Water Height and River Flow Speed Monitoring System Based on the Internet of Things

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Abstract. The growth in the number of passengers and goods using ferry transportation continues to increase so increasing shipping safety is considered. The use of advanced technology to improve shipping safety continues to be developed, one of which is a system for monitoring water levels and flow speed. This technology is very necessary because it can cause the ship to run aground and make the ship unstable if there are errors in measurements. In this research, a prototype design of an IoT-based water level and water flow speed monitoring system was carried out so that monitoring can be carried out in real-time and remotely. In this research, the ESP 32 microcontroller was used as a data processor for measurement results and data transfer to the Internet. To measure water level, an ultrasonic sensor type JSN-SR04T is used and to measure water flow speed, a turbine sensor type YF-S201 is used. Meanwhile, the interface for reading measurement results uses the Thingview application. Based on the results of research that has been carried out, data was obtained that the JSN-SR04T type ultrasonic sensor can measure water level with an accuracy of 98.67%. Meanwhile, the accuracy of measuring water flow speed using the YF-S201 type turbine sensor is 96.00%.
Keywords: IoT, Shipping Safety, Turbine sensors, Ultrasonic sensors

1 Introduction

The development of the world of transportation today is growing very rapidly, various innovations and strategies are made to continue to improve the quality of service and operational quality. One type of transportation that continues to develop is the type of ferry transportation, this is because ferry transportation has a vital role in regional and international connectivity, providing important routes for trade, tourism, and local communities. Several aspects are of primary concern in the development of sustainable transportation, one of which is related to the culture of transportation safety

Transportation Safety Culture is a top priority in all forms of transportation, including ferry transportation. Accidents in the waters can have serious consequences that will have an impact on reducing the level of public trust in operators and regulators providing transportation, therefore the adoption of a strong safety culture is needed to prevent incidents and ensure protection for all involved. In the culture of ferry transportation safety, one aspect that is considered is related to the safety of the shipping lane.

The shipping lane that will be passed by the ferry ship has many parameters to consider before crossing the predetermined shipping lane, one of the parameters that is considered is related to the depth of the water surface and the speed of the water current

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because if it is wrong in predicting the condition of the depth of the water surface and the speed of the water current, it will have a major impact on shipping safety. Real-time mapping of current conditions of water surface height and current speed is very important to have because it determines the shipping route to be taken. Various current technologies can be used to find out real-time conditions of water surface depth and river current speed, one of which is Internet of Things (IoT) technology. The Internet of Things (IoT) is a revolutionary concept that refers to a network of physical devices that are interconnected via the internet, allowing them to collect, share, and act on data without direct human intervention. In this study, a design and construction of an IoT-based water level and river current speed monitoring system will be carried out.

2 Research Methods

The research methodology that will be used in compiling this research is: first by identifying the problem and continued with a literature study from various studies that have been conducted previously, then the design stage of the electrical circuit and program code is carried out to provide the workflow of the system and continued with implementation and testing to obtain results and conclusions. The stages of this research process are described in Figure 1.

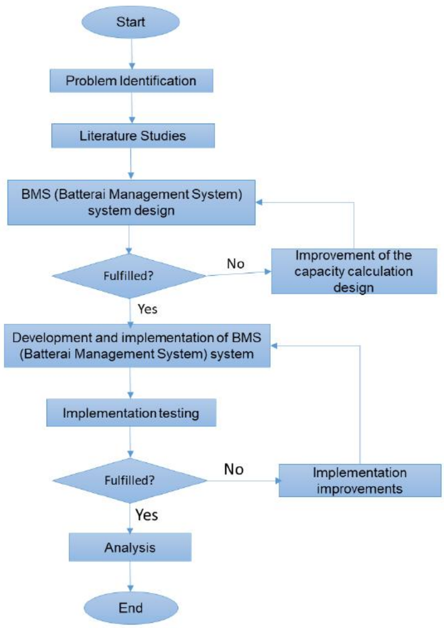

Figure 1. Research flowchart

3 Result and Discussion

The design carried out in this research is divided into two parts, namely the first is the design of the electrical system, the second is the design of the electrical energy output using the application.

The design of the IoT-based water level and water current speed monitoring system that functions as a guide for ferry ships in preparing for sailing can be seen in the system work block diagram in Figure 2.

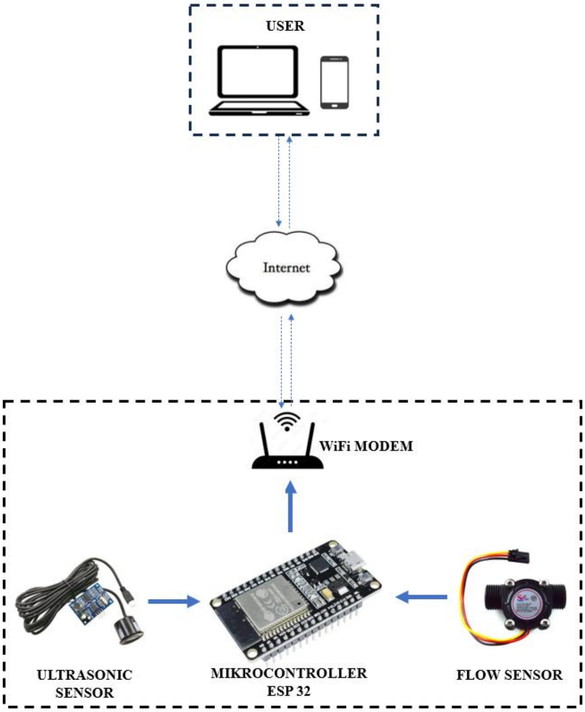

Figure 2. Water level and water current speed monitoring system

This water level and water current speed monitoring system uses the Arduino ESP 32 microcontroller to process data obtained from the installed sensors. The Arduino ESP 32 microcontroller also functions as a medium that will send current condition data from the reading results of the installed sensors via a WiFi network which can ultimately be accessed by various devices through a series of program code designs and applications that have been created.

The sensor used to measure water level is a JSN-SR04T type ultrasonic sensor which has the characteristic of emitting digital signals. The signal is in the form of a 4-20 mA current voltage that will be processed on the JSN-SR04T sensor module which will then be sent to the ESP 32 microcontroller. Meanwhile, for the water flow speed sensor using the YF-S201 type turbine sensor which will read the number of turbine rotations and then processed into digital data that will produce the water flow speed value. This water level and water flow speed monitoring system will use a 9 volt DC voltage sourced from PLN electricity which will be converted into DC power through an adapter or power supply. The programming language used is C language with the program code design application being Arduino.

a. Implementation

After the design stage of the circuit and testing with the project board, then continued with the design of the main program code of the water level and current speed monitoring system, the next stage is implementation by creating a system and uploading the program code.

The process of implementing the electrical circuit of the water level and current speed monitoring system begins by connecting the cables to each other according to the specified pins. At this stage, the pins of the JSN-SR04T type ultrasonic sensor and the YF-S201 type turbine sensor are connected directly to the pins owned by the ESP 32 microcontroller. After all pins are confirmed to be connected to the cable media, the next step is to test the cable connection using a multimeter by measuring the resistance value of each connection.

Measurement of this resistance value is important because it aims to ensure that the cable is connected properly and correctly. If each pin has been connected with a cable and measurements are taken at both ends of the connected pins and a resistance value of <=10 Ω is obtained, then it is certain that both ends of the pins are connected. Conversely, if both ends of the pins that have been connected with a cable have a resistance value of >=10 Ω or have an infinite resistance value, then it can be ascertained that there is a problem with the cable connection between the two pins or that they have not even been connected.

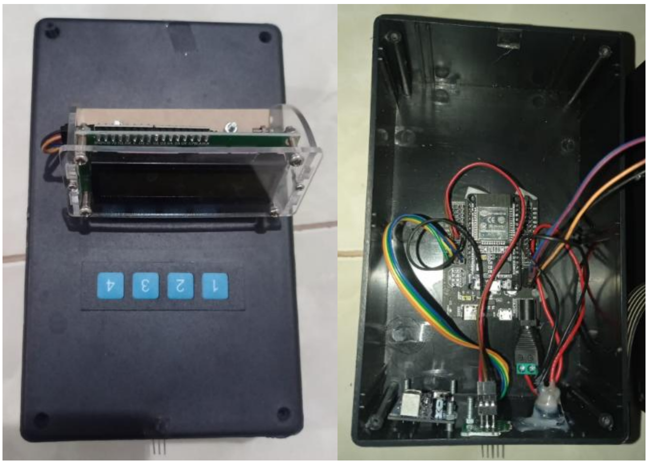

Figure 3 Circuit Implementation

After the connection between the pins owned by the sensor and microcontroller is made, the next step is to test each sensor. The purpose of this test is to ensure that all sensors connected to the ESP 32 microcontroller can read the water level and water flow speed.

Based on the test results, it was found that the JSN-SR04T type ultrasonic sensor can read the water level. In testing the water level sensor, a medium containing water with a maximum height of 1 meter was provided. The JSN-SR04T type ultrasonic sensor is placed on the top of the medium containing water to measure the water level. As a comparison of the water level measurement results, manual measurements were carried out using a ruler to validate the water level measurement results.

Testing the results of the implementation of water flow velocity measurements was carried out by flowing water to the sensor. At this testing stage, water is flowed through a YF-S201 type turbine sensor which will rotate the turbine on the sensor. The rotation of the turbine will be converted digitally by the sensor system and produce a water flow velocity value. As a comparison to validate the water flow velocity from the sensor measurement results, a current meter measuring instrument was used.

Figure 4. Sensor testing

b. Analysis of Water Level Measurement System

Analysis of the water level measurement system is carried out by taking data from the results of water level measurements read through the cellphone screen display because the system is IoT-based. Data collection is carried out 10 times taking data from sensor readings and 10 times manual measurement results using a ruler. The data is then compared to determine the accuracy of water level measurements using sensors. The measurement accuracy value is in percentage.

Table 1. Water level measurement results

No	Sensor Measurement (cm)	Manual Measurement (cm)	Accuracy (%)
1	20,2	20,1	99,50
2	30,4	29,9	98,36
3	40,3	40,2	99,75
4	50,4	48,7	96,63
5	69,4	69,2	99,71
6	70,1	68,8	98,15
7	80,3	78,6	97,88
8	89,1	88,3	99,10
9	90	89,3	99,22
10	95,6	94,1	98,43

Based on the data that has been taken from the results of water level measurements using sensors and compared with the results of manual measurements using a ruler, the highest accuracy is 99.75% and the lowest accuracy is 96.63%. Meanwhile, the average accuracy of the measurement results is 98.67%, so it can be said that the average error in the results of water level measurements using sensors compared to manual measurements using a ruler is less than 1.5%.

c. Analysis of Water Current Velocity Measurement System

Analysis of the water current velocity measurement system is carried out by taking data to record the results of the speed value readings by the sensor and then comparing them with the measurement results carried out manually using a current meter. Data collection is carried out 10 times the measurement results using the sensor and 10 times the measurement results using the current meter.

Table 2. Results of water current velocity measurements

No	Pengukuran Sensor (m/s)	Pengukuran Manual (m/s)	Akurasi (%)
1	2	1,9	95,0
2	2,4	2,3	95,8
3	2,4	2,3	95,8
4	2,5	2,4	96,0
5	3,1	2,9	93,5
6	3,2	3	93,8
7	3,6	3,5	97,2
8	3,8	3,7	97,4
9	4,2	4,1	97,6

10	4,5	4,4	97,8

Based on the data that has been taken from the results of water current velocity measurements using the sensor and compared with the results of manual measurements using the current meter, the highest accuracy is 97.8% and the lowest accuracy is 95.0%. Meanwhile, the average accuracy of the measurement results is 96.00%, so it can be said that the average error in the results of water current velocity measurements using the sensor compared to manual measurements is less than or equal to 4%.

4 Conclusion

Based on the research that has been done by designing, implementing and testing the water level monitoring system and river current speed, it can be concluded that:

1. The design and construction of a prototype of an IoT-based water level and river current monitoring system can be made well. The system can function well because the JSN-SR04T type ultrasonic sensor can measure water level, the YF-S201 type turbine sensor can measure water current speed and the microcontroller can process the sensor measurement results which are then displayed on the interface screen with the help of IoT.
2. The IoT-based water level and river current monitoring system has a water level measurement accuracy level using the JSN-SR04T type ultrasonic sensor of 98.67%. Meanwhile, the accuracy of water current speed measurement using the YF-S201 type turbine sensor is 96.00%.

References

[1] Bhattacharyya, R. *Dynamics of Marine Vehicles*, 1st ed.; John Wiley & Sons Inc.: Hoboken, NJ, USA, 1978; pp. 75–80.

[2] Journée, J.M.J.; Massie, W.W. *Offshore Hydromechanics*; Lecture Notes; Delft University of Technology: Delft, The Netherlands, 2001.

[3] Kementrian perhubungan. 2017 Buku pintar distrik Navigasi*,*

[4] Martopo Arso. 2004. *Alur pelayaran dan sarana bantu Navigasi Pelayaran. Semarang : Politeknik Ilmu Pelayaran Semarang.*

[5] C.H. NeerajaSoni, C.H.Sarita, S. Maheshwari, B. Sahu, B. Jain, G. Shrivastava, "Distance Measurement using Ultrasonic Sensor and Arduino", International Journal of Engineering Science and Computing, vol. 7, no. 3, pp. 5991-5992, 2017.

[6] A. Soni, A. Aman, "Distance Measurement of an Object by using Ultrasonic Sensors with Arduino and GSM Module", International Journal of Science Technology & Engineering, vol.4, no. 11, pp.23-28, 2018.