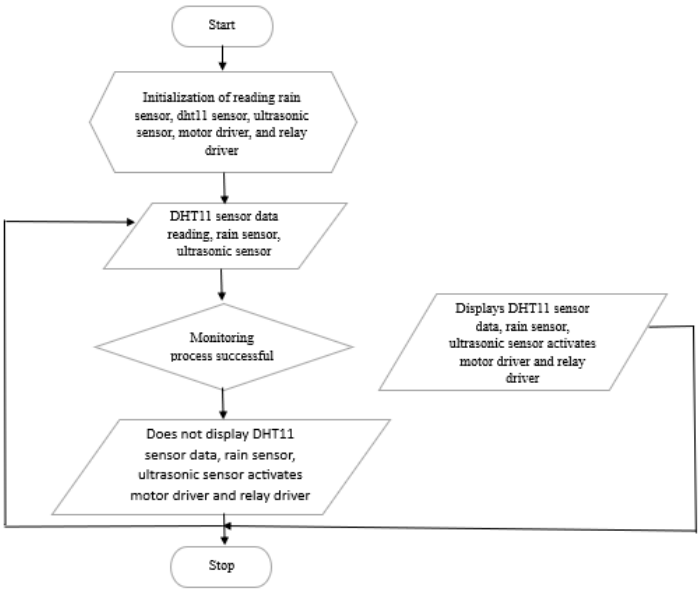

Fig. 3 Flowchart

Software design is creating an algorithm for a system. An algorithm is an outline of how a program works, where one of the algorithms is presented in the form of a flowchart. The direction of a program will be clearly visible from the

flowchart. A flowchart is a sequence of instructions for creating a program. Creating a flowchart is necessary to make it easier to create a program.

RESULT

From Figure the design of the tool manufacturing results is the result of the design and manufacturing of the tool that has been completed with a fairly broad form, namely on the tool there is a composition of the components used, including several sensors, a stepper motor on the blue door and on the right, the part of the DC12 VDC pump is clearly visible.

Fig. 4 Prototype Tool Design

Fig. 5 MIT App Inventor View On Smartphone

The design and creation of this application aims to provide an overview of the form, arrangement and form of the application menu that will be used as a controller for this robot. Where the design of the application menu uses MIT App Inventor 2 software which uses a software design system, namely the drag and drop system. This smartphone display is the result of the design of the application menu which contains several monitoring information including water levels in the form of centimetres, then the rain value in reading ADC (Analog Digital Converter) data, reading temperature and humidity sent or received from the device to the firebase database to the MIT App inventor display and control of the pump motor which can be opened and closed its flow via the smartphone application.

Fig. 6 Realtime View of Firebase Database

The database used is the firebase database which is connected to the MIT App inventor design. In the firebase database storage display, it is the result of creating a database storage that will be a data storage medium from sensors that will be monitored and controlled by receiving data from sensor data sent to the device created. In the realtime display, this firebase database is the result of data sent by the device to the firebase database in the form of numeric and text data that is sent in real time every second when the device is on.

Table 1 Voltage Measurement On Components

No	Component Name	Measurement Point	Input Voltage (DC Voltage)	Measured Voltage (DC Voltage)
1.	DHT11 Sensor	TP1	5.01	4.34
2.	Rain Sensor	TP1	5.01	2.04
3.	Ultrasonic Sensor	TP1	5.01	4.34
		TP2	5.01	4.34
4.	LED	TP1	5.01	3.50
		TP2	5.01	3.50
		TP3	5.01	3.50
5.	Buzzer	TP1		4.8
6.	Relay	TP1	12.1	11.20
7.	Motor Driver A4988	TP1	12.1	11.17

Testing on the DHT11 sensor is done to get the voltage measurement value when the sensor is on and to see some temperature and humidity test values on the sensor that are sent to the application used. Testing on the rain sensor is a test that is done to get the measurement value on the rain sensor that can read the voltage value, namely with a maximum value at a voltage of 5VDC. Testing of the ultrasonic sensor aims to get the measured voltage value when the sensor can work properly and this test is to see the conditions where the ultrasonic sensor can read the condition value from the distance to be measured. Testing of the LED aims to see the condition of the LED that works by activating the output in the form of light on the active indicator LED with a voltage value that works on each active LED, namely 3.5VDC. Testing on the buzzer is a test that is done to get the voltage value of the buzzer when the buzzer is active through the test value conditions that are carried out. Relay testing is a test that is done on the relay to see the condition of the relay whether it can work properly or not and to see the condition of the relay, namely with the Normally Close (NC) condition or the Normally Open (NO) condition. Testing of the A4988 motor driver is a test that aims to test the condition of the stepper motor with conditions, namely clockwise and counterclockwise rotation.

Table 2 Rain Sensor Test Results Against Weather

Weather Conditions	Rain Intensity (ADC)
Rainy Season	430
	486
	479
	463
Dry Season	514
	515
	644
	671

The results of the rain sensor test on the weather obtained the reading results from the sensor with the reading of the ADC (Analog Digital Converter) value where the reading of data from the sensor used detects conditions with two weather conditions, namely the rainy season and the dry season. The ADC converts the analog signal (voltage generated by the sensor) into a digital value that can be read by a microcontroller such as the ESP 32. The ADC value is usually in the range of 0 to 1023 with a resolution of 10-bit. On the rain sensor there is an analog reading value during the rainy season, namely 430 to 463, while during the dry weather conditions it is worth 514 to 671.

Table 3 Ultrasonic Sensor Dam Water Level Testing

Water Height (cm)	Height Condition	LCD Condition
10	Alert 3	Water Level Alert 3
9	Alert 2	Water Level Alert 2
8	Alert 1	Water Level Alert 1
7		
6	Medium	Medium Water Level Condition
5		
4		
3		
2	Low	Low Water Level Condition
1		

Distance testing conducted with a value of 1 cm to 10 cm works well to read the distance from the water level. At a height of 1 to 4 cm, the low height condition with the LCD display condition is the low water level condition. At a height of 5 to 7 cm, the medium height condition with the LCD display condition is the medium water level condition. At a height of 8 cm, the standby height condition 1 with the LCD display condition of the standby water level 1. At a height of 9 cm, the standby height condition 2 with the LCD display condition of the standby water level 2. At a height of 10 cm, the standby height condition 3 with the LCD display condition of the standby water level 3.

DISCUSSION

The DHT11 sensor test analysis is where the DHT11 sensor is a sensor that can measure the temperature and humidity values of this sensor, but in this test the author aims to find the measurement value, namely by using a measuring instrument, namely a multimeter, where the voltage used is 5.01VDC while the measurement results obtained from measurements using a measuring instrument are 4.34VDC. The test analysis of the rain sensor is when the sensor is actively working when it finds a rainwater value, namely with a low voltage value of 2.04VDC, while the voltage used on the sensor is to find a supply value of 5VDC. It can be concluded that when the sensor is in normal condition, namely at a voltage value of 5VDC, while when the sensor finds a rain value that activates the reading from the rain sensor, the measurement value obtained is 2.04VDC. On the rain sensor there is an analog reading value during the rainy season which is 430 to 463 while during dry weather conditions it is 514 to 671.

The test analysis of the ultrasonic sensor is found that the test in the measured distance the sensor can work well where this test finds a measured value from the sensor which is 4.34VDC which uses a supply value of 5VDC. And the distance test carried out with a value of 1 cm to 10 cm works well to read the distance from the water level. At a height of 1 to 4 cm, the low height condition with the LCD condition display is a low water level condition. At a height of 5 to 7 cm, the medium height condition with the LCD condition display is a medium water level condition. At a height of 8 cm, the standby height condition is 1 with the LCD display of the standby water level condition 1. At a height of 9 cm, the standby height condition is 2 with the LCD display of the standby water level condition 2. At a height of 10 cm, the standby height condition is 3 with the LCD display of the standby water level condition 3.

The analysis of this LED test is where when the LED is working actively, a voltage value of 3.50 VDC is obtained, while when the LED is off, the voltage value on the LED is only 0 VDC. Which voltage value is obtained because the LED is activated through a series circuit on the anode leg of the LED to the resistor. The analysis of the buzzer test found a test result value of an active voltage value of 4.8VDC which will be active with the activation condition of the condition that produces a "Beep" sound. Which condition is active through the activation condition of the condition with active voltage on the microcontroller. The LCD test itself is a test that aims to obtain output in the form of a display or display in a Liquid crystal that displays numbers and letters that are input or set via a microcontroller.

The analysis of the relay test is a test that is to get a value with the condition of the relay, namely two conditions including the connected condition of the relay, namely the Normally Close (NC) condition with a voltage of 11.20VDC while in the disconnected condition, namely the Normally Open (NO) condition with a voltage of 0. The test analysis of

the A988 driver is where the condition of the motor control that is used on the dam gate finds a measured voltage value of 11.17VDC, which is also this voltage value obtained through measuring the V mode pin on the A4988 stepper motor driver.

CONCLUSION

After data collection and direct tool trials, it can be concluded that the design of the water level monitoring system in the rainy season, the measured water level is 7 to 10 cm with the output on the LCD being a high water level display, then in medium water level conditions, it is measured as 5 to 6 cm, and in low water level conditions, it is measured as 1 to 4 cm. The design of the automatic water gate control system integrated with the monitoring system can be conditioned, namely automatic and stepper motor control on the dam gate via smartphone if there is a failure to read from the ultrasonic sensor via water level. The readings on the DHT11 sensor and rain sensor in the information revenue system are in the form of temperature and humidity readings, and on the rain sensor there is an analog reading value during the rainy season, namely 430 to 463, while during dry weather conditions it is 514 to 671. Early warnings about potential flooding are obtained through automatic notifications to users via the application used and there is an LED indicator that lights up when getting water level conditions with flood conditions accompanied by the sound of a buzzer for 10 seconds.

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