Research Article

Monitoring and Detection System of Level and Turbidity in Embankment Water in Real Time Based on IoT

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Abstract: In 2020 there were floods in the Air Hitam and Tanjung Alam villages, Bengkulu Province, and surrounding areas. These floods have caused a lot of losses to the community, especially resulting in damage to houses and agricultural land. Flooding in the Air Hitam and Tanjung Alam village areas, Bengkulu Province, occurred due to heavy rain that fell for 3 consecutive days, resulting in the overflow of the Musi Hydroelectric Power Plant (Hydroelectric Power Plant) dam which was unable to withstand the water discharge and eventually overflowed. So in this research, a prototype system for monitoring and detecting height and turbidity in embankment water in real time based on IoT will be designed. The method used is a waterfall, where the ultrasonic sensor and turbidity sensor will be connected to the ESP-8266 NodeMCU so that data on the height and turbidity of the embankment water is obtained in real-time via the user interface on the Thinger io Platform. Apart from that, the system uses LEDs in red, yellow, and green as indicators of the embankment water level. These results show that the implementation of a real-time IoT-based monitoring and detection system for height and turbidity in embankment water has good capabilities. This is indicated by the user being able to see data on the prototype system for monitoring and detecting height and turbidity in embankment water in real-time based on IoT with the display of numbers and LED indicator lights. The seawater height scale used in the system on the red LED indicator lights is 16 - 20 cm, yellow is 10 - 15 cm, and green is 0 - 9 cm.

Keywords: Monitoring; Turbidity; NodeMCU ESP-8266; Ultrasonic Sensor, LED

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1. Introduction

In 2020 there were floods in the Air Hitam and Tanjung Alam village areas of Bengkulu Province and surrounding areas. The floods have caused many losses to the community, especially resulting in damaged houses and agricultural land. Flooding in the village areas of Air Hitam and Tanjung Alam in Bengkulu Province occurred due to heavy rain that poured for 3 consecutive days resulting in the overflow of the Musi Hydroelectric Dam (Pembangkit Listrik Tenaga Air) which was unable to withstand the water discharge and eventually overflowed.

A flood event is one of the natural disasters where excessive water flow inundates the land. In Indonesia, several areas have also been hit by floods. Flooding is a common problem because it happens every year. There are several ways to deal with flooding, one of which is to make a barrier embankment so that when the river overflows the lower plains are not inundated with water, but there are times when the embankment also cannot accommodate the overflowing water level [9,10,11,12], so monitoring of water discharge is needed so that it can be a reference for evaluation data when it is time to increase the height of the embankment so that flooding does not occur. Based on the description above, the author wants to make a monitoring system to detect the height and turbidity of embankment water in real-time using IoT (Internet of Things) as a medium of information. The IoT (Internet of Things) system is used as an information medium for data collection, modeling, management, and monitoring the level of water levels, and turbidity in water [16,17,18], to evaluate the height of the embankment to prevent flooding.

The IoT (Internet of Things) system uses the Internet as an intermediary with the prototype so that it is connected to the Internet network. The water level is measured using an ultrasonic sensor and visualized in the form of Thinger.io web API platform data. The advantage of the system is that it can display monitoring data on water level height and water turbidity remotely based on IoT (Internet of Things) so that it can provide monitoring data information in real-time. Then the system will add red, yellow, and green LED lights to be used as level indicators of the water level [13,14,15].

2. Theory

2.1 Ultrasonic Sensor

Ultrasonic sensor type HCSR04 is a sensor that uses ultrasonic waves. Ultrasonic waves are waves that are commonly used to detect the presence of an object by estimating the distance between the sensor and the object (Alfatah, 2017) Ultrasonic sensor type HCSR04 is a device used to measure the distance from an object. The range of distances that can be measured is around 2-450 cm. This device uses two digital pins to communicate the distance read. The working principle of this ultrasonic sensor works by sending ultrasonic pulses around 40 KHz, then can reflect the echo pulse, and calculate the time taken in microseconds (Puspasari, 2019).

2.2 Turbidity Sensor

A turbidity sensor is a sensor module that works to read turbidity in water turbidity particles cannot be seen by the direct eye. The more particles in the water indicate that the turbidity level of the water is also high [19,20,21,22,23]. The higher level of water turbidity will be followed by a change in the sensor output voltage (Irawan, 2019). The turbidity sensor is a sensor that functions to measure water quality by detecting the level of turbidity. This sensor detects suspended particles in water by measuring transmittance and light scattering which is directly proportional to Total Suspended Solids (TSS) levels. The higher the TSS level, the higher the turbidity level of the water (Sulistyo, 2019).

2.3 NodeMCU ESP-8266

NodeMCU is one of the single-board micro-controllers that has WiFi features so it is useful in making IoT platform products. NodeMCU is an IoT platform that is open-source and uses LUA scripts as its programming language. NodeMCU consists of hardware in the form of System on Chip Esp8266 made by Espressif System and also uses LUA scripting language firmware (Windarto and Haekal, 2017). NodeMCU can be analogized as an Arduino board that has been integrated with the Esp8266 WiFi module. Programming the Esp8266 is a bit troublesome because it requires some wiring techniques and an additional USB to serial module to download the program. However, NodeMCU has embedded the Esp8266 into a compact board with all the features of a microcontroller with WiFi access capabilities as well as a USB to serial communication chip. Esp8266 is an integrated chip component designed for today's connected world. It offers a complete and unified WiFi networking solution, which can be used as an application provider or to separate all WiFi networking functions from other application processes. Esp8266 has onboard processing and storage capabilities that allow the chip to be integrated with sensors or with certain tool applications through input or output pins with just short programming (Hasan, 2017).

2.4 Arduino IDE

Arduino is one of the open-source single-board microcontrollers. Arduino is designed to make it easier for users to integrate software and hardware. Arduino hardware uses an Atmel AVR processor with software that has its language making it easier to use. Apart from simple use, Arduino can be used by anyone who wants to create an interactive electronic prototype (Ardi, 2020). Arduino was first introduced in 2005. The initial team that initiated Arduino were Massimo Banzi, David

Cuartielles, Tom Igoe, Gianluca Martino, and David Mellis. The name Arduino comes from the name of the tavern in Ivrea, Italy, where they gathered to discuss the Arduino project (Kadir, 2017).

2.5 Internet of Things

The Internet of Things is a concept that aims to extend the benefits of continuous internet connectivity, along with the ability to control, and share data, and so on. Foodstuffs, electronics, and collections, including living objects, are all connected to local and global networks through embedded sensors and are always 'ON' (Sugiono, 2017). The Internet of Things (IoT) is a concept where an object can transfer data over a network without requiring human-to-human or human-to-computer interaction. So the Internet of Things (IoT) is a concept where an object that can send data over a network without requiring human-to-human or human-to-computer interaction. IoT has evolved from the merging of wireless technology, micro-electromechanical systems (MEMS), and the internet (Haryanti, 2017).

3. Method

The research method in designing the IOT-based Real Time Water Level and Turbidity Monitoring System uses the System Development Life Cycle (SDLC) where this system is the stage in building an information system. The stages of the SDLC Waterfall model are as follows: 1) Analysis: activities to examine or investigate an event through data to find out the actual situation 2) Design: designing a series of tools that will be made. 3) Implementation: is an activity that involves action, control, starting, and finishing. 4) Testing: Test or run the tool that has been made whether it is as desired. 5) Maintenance: Activities to monitor and maintain facilities by designing, organizing, handling, and rechecking tools that have been made. A. Research Instruments 1) The Hardware used in this research is shown in Table 1.

Table 1. Hardware used in this research

No	Hardware		
	Tools/Materials	**Specifications**	**Total**
1	NodeMCU	ESP-8266	1 unit
2	Ultrasonic Sensor	HCSR04	1 unit
3	Turbidity Sensor	SEN0189	1 unit
4	LED light	M, K, H	3 Pcs
5	Jumper cable	Female & Male	to taste

Furthermore, the software used in this research is shown in Table 2.

Table 2. Software used in this research

No	Software		
	Application	**Specifications**	**Total**
1	Arduino IDE	Versi 1.8.18	-
2	Platform	Thinger.io	-
3	Fritzing	1.0.1	-

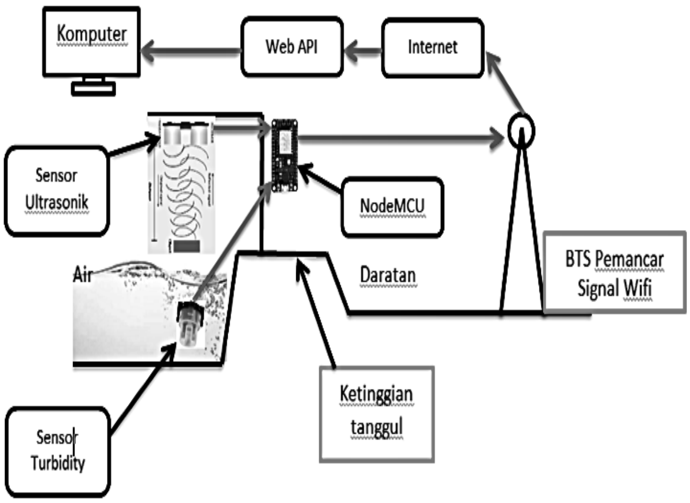

Figure 1. Global Tool Block Diagram

Figure 1 description: - Ultrasonic Sensor as a water level meter. - Turbidity Sensor to measure the level of turbidity in water. - NodeMCU serves to send data read by sensors to the internet so that it can be seen by computers via the internet network. - Wifi signal transmitter functions so that NodeMCU can connect to the internet. - Internet as a medium for connecting between NodeMCU and web API, to send data in real-time over long distances.

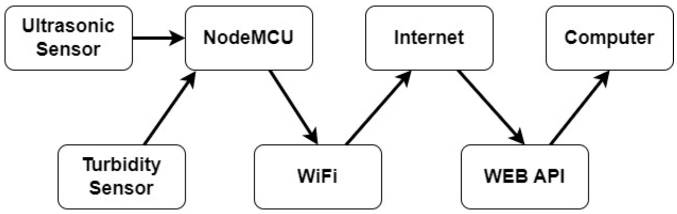

Figure 2. Tool Set Block Diagram

Figure 2 Description: - Ultrasonic Sensor as a water level meter. - Turbidity Sensor to measure the level of turbidity in water. - NodeMCU functions to send data read by the sensor to the internet so that it can be viewed by a computer via the internet network. - Wifi signal transmitter functions so that NodeMCU can connect to the internet. - Internet as a connecting medium between NodeMCU and web API, to send data in real-time over a long distance. - Computer as a medium to view data that has been sent by NodeMCU.

Moreover, User Interface Design The Tinger.io platform as in Figure 3, will be used as an interface that can display water level and turbidity monitoring data on embankment water in real-time from data readings through the HCSR04 ultrasonic sensor and SEN0189 turbidity sensor.

Water level data will be divided into 2 different levels, high and low, and then the water level data that is read by the level will be grouped based on the green and red color indicators. D. Working Principle of the Tool The working principle of the tool is that the ultrasonic and turbidity sensors will send digital data to the NodeMCU and will be processed by the NodeMCU following the program that has been embedded in the NodeMCU, namely the ultrasonic sensor will issue water level measurement data, and the turbidity sensor will issue water turbidity measurement data, after the NodeMCU has obtained the appropriate data, the NodeMCU will send the data to the internet so that the data can be viewed via a computer even though the distance between the computer and the tool is very far away. Moreover, The Tool Work Plan can be seen in Figure 4.

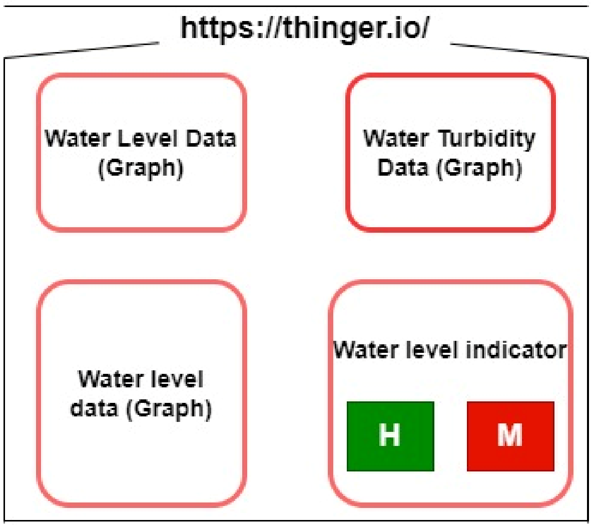

Figure 3. User Interface Design

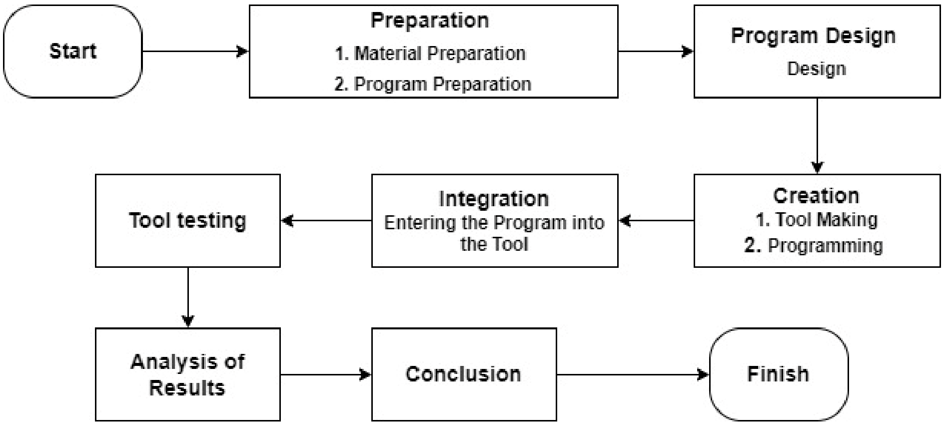

Figure 4. Tool Work Plan

Description: a. Preparation The author searches for and collects components that will be used in a series of research tools Furthermore, the author downloads Arduino software to program the tool b. Design The author designs with references from books, and the internet, and asks directly to sources that are considered biased to help in this writing. c. Manufacture The author begins to assemble the components that the author collects to be able to become a tool that follows the research. Furthermore, the author begins to create program code in the Arduino software d. Integration After the tool and program code has been made, the author starts entering the program code into the tool using a micro USB cable and a computer. e. Trial Here the author conducts a trial by making a miniature simulation of the river and embankment 30x30 cm.

4. Result and Analyzes

Samples of data collection are carried out to be able to determine the work function of the tool on the system of monitoring and detecting the height and turbidity of the embankment water in real-time based on IoT and whether it has worked properly. Data is taken using several different categories, namely high, medium, and low. The low category of embankment water level is from 0-9 cm, the medium category of wave height is from 10-15 cm and the high category of wave height starts from 16-20 cm.

1) Data Collection for Low Embankment Water Level Category
   The first data collection will be carried out for the low category, namely when the embankment water level is at a value of 0-9 cm, while the turbidity test uses tap

water. The indicator light that will appear on the user interface is green. This data collection is done to find out that the system designed for monitoring and detecting the height and turbidity of embankment water in real-time based on IoT has run well.

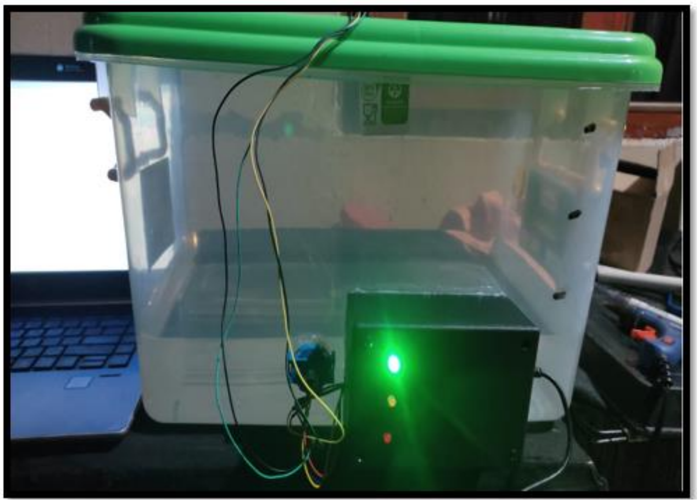

Figure 5. Data Collection for Low Embankment Height Category Using Tap Water

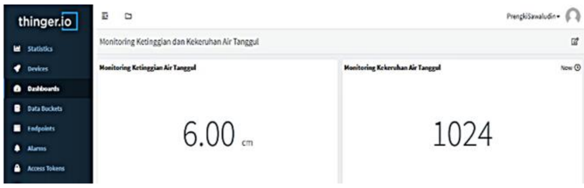

Figure 6. User Interface Display of Low Embankment Water Level Using Tap Water

2) Data Collection of Medium Embankment Water Level Category
The first data collection will be carried out for the Medium category, namely when the wave height is at a value of 10-15 cm. The indicator light that will appear on the user interface is yellow. This data collection is done to find out that the system designed for monitoring the height of sea waves in real-time based on IoT has run well.

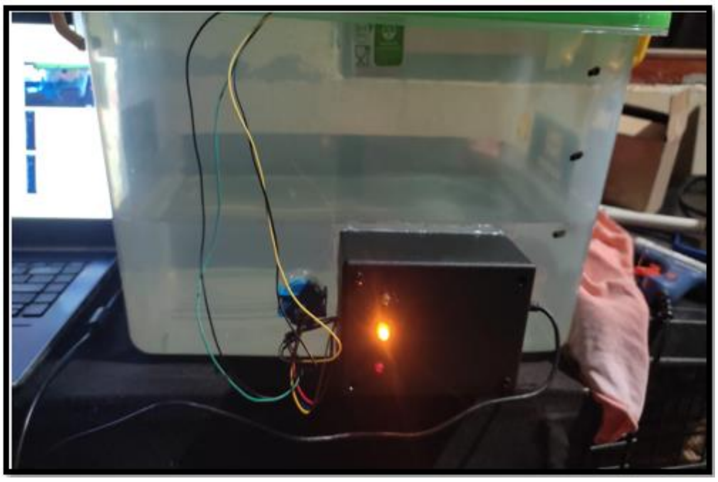

Figure 7. Data Collection for the Medium Embankment Height Category Using Tap Water

Figure 8. User Interface Display of Embankment Water Level Using Tap Water

3) Data Collection for High Embankment Water Level Category
Furthermore, the last data collection will be carried out for the high category, namely when the embankment water level is at a value of 16-20 cm. The indicator light that will appear on the user interface is red. This data collection is done to find out that the system designed for monitoring the height and turbidity of sea water in real-time based on IoT has run well.

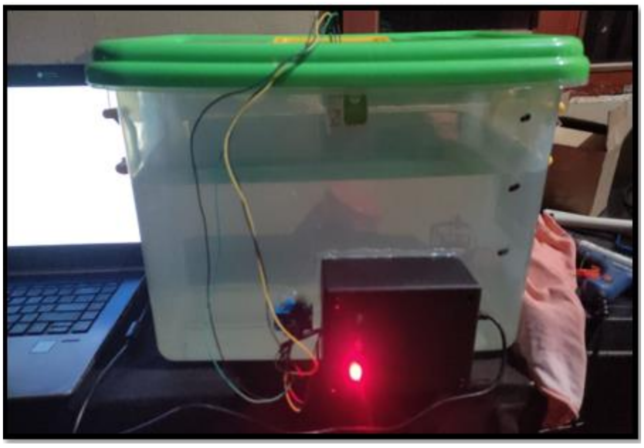

Figure 9. Data Collection for High Embankment Height Category Using Tap Water

Figure 10. User Interface Display of High Embankment Water Level Using Tap Water

Table 3. Overall Testing Results

No	Overall Testing Results		
	Testing Criteria	**Results**	**Description**
1	The capability of the HC-SR04 ultrasonic sensor to measure water level	Ultrasonic sensors can read the water level of the embankment	Successful
2	The ability of the SEN0189 turbidity sensor to measure water turbidity	SEN018 turbidity sensor can read the turbidity of dyke water	Successful
3	The ability of NodeMCU esp8266 to receive data from ultrasonic sensor and turbidity sensor SEN0189	NodeMCU ESP 8266 can receive and retrieve sensor data	Successful
4	IoT (Internet of Things) testing in remote tool monitoring	IoT works well in displaying data	Successful
5	Testing the color indicator on the user interface display according to each water level	The indicator light turns on according to the water level of the embankment	Successful

From Table 3, which is the result of overall system testing, it can be concluded that the design of a monitoring and detection system for the height and turbidity of embankment water in real-time based on IoT has been successfully carried out because the system has been able to monitor the height and turbidity of embankment water in real time both when the water is at low, medium and high altitude conditions.

5. Conclusion

Based on the results of research on the monitoring and detection system of height and turbidity in embankment water in real-time based on IoT, it can be concluded that several conclusions include the following: The monitoring and detection system of height and turbidity in embankment water in real-time based on IoT has operated properly following the design carried out. Where the embankment water level is divided into three conditions, namely high, medium, and low. The wave height can be seen according to a predetermined scale, namely more than 2.00 M scaled 16-20 cm, 1.00-1.90 M scaled 10-15 cm, and less than 1 M scaled 0-9 cm. Furthermore, turbidity testing of embankment water is carried out using three different types of water according to the level of turbidity, namely tap water, coffee water, and groundwater. Based on the data obtained, groundwater has the highest turbidity value. It can be seen that the user interface on Thinger.io can be accessed by users with the display of embankment water level data and embankment water turbidity data.

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