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Design and Construction of an Internet of Things (IoT)-Based Water Level Monitoring System Using ESP32 for Early Flood Prevention

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***Abstract*— This research focuses on the design and implementation of an Internet of Things (IoT)-based water level monitoring system as an innovative solution for early flood disaster prevention. The core of this system lies in the ESP32 microcontroller which functions as the main processing unit, and the HC-SR04 ultrasonic sensor which is responsible for measuring the distance of the water surface in real-time by utilizing the principle of sound wave reflection. The ESP32 then sends the water level data obtained by the sensor via an internet connection to a web-based monitoring platform. This platform allows users to continuously access and monitor water level information from anywhere, at any time. Based on a series of tests, the developed system proved reliable, with a high level of measurement accuracy and a data transmission success rate of 92%, demonstrating stable communication performance. The findings of this study confirm that integrating IoT technology into a flood early warning system is an effective, efficient, and relatively low-cost solution. This system can significantly increase public and regulatory awareness and preparedness by providing critical real-time data, enabling faster and more targeted mitigation and evacuation measures to reduce the impact of flood damage.**

***Keywords*— ESP32, Flood, Internet of Things, Ultrasonic Sensor, Water Level Monitoring.**

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I. INTRODUCTION

Floods are one of the natural disasters that often occur in Indonesia and cause major losses both in terms of economic and human safety [1]. One of the main factors exacerbating the impact of flooding is the delay in providing information about water levels in vulnerable areas. The development of Internet of Things (IoT) technology enables the integration of sensors, microcontrollers, and internet networks to build monitoring systems that can work in real-time [2]. With an IoT-based water level monitoring system, environmental condition information can be accessed quickly so that mitigation measures can be taken earlier. Several previous studies have developed water level monitoring systems using ultrasonic sensors and microcontrollers.

Previous Research In compiling this research, the author includes several previous studies conducted by other parties related to this research topic. Some previous studies that are relevant to this research include: ESP32-Based Water Level Monitoring Using Web Responsive. This research creates a water level monitoring device that can be accessed remotely via a website. This device uses the NodeMCU ESP8266 component as the microcontroller.

The HC-SR04 ultrasonic sensor is used to detect the distance between the device and the water (object), and the Arduino IDE software is used to program the device. Data from the ultrasonic sensor is sent to the NodeMCU ESP8266, which then displays it on the website. The website displays information about the water level based on the data collected from the ultrasonic sensor.

Water Level Monitoring Using a Telegram Bot Based on the NODEMCU ESP8266. This study discusses the creation of a water level monitoring tool using a teleghram bot. The purpose of this study is to make it easier for users to monitor water levels. The components used are the nodemcu esp8266, an ultrasonic sensor, a breadboard, and a power supply. This tool can make decisions and send messages automatically to Telegram if the distance is below 80 cm, then the decision is made that the water is overflowing [3].

FIGURE 1. ESP 32

FIGURE 2. Ultrasonic Sensor

IoT-Based Catfish Pond Water Quality Monitor. This research creates a water quality monitor for catfish ponds. The goal is to simplify the care and cultivation of catfish and reduce mass mortality caused by high water pH. The sensors used to monitor water quality include a pH sensor, a total dissolved solids (TDS) sensor, a temperature sensor, and a dissolved oxygen (DO) sensor.[4]Design and Implementation of a Web-Based and IoT (Internet of Things) Flood Height Monitoring System Using Ultrasonic Sensors. This research discusses the design and construction of a flood height monitoring tool that can be accessed remotely.via the website. The components used in this device are the NodeMCU ESP8266, relay, LED light, water pump, and ultrasonic sensor.

FIGURE 3. Blynk

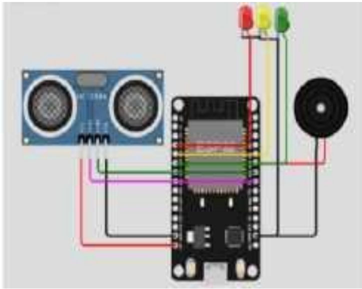

FIGURE 4. Circuit

The relay in this study is to turn on and off the LED lights and water pumps. The LED light functions as a water level indicator, if the LED is green on, the water level is classified as a safe condition, if the LED is yellow on, the water level is in an alert condition, and if the LED is red on, the water level is classified as a dangerous condition or flood alert. The way this tool works is when the water level is 8 cm, the green LED light does not flash and the buzzer will turn off. Then if the water level is 5-7 cm, the yellow LED light will flash slowly and the buzzer will sound slowly, and when the water level is 5-7 cm.

II. RESEARCH METHOD

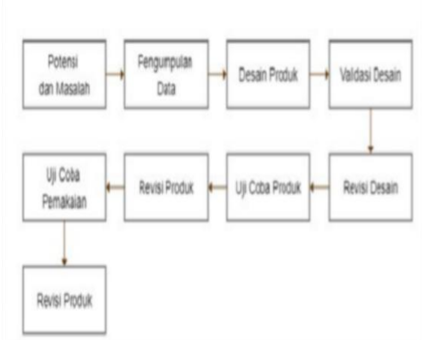

FIGURE 5. System Flowchart

FIGURE 6. System flow chart

FIGURE 7. Project Results

A. System Flow

The water level monitoring system begins by reading the water surface distance using the HC-SR04 ultrasonic sensor. This distance data is processed by an ESP32 microcontroller to determine the water level. The data is then sent via WiFi to a web-based monitoring platform for real-time display [5].

B. Equipment and Materials

The devices used in this research include ESP32, HC-SR04 ultrasonic sensor, power adapter, as well as Arduino IDE software and web-based IoT platform.

C. System Working Principle

The ultrasonic sensor sends sound waves toward the water's surface and receives the reflected waves. The ESP32 calculates the wave's travel time to determine the distance to the water's surface, then sends the data to a monitoring server [6].

D. System Testing

Testing was conducted by comparing system measurements with manual measurements at various water level conditions. Parameters observed included sensor accuracy and successful data transmission [7].

III. RESULTS AND DISCUSSION

A. Sensor Test Results

The test results show that the HC-SR04 ultrasonic sensor is able to measure water levels with an average difference of less than 2 cm compared to manual measurements, in line with Pratama's research [8].

B. Data Delivery Results

Water level data was successfully sent to the web-based monitoring platform with a 92% success rate, demonstrating the ESP32's robust performance in IoT applications [9].

TABLE I
Flood Detection Tool Testing

Day	Time	Distance	Buzzer	Indicator	Application Status
1	08.00	86	Off	On Green	Safe
	11.00	82	Off	On Green	Safe
	14.00	60	Off	On Yellow	Alert
	17.00	33	On	On Red	Danger
2	08.00	74	Off	On Yellow	Alert
	11.00	53	Off	On Yellow	Alert
	14.00	30	On	On Red	Danger
	17.00	80	Off	On Green	Safe
3	08.00	90	Off	On Green	Safe
	11.00	95	Off	On Green	Safe
	14.00	73	Off	On Yellow	Alert
	17.00	62	Off	On Yellow	Alert

1. SAFE Status
    - Distance: ≥ 80 cm
    - Indicator: Green light on, Buzzer OFF.
    - Example: Day 1 (08.00 & 11.00), Day 2 (17.00), Day 3 (08.00 & 11.00).
2. ALERT status
    - Distance: 50–79 cm
    - Indicator: Yellow light on, Buzzer OFF.
    - Example: Day 1 (14.00), Day 2 (08.00 & 11.00), Day 3 (14.00 & 17.00).
3. DANGER status
    - Distance: ≤ 49 cm
    - Indicator: Red light is on, Buzzer is ON (sounds).
    - Example: Day 1 (17.00), Day 2 (14.00).

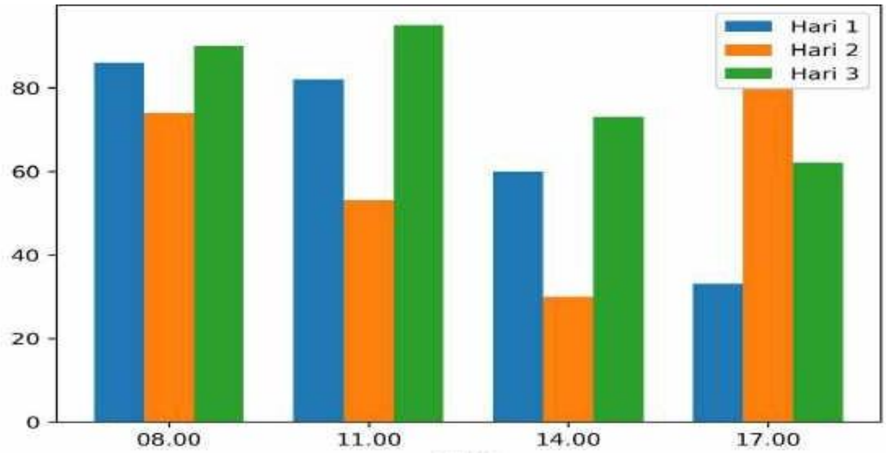

FIGURE 8. Distance vs Time Graph (3 days of testing)

C. System Analysis

Overall, the designed water level monitoring system is able to work well and stably. The main constraints that are Based on table 1, it can be explained that the water level monitoring tool testing was carried out for three days in 4 times, namely at 08.00, 11.00, 14.00, and 17.00. On the first day at 08.00, the water level was 86 cm, the buzzer was in the off condition (Off), the indicator light was green, and the status in the Blynk application showed the condition "Safe." At 11.00, the condition remained the same "Safe", but at 14.00, the water level dropped to 60 cm, the indicator light turned yellow, and the status in the Blynk application showed "Alert." At 17.00, the water level dropped further to 33 cm, the buzzer was active (On), the indicator light turned red, and the status in the Blynk application was "Danger" [10].

On the second day at 8:00 AM the water level was 74 cm, the buzzer was off, the indicator light was yellow, and the Blynk app status was "Alert." At 11:00 AM the same condition was "Alert." At 2:00 PM, the water level dropped to 30 cm, the indicator light was red, and the status in the Blynk app was "Danger." At 5:00 PM, the water level rose to 80 cm, the buzzer was off, the indicator light turned green, and the status in the Blynk app was "Safe" [11].

On the third day, the water level ranged from 62 cm to 95 cm. The status of the buzzer, indicator light, and Blynk app changed according to the water level. This table provides information on how the device functioned during testing and how its status changed according to changes in water level [12].

Based on the results of three days of testing of the water level monitor, it can be concluded that the device successfully performed its water level monitoring function. This device is capable of measuring changes in water level in centimeters with good accuracy at various times. A buzzer is activated when the water level exceeds the threshold, and the indicator light changes according to the level of flooding. These test results demonstrate that the water level monitor can provide effective warnings in flood situations and enable rapid action to address potential hazards [13].

The third day of testing, with water levels ranging from 62 cm to 95 cm, confirmed the device's consistency. The buzzer, indicator lights, and status in the Blynk app consistently changed according to the detected water level, proving the system's reliability under various conditions.

Based on the overall test results over three days, it can be concluded that this water level monitor successfully performed its function. Not only is the device accurate in measuring changes in water level, but it also effectively provides visual warnings via lights, audio via a buzzer, and digital alerts via an app. Therefore, this device can serve as a reliable early warning system, enabling swift action in the face of potential flooding [14].

IV. CONCLUSION

Based on the research results, it can be concluded that the Internet of Things (IoT)-based water level monitoring system using ESP32 was successfully designed and implemented. The system is capable of monitoring water levels in real time with a sufficient level of accuracy and high data transmission success. This system has the potential to be used as an early flood warning solution. Further development can be carried out by adding automatic notification features and independent power sources

REFERENCES

[1] Sulistyorini, T., Sofi, N., & Sova, E. (2022). Utilization of Android-Based NodeMCU ESP8266 (Blynk) as a Tool for Turning Lights On and Off. JUIT (Jurnal Informatika Utama), 1(3), 40–53.
[2] Anwar, S., & Abdurrohman, A. (2020). NodeMCU-Based Water Level Monitoring Using Responsive Web. Bulletin of Islamic Information Systems and Technology, 2(1), 1–5.

[3] Hardjianto, M., Ariyanto, D., & Aryasanti, A. (2022). Application of HC-SR04 Ultrasonic Sensor and Rain for IoT-Based River Water Level Monitoring. Budidarma Informatics Media Journal, 6(1), 251–257.

[4] Susanti, R., Aidha, Z. R., Anwara, A. T., Mayura, Y., & Suleiman, S. B. (2024). Optimising Energy for Automatic Plant Watering Using Dual Axis Solar Tracking. Innovative Journal of Intelligent Control and Optimization for Electrical System (IJCIOES), 1(2), 47–55.

[5] Wicaksono, EFA, & Yuana, H. (2023). Design of an IoT-Based Water Level Detection and Monitoring System Using NodeMCU ESP8266. JIFOSI (Journal of Informatics and Social Sciences), 5(3).

[6] Yusro, M., & Diamah, AS (2022). Punia Fund Box Security System Based on NodeMCU ESP32 Microcontroller and Telegram Application. Sarwahita, 19(1), 83–92.

[7] Hudry, MHA, Fathoni, F., & Arkan, M. (2023). Web-Based and IoT Flood Height Monitoring System Using Ultrasonic Sensors. Proceedings of SNASTIKOM (National Seminar on Information and Communication Technology), 9, 1–10.

[8] Hendrian, Y., Ramadhan, GF, & Nugroho, P. (2023). Implementation of the Internet of Things (IoT) on a Flood Monitoring Device by Utilizing the HC-SR04 Sensor and NodeMCU ESP-8266. Journal of Informatics Engineering and Information Systems, 2(3), 87–93.

[9] Susanti, R., Aidha, Z. R., Anwara, A. T., & Mayura, Y. (2024). Dual Axis Solar Tracker for Automatic Plant Watering System. Innovative Journal of Intelligent Control and Optimization for Electrical System (IJCIOES), 1(2), 47–55.

[10] Suriana, IW, & Setiawan, IGA (2021). Design and Construction of a Punia Fund Box Security System Based on a NodeMCU ESP32 Microcontroller and Telegram Application. Journal of Electrical Technology, 12, 12- 13

[11] Gede, IMS, & Graha, IMS (2022). "HC-SR04 Ultrasonic Sensor: Principles and Applications". Teknokrat Publisher. 20-25

[12] Puspita, J., Gustina, G., Wahyono, U., Untara, KAA, Santoso, R., & Ilmianih, R. (2024). Development of an Internet of Things (IoT)-Based Flood Detection Tool as a Physics Learning Medium for High School Students. Tadulako Online Physics Education Journal, 12(3), 169–177.

[13] Jafar, M., & Simanjuntak, S. (2022). Design and Implementation of a Web-Based Flood Height Monitoring System and IoT (Internet of Things) Using Ultrasonic Sensors. In Proceedings of the National Seminar on Information and Communication Technology 1–10.

[14] Susilo, A. (2021). IoT-Concept Water Quality Monitoring for Catfish Cultivation Ponds. Journal of Science & Technology, Darma Persada University, 11(2), 34–41Y. N. Hilal, P. Muliandhi, And E. N. Ardina, "Analisa Balancing Bms (Battery Management System) Pada Pengisian Baterai Lithium-Ion Tipe Inr 18650 Dengan Metode Cut Off," Simetris J. Tek. Mesin, Elektro Dan Ilmu Komput., Vol. 14, No. 2, Pp. 367–374, 2023, Doi: 10.24176/Simet.V14i2.9852.