Monitoring The Usage of Marine Fuel Oil Aboad Ketapang-Gilimanuk Ship Based on Internet of Things

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***Abstract*—The development of the shipping industry in Indonesia has continued to increase over the past 10 years due to the sabotage principle. This development can be seen from the increasing number of national vessels. The number of national vessels becomes wider from 6,041 units in 2005 to 24,046 units in 2016. The more number of vessels owned makes monitoring the operational performance of the vessel difficult because each ship has different travel routes. This research made tools that can monitor the performance of ships especially the use of MFO aboard the ship from a distance. The sensors used to measure the volume of MFO in the tank on board are HC-SR04 ultrasonic sensors and potentiometer pendulum sensors. The data from the sensor was processed by Arduino Uno microcontroller. This study would compare the performance of ultrasonic sensors and potentiometer pendulum sensors mounted on MFO oil premises. The study was conducted by measuring the position of the ship horizontally, right and left tilted with a slope level of 30 degrees and 45 degrees. The result of this research is that the potentiometer pendulum sensor was better when MFO surface condition was flat with the average of error sensor 1.60%, while HC-SR04 ultrasonic sensor has an average of error for 2.87%. However, on the skewed surface conditions of MFO, the usage of HC - SR04 ultrasonic sensors was better with average of error for 3.21%, while the potentiometer pendulum sensor had an average of error for 8.66%.**

Keywords—Arduino Uno Microcontroller, Ultrasonic Sensor, Potentiometer Pendulum Sensor

I. INTRODUCTION

The development of the shipping industry in Indonesia has continued to increase in the past 10 years. This development can be seen from the increasing number of national vessels. The number of national vessels increases from 6,041 units in 2005 to 24,046 units in 2016 [1]. The number of ships owned by ship owners in Indonesia is more and more after the existence of Law No. 17 of 2008 which is about the sabotage principle. Sabotage principle is a way of empowering national sea transport that provides a conducive climate in order to promote the transport industry in the waters, among others, in the field of taxation, and capital in the procurement of vessels and the existence of long-term contracts for transport in waters [2].

The more number of vessels owned makes its own problems for ship owners. One of the problems faced is the way to monitor the performance of the vessel because each ship has different travel routes. During this monitoring of the ship is done by analyzing data from records made by ABK. This method has a weakness of human error made (by ABK) in making report

II. BACKGROUNDS

Many data reported by ABK to the ship owner company. One of the data reported was the use of Marine Fuel Oil (MFO). MFO usage reports are important because they affect production cost calculations by management. In order to avoid reporting errors on the use of MFOs on board, this study made a tool that could monitor the use of MFOs aboard the ship from a far-distance.

Research on making wireless ship balance monitoring system has been done by [3]. The sensor used to read the slope of the ship is the IMU sensor. The data from the IMU sensor is sent via Bluetooth to the android system. This system can be used with a maximum distance of 30 meters. Another study was to measure temperature and humidity in agriculture [4]. The module used to measure temperature and humidity is DHT11. Data from DHT11 is sent via Short Message Service (SMS) when there is data request via SMS. In addition, the built system can send SMS automatically to the farmer when the soil moisture is less and the system turns on the pump automatically to water the ground.

Previous studies related to the monitoring of fuel consumption were volume monitoring and water clarity in Lab View based tanks with Ni Myrio controller [5]. Other studies monitored the volume of water in the tank using ultrasonic sensors and water clarity using turbidity sensors. Readout data from the sensor is sent to personal computer (PC) via wireless. The result of SRF 04 ultrasonic sensor reading in the form of volume displayed in PC as simulation of water level condition in tank. While the readout data from turbidity sensor is displayed on the PC in the form of nominal score of water clarity.

III. SYSTEM MODEL

This study calculated MFO consumption on board by measuring tank volume from MFO using HC - SR04 ultrasonic sensor and potentiometer pendulum sensor. Data from HC - SR04 ultrasonic sensor and potentiometer pendulum sensor. Data from HC - SR04 ultrasonic sensors and potentiometer pendulum sensors were converted by microcontroller into the use of MFO. Data on the amount of use of MFOs remotely sent over the internet using ESP 8266 so that the usage of MFO on board can be monitored from different computers where using the internet network. The architecture system built on this research can be seen in Fig. 1.

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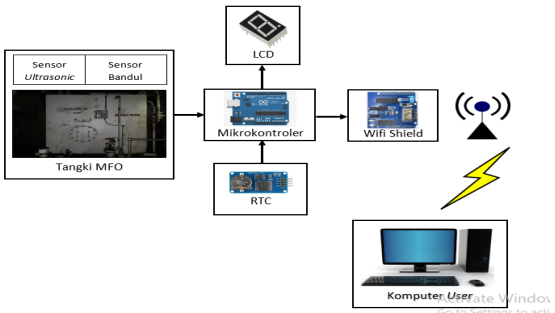

Fig. 1. Architecture System

IV. Design Model

The design used in this study can be seen in Figure 2. The working of the system is that HC - SR04 ultrasonic sensor and potentiometer pendulum sensor will read the height of MFO in the tank continuously. Data from HC - SR04 ultrasonic temperature sensors and potentiometer pendulum sensor are transformed firstly by Arduino Uno into digital through ADC. Data that has been digital are processed inside the Arduino Uno to be the MFO volume data present in the tank. The volume and time information data from the RTC is sent continuously to the remote user's computer via Wi-Fi Shield ESP 8266 and to the LCD via I2C. Then, LCD and the user's computer display the MFO volume data.

Fig 2. Shows the diagram block, this study used hardware which has the following functions:

1. Ultrasonic sensor is a measure of MFO surface distance with position of ultrasonic sensor being placed.
2. The potentiometer pendulum sensor is a measure of MFO surface distance with the position of the potentiometer pendulum sensor being placed.
3. RTC is a timing information system related to seconds, minutes, hours, days, months, and years when taking the data.
4. The controller is the overall system control center. The controller processes the data from the potentiometer pendulum sensor and the ultrasonic sensor and the timer system from the RTC which is then sent to the LCD and the user's computer.
5. Wi-Fi shield 8266 is as a medium of wireless communication between the microcontrollers to the internet.
6. I2C (Inter-Integrated Circuit) is a serial communication media with a cable between microcontroller to LCD.
7. The LCD is the display of MFO volume near the MFO tank.
8. The user's computer is a remote view of MFO volume (from a distance).

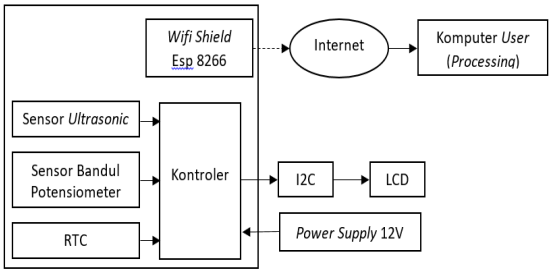

Fig. 2. Hardware Designing Block Diagram

The controller used is Arduino Uno microcontroller module. Arduino Uno microcontroller is a module in which already consists of a minimum system of a microcontroller, ATMEGA 328 series of microcontroller, digital input and output pins, analog input pins, and utility pins. Microcontroller connections with other hardware can be seen in Table 1. The plan used is a miniature tank from the actual MFO tank, as shown in Figure 3.

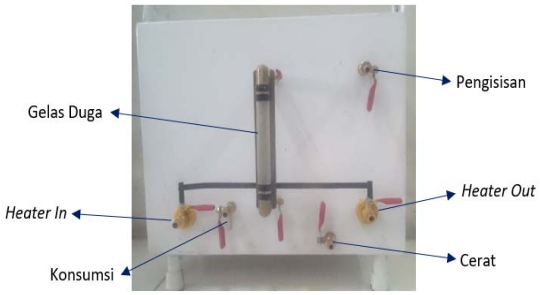

Fig. 3. MFO Miniature Tank

V. Results And Analysis

The test was done by using two types of sensors to measure the volume, namely HC - SR04 ultrasonic sensor and potentiometer pendulum sensor. In addition to using 2 types of sensors, testing was also done with a flat, sloping, and wavy MFO surface as shown in Figure 4

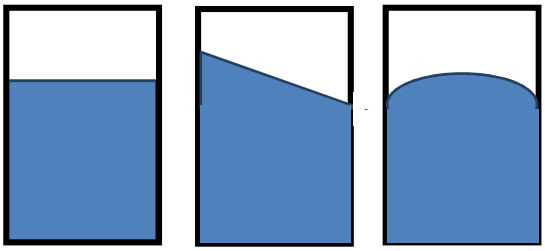

Fig. 4. MFO's Flat, Sloping and Wavy Surfaces

Test results from this research can be seen in Table I and Table II. Based on test results data for HC-SR04 ultrasonic sensors, it is seen that if using HC-SR04 ultrasonic sensor either with flat position, 300 right tilted, 450 right tilted, 300 left tilted, and 450 left tilted on MFO surfaces produced the same output, which was the fuller of MFO volume inside the MFO miniature tank then the better of the sensor readings. This is seen when the volume on the MFO miniature tank showed 13 liters, it was at average of error for 2.09%. Otherwise, the less volume of MFO made the bigger of the error reading. When the volume on the MFO miniature tank showed 9 liters, it was at average of error for 5.68%. The HC-SR04 ultrasonic sensor would have an increasing error when the surface of the MFO was wavy that was 11.09% in average.

Test results for potentiometer pendulum sensor with MFO flat surface position, 300 right tilted, 450 right tilted, 300 left tilted, and 450 left tilted had the same output with HC-SR04 ultrasonic sensor which was the fuller of MFO tank filled then the lower error that happened. When the maximum volume tested in this study was 13 liters, the average of error occurred was 2.95%. Otherwise, when the less MFO tank filled made

the larger of the error that occurred which was 14.31% in average.

TABLE I. RESULT DATA OF ULTRASONIC SENSOR TESTING

MFO Surface	Prediction Glass (Liter)	HC – SR04 Ultrasonic Sensor (Liter)	Error (%)
Flat	9	9,42	4,46
	10	10,32	3,10
	11	11,30	2,65
	12	12,27	2,20
	13	13,26	1,96
30^0 Right Tilted	9	9,50	5,26
	10	10,32	3,10
	11	11,28	2,48
	12	12,22	1,80
	13	13,2	1,52
45^0 Right Tilted	9	9,61	6,35
	10	10,33	3,19
	11	11,28	2,48
	12	12,32	2,60
	13	13,3	2,26
30^0 Left Tilted	9	9,47	4,96
	10	10,35	3,38
	11	11,32	2,83
	12	12,3	2,44
	13	13,25	1,89
45^0 Left Tilted	9	9,59	6,15
	10	10,31	3,01
	11	11,33	2,91
	12	12,37	2,99
	13	13,36	2,69
Wave	9	10,52	14,45
	10	11,45	12,66
	11	12,21	9,91
	12	13,34	10,04
	13	14,19	8,39

TABLE II. RESULT DATA OF POTENTIOMETER PENDULUM SENSOR TESTING

MFO Surface	Prediction Glass (Liter)	Potentiometer Pendulum Sensor (Liter)	Error (%)
Flat	9	9,10	1,10
	10	10,08	0,79
	11	11,15	1,35
	12	11,54	3,99
	13	13,10	0,76
30^0 Right Tilted	9	7,98	12,78
	10	9,02	10,86
	11	10,23	7,53
	12	11,22	6,95
	13	12,71	2,28
45^0 Right Tilted	9	7,65	17,65
	10	8,87	12,74
	11	10,01	9,89
	12	11,45	4,80
	13	12,6	3,17
30^0 Left Tilted	9	8,1	11,11
	10	9,13	9,53
	11	10,37	6,08
	12	12,89	6,90
	13	12,65	2,77
45^0 Left Tilted	9	7,78	15,68
	10	8,89	12,49
	11	10,11	8,80
	12	11,15	7,62
	13	12,55	3,59
Wave	9	9,78	7,98
	10	10,95	8,68
	11	12,03	8,56
	12	13,11	8,47
	13	14,21	8,52

In addition, in the usage of potentiometer pendulum sensor was occurred a bigger error when the MFO surface position was more skewed when the right side tilted to 450 then the average of error that occurred up to 9.64%. In the 300 tilted, the average of error was 7.68%. The comparison for the wave MFO surface showed that the potentiometer pendulum sensor was better with an average of error for 8.44%, while the HC-SR04 ultrasonic sensor's average of error was 11.09%.

The results of comparing HC-SR04 ultrasonic sensors with potentiometer pendulum sensor indicated that the potentiometer pendulum sensor was better when the MFO surface was flat with an average of error 1.60%, while the mean of error for the HC-SR04 ultrasonic sensor was 2,87%. But when in a sloping position, the usage of HC-SR04 ultrasonic sensors was still better than the potentiometer pendulum sensor. The average of error from HC-SR04 ultrasonic sensor when in a sloping position was 3.21%, mean error for potentiometer pendulum sensor with tilted MFO surface position was at 8.66%.

The results of this study with the best results occurred when the potentiometer pendulum sensor was used to measure the volume of MFO in flat surface conditions with the error of 0.76%. And the worst result occurred when the potentiometer pendulum sensor was used to measure the volume in 45% right tilted condition by 17.65%.

VI. CONCLUSION

Based on the results of the tests conducted, this study can take some conclusions:

1. Prototype to monitor MFO volume on board by using HC-SR04 ultrasonic sensor and potentiometer pendulum sensor. Test results show that both sensors can transmit data in the form of volume.
2. The usage of the sensor that will be used depends on the location of the ship's operation. If the ship's operation location is not too wavy, it is better to use a potentiometer pendulum sensor than the HC-SR04 ultrasonic sensor because the error result is smaller. But if the ship's location is operating in big waves then it is better to use a potentiometer pendulum sensor because the HC-SR04 ultrasonic sensor produces a big error when the MFO tank is tilted.

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