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Water Level Monitoring for Flood Early Mitigation Based on Internet of Things (IoT)

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***Abstract*—**Flooding is a disaster that often threatens communities, especially in high-risk areas. It is not surprising that this disaster causes many losses to the community morally and materially. This is because the area is on the riverbank and is the lowest point. The purpose of this final project is to design a flood early warning system as a water level monitoring to minimize the losses caused by floods with a water level monitoring tool to provide early warning to the community in the event of a flood. This water level monitoring tool utilizes solar panels as an energy source, where this tool uses ultrasonic sensors as water level detection and rain sensors as rainfall detection. This tool requires 28.6 Watts of power to power the system and the accuracy of the ultrasonic sensor is 99.94% with an average ultrasonic sensor error of 0.05%. This water level monitoring tool will help improve the flood early warning system, thus enabling the community to take appropriate mitigation steps before floods reach dangerous levels. Thus, losses due to flooding can be reduced, and assets can be restored, communities can be better protected from the threat of flooding.

***Keywords*—**Rainfall Sensor, NodeMcu Esp8266, Water Level Monitoring, Ultrasonic Sensor, Thinger.IO.

I. Introduction

Flooding is a natural disaster that occurs most often, it is not surprising that this disaster has many negative impacts on society. Where the impact caused is the breakdown of the economy in flood-affected areas, loss of shelter, and property where the handling to date has not been able to be dealt with quickly (Nasution Rizki Fitriana, 2019). Thus, it is very necessary to monitor the water level as an early warning of flooding.

Research (Hanggara, 2020) has designed an internet of things-based flood early mitigation system using ultrasonic sensors as Arduino UNO R3 water level readers as data processors and monitored through the Thingspeak application. Research (Danang et al., 2019) has designed flood disaster mitigation with monitoring and early warning information systems using water level sensors as water level limit readers, sms gateway to send notifications and websites for monitoring water level conditions. Research (Hasiholan Chrisyantar , Primananda Rakhmadhany, 2018) has designed the implementation of the internet of things concept in flood monitoring using Raspberry Pi as a microcontroller, ultrasonic sensors to measure distance and MQTT as a flood monitoring system. Research (Pratama et al., 2020) has designed a water level monitoring system as an internet of things-based flood detector using ultrasonic sensors to detect distance, Arduino UNO as a microcontroller, and sms.gateway as a notification. Research (Jannah, 2019) has made an early warning system for flood information with Arduino UNO as a microcontroller, rain sensors to measure water levels, rain sensors for rain detection and sms gateway to send notifications. Therefore, this problem must be taken seriously so that it does not cost lives by making a water level monitoring tool as an early warning of flooding.

Based on the research that entirely raises the discussion about monitoring water levels as an early flood mitigation, in this study a water level monitoring system is made as an early flood mitigation in the form of an implementation with Node MCU ESP8266 as a microcontroller. Ultrasonic sensor for water level detection, rain sensor for rain detection, Thinger.IO as a monitoring tool, telegram as notification and siren as a warning indicator.

II. Literature Review

A. NodeMCU ESP8266

According to (Ryan Handika et al., 2022) (NodeMCU ESP8266 is a microcontroller and also functions as a Wi-Fi module, so it can help in making internet of things systems and can also run programming directly without the need for additional microcontrollers as seen in Figure 1

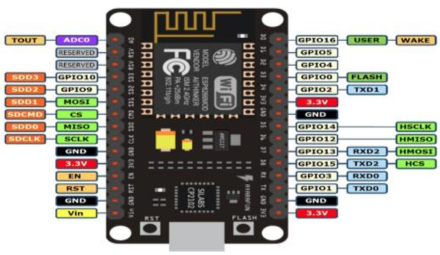

Figure 1. NodeMCU ESP8266

B. Internet of things

According to (Y. Saragih, j. H. Prima silaban, h. Aliya roostiani, 2020) Internet of Things is a concept where certain objects have the ability to transfer data over a wifi network, so it does not require interaction between human to human or human to computer but is run automatically with a program.

C. Flood

Flood is a natural disaster where the volume of water rises in an area so that it covers the area. Where areas that are often affected by floods are low-lying areas, areas along rivers and densely populated urban areas. This system aims to provide early warning when the water level is in alert and danger conditions and can be monitored through the Thinger.Io application.

D. HC-SR04 Ultrasonic Sensor

According to (U. M. Arief, 2011) Ultrasonic sensor is a sensor that functions to convert physical quantities (sound) into electrical quantities. Ultrasonic sensors are generally used to calculate the distance of the target to the object using the speed of sound in the medium, according to (R. C. Jisha, g. Vignesh, 2019) And ultrasonic sensors in reading distance take time to send and receive sound waves by comparing the distance from the sensor to the object (Figure 2).

Figure 2. HC-SR04 Ultrasonic Sensor

E. FC-37 Rain Sensor

According to (Mufidah, 2018), a rain sensor is a device that can detect rain or rainy weather in the vicinity, used to measure the intensity of rainfall (Figure 3).

Figure 3. Rain Sensor

F. Siren MS-190

According to (L. P. Inside, 2014) Siren is a vibrating device that uses an electric current source to produce a continuous roaring sound. Sirens have the advantage of being able to provide an early warning of the danger that will occur so that the owner can anticipate and minimize casualties and material losses (Figure 4).

Figure 4. Siren

G. 20x4 LCD

According to (Nasution Rizki Fitriana, 2019) LCD is an electronic component that functions as a display of data, either characters, letters or graphics. According to (Mulyanto, 2020) LCD screen is a module screen with 4 rows and 20 columns and this module is equipped with a microcontroller specifically designed to control LCD (Figure 5).

Figure 5. LCD

H. Thinger.IO

According to (Zulkarnaen et al., 2021) Thinger.io is an opensource platform for IoT that provides cloud facilities for connecting IoT devices. This platform supports all types of boards such as Arduino, ESP8266, Rasberry Pi, and Intel Edison. Thinger.Io can also visualize sensor readings in the form of values or graphs (Figure 6).

Figure 6.Thinger.IO

I. Telegram Bot App

According to (Mulyanto, 2020) Telegram is the only short message application that provides a fire for users to be able to create bots that can be utilized for information systems. Bots are third- party applications that can be run inside Telegram. Users can send messages, commands, and inline requests. We can control the bot using HTTPS to the telegram API.

J. Solar Panels

According to (P. Harahap, 2021) Solar panel is a device that can convert sunlight into electrical energy (Figure 7).

Figure 7. Solar Panel

K. Battery

According to (Usman, 2020) the battery in PLTS functions to store the electric current generated by solar panels before being utilized to operate the load. Loads can be refrigerator lights or electronic equipment and other equipment that requires DC electricity (Figure 8).

Figure 8. Battery

L. Solar Charge Controller

According to (Usman, 2020) Solar charge controller is used to regulate the current for charging to the battery, avoiding over charging, and over voltage. If the battery is in a fully charged condition, the electricity generated from the solar panel will not be put back into the battery and vice versa if the battery condition is less than 30% then the charge controller will charge the battery back to full (Figure 9).

Figure 9.SCC

III. Methods

The design of this system is made based on the block diagram and flowchart on the tool that has been implemented. This block diagram is an arrangement of components used in this system. In general, the system design block diagram consists of three parts, namely input, process, and output. The inputs of this system are ultrasonic sensor to detect water level, rain sensor to detect rainfall, solar panel to convert sunlight energy into electrical energy. The process of this system is the NodeMCU EPS8266 microcontroller as the controller of the entire system, Solar Charge Controller to regulate direct current charged to the battery and taken from the battery to the load, Battery to store electrical energy generated by solar panels in the form of DC current energy. The output of this system is the MS-190 siren as an alarm if it is at a danger point, Thinger.IO as monitoring of the sensor detection results, LCD as a display of conditions that have been detected by the sensor, Telegram as a warning notification according to the conditions that have been detected by the sensor (Figure 10).

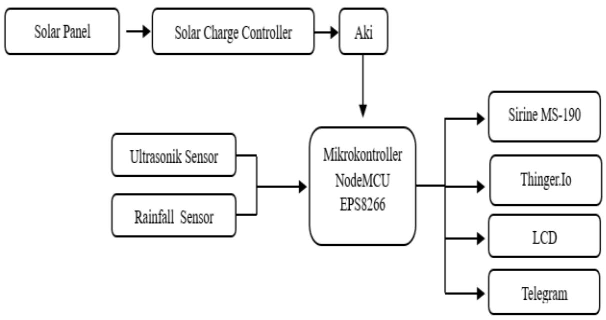

Figure 10. Block diagram

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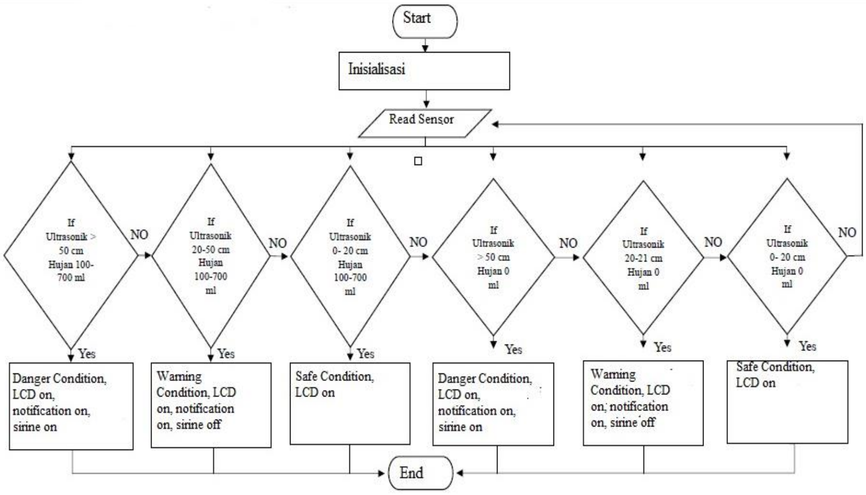

Figure 11. System Flowchart

Explanation of Figure 11. about System Flowchart:

1. Module and Sensor Initialization (FC-37 rain sensor and HC-SR04 ultrasonic sensor). This stage is to initialize the modules and sensors that will be used in the final project.
2. Sensor Readings. After initializing the sensors and modules, it will then perform sensor readings according to the previously initialized sensors.
3. Safe Condition Reading. There are two safe conditions, the first is when the rain sensor value is 100-700 ml, the ultrasonic sensor value is 0-20 cm and the second is when the rain sensor value is 0, the ultrasonic sensor value is 0-20 cm with the buzzer OFF and will be displayed on the LCD.
4. Alert Condition Reading. There are two Alert conditions, the first when the rain sensor value is 100-700 ml, the ultrasonic sensor value is 21-50 cm and the second when the rain sensor value is 0, the ultrasonic sensor value is 21-50 cm with the buzzer OFF condition and will be displayed on the LCD and send a telegram notification.
5. Danger Condition Reading. Danger conditions are two conditions first when the rain sensor value is 100-700 ml, ultrasonic sensor value >50 cm and second when the rain sensor value is 0, ultrasonic sensor value >50 cm with the buzzer ON condition and will be displayed on the LCD and send a telegram notification.
6. LCD Display. The LCD will display the conditions read by the sensor.
7. Siren Conditions. The siren will sound when it reads a danger condition that is satisfied by the sensor.
8. Telegram Notification. Telegram notifications will appear on the phone when reading Alert and danger conditions are met.

IV. Results and Discussion

A. *Solar Panel Testing*

Solar panel testing is done to determine the voltage, current, and power possessed by solar panels. To test it using a multimeter measuring instrument. The following are the results of solar panel testing (Figure 12 to 13).

Figure 12. Solar Panel Testing

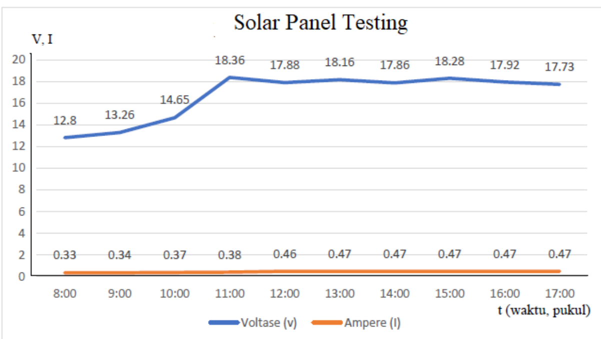

Figure 13. Solar Panel Result

From testing the solar panel in Figure 13 the solar panel used is 50Wp (watt/peak) where 1 Wp gets 1 Watt, then 50Wp can produce 50 Watts, which means that in the peak (hot heat) the solar panel can produce 50 Watts of power. So, when in a day the weather is hot for 3.5 hours of scorching heat, it means that solar panels in 1 day produce 175 Watts of power, which is obtained from the Wp value of solar panels multiplied by time (hours) so, 50Wp X 3.5 hours = 175 Watts.

B. Battery Battery Testing

This test is carried out to determine whether the solar panel can charge the battery and solar charge controller to keep the battery voltage stable and can flow the electrical load to the load through the solar charge controller. The following are the results of the Battery test (Figure 14 to 15).

Figure 14. Battery Battery Testing

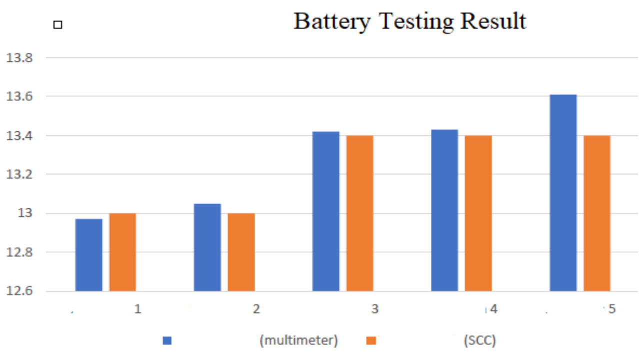

Figure 15. Battery Testing

C. Overall Testing

Overall testing of this *internet of things-based* water level monitoring tool aims to find out whether the tool can work properly. In the work system of this tool, solar panels are usedto provide an energy source that is stored in a 12v battery.

The following is the overallcircuit in testing the entire *internet of things-based* water level *monitoring* tool (Figure 16).

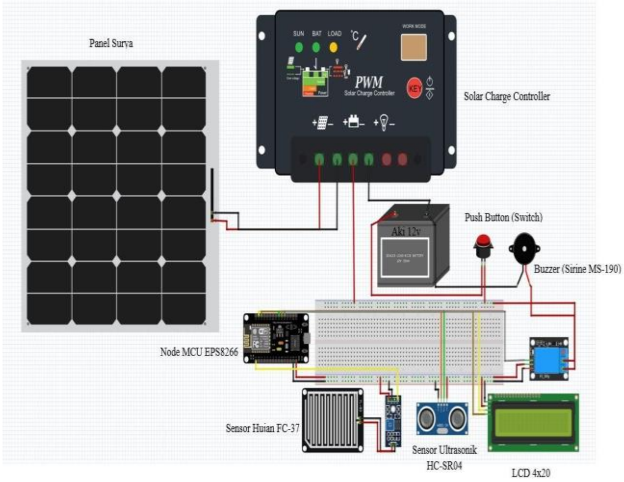

Figure 16. Overall circuit

The overall implementation picture can be seen in Figure 17

Figure 17. Overall Implementation

The following are the overall test results that have been carried out can be seen in Table 1:

Table 1. Overall Test Results

No	Sensor Result	Thinger.Io	LCD	Telegram	Siren	Condition
1	U = 53 cm R = 0 ml	Safe condition, Distance 53 cm, Interred value 0	Safe, Water Level : 53 cm Rainfall : 0	-	OFF	Safe
2	U = 45 cm R = 0 ml	Warning condition, Distance 45 cm, Interred value 0	Warning Water Level : 45 cm Rainfall : 0	Warning	OFF	Warning
3	U = 17 cm R = 0 ml	Danger condition, Distance 17 cm, Interred value 0	Danger Water Level : 17 cm Rainfall : 0	Danger	ON	Danger
4	U = 55 cm R = 443 ml	Safe condition, Distance 55 cm, Interred value 443	Safe Water Level : 55 cm Rainfall : 443	-	OFF	Safe
5	U = 38 cm R = 623 ml	Warning condition, Distance 38 cm, Interred value 623	Warning Water Level : 38 cm Rainfall : 623	Warning	OFF	Warning
6	U = 17 cm R = 632 ml	Danger condition, Distance 17 cm, Interred value 632	Danger Water Level : 38 cm Rainfall : 623	Danger	ON	Danger

From the test results in Table 1, it can be concluded that the ultrasonic sensor and rain sensor can work well, namely if the value of the ultrasonic sensor is 53 cm and the rain sensor is 0 ml then it can be said to be a safe condition, if the value of the ultrasonic sensor is 45 cm and the rain sensor is 0 ml then it can be said alert condition, if the ultrasonic sensor value is 17 cm and the rain sensor is 0 ml then it can be said to be a dangerous condition, if the ultrasonic sensor value is 55 cm and the rain sensor is 443 ml then it can be said to be a safe condition, if the ultrasonic sensor value is 38 cm and the rain sensor is 623 ml then it can be It is said to be an alert condition, if the value of the ultrasonic sensor is 17 cm and the rain sensor is 632 ml then it can be said to be a dangerous condition.

The success of information on water level heights and rain conditions which can be monitored remotely via the Thinger.Io application and the Telegram application means that the system created can be said to be based on the Internet of Things because it can be accessed anywhere as long as there is an internet network (Figure 18 to 20)

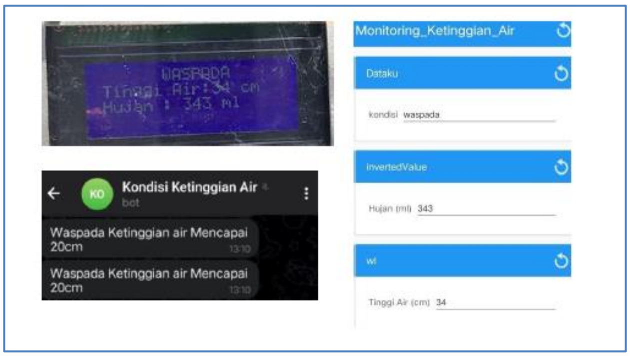

Figure 18. Display during safe condition

Figure 19. Display during warning alert

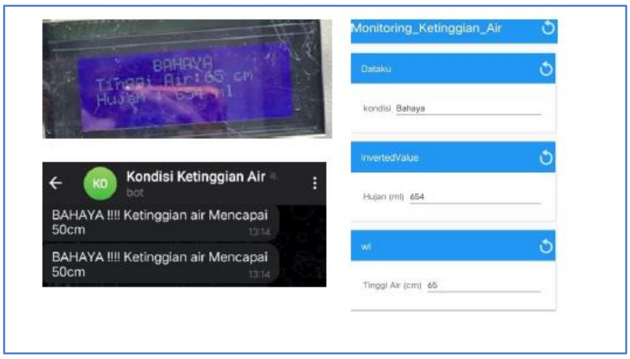

Figure 20. Display during danger condition

V. Conclusion

This research uses ultrasonic sensors and rain sensors as flood monitoring tools that can provide information about water levels and rainfall in the monitored area. In this final project using Thinger.IO for monitoring flood conditions and for notifications using telegrams that will provide warnings in the event of alert and danger conditions where during danger conditions the siren is ON as an initial warning. By integrating solar panels as an energy source, the system can operate independently and sustainably, collecting water level data accurately and continuously as a step to reduce the risk of flooding by providing information to the public. Where this tool requires 28.6 Watts of power where the solar panel used is 50Wp which can produce 175 Watts per day in hot weather conditions.

The use of NodeMCU ESP8266 microcontroller in processing ultrasonic sensor and rain sensor measurements is necessary to connect and process data from sensor detection. By using NodeMCU ESP8266, the system can collect, process and transmit information efficiently and assist in monitoring water levels in real time. And for the results obtained from this study, namely that the accuracy of the ultrasonic sensor is 99.94% with an average ultrasonic sensor error of 0.08%.

The application of the internet of things method using NodeMCU ESP8266 can provide speed in sending data from sensor detection and getting information when conditions occur when alert and danger conditions occur. Using NodeMCU ESP8266 will provide a quick response to changes in water level conditions to help and take appropriate mitigation actions.

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