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# Analysis of speed using optocoupler sensors on electric boats in Sayung Demak

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## ABSTRACT

Boats are an essential part of daily life for individuals living in the Indonesian archipelago. When it comes to transportation, especially when going long distances on a sea vessel, it is imperative to monitor the conditions and situation. The aim of this research is to track the speed of an electric boat using an optocoupler sensor based on the Internet of Things (IoT) and a real-time monitoring method. Three distinct treatments (low-level gas, medium-level gas, and high-level gas) with five repeats can be used to evaluate this instrument. XSpeed was used to measure the motor speed at 938 Rpm with an optocoupler sensor for low-speed measurements, and there was a Knot difference of 0.7. The medium speed testing using an optocoupler sensor and XSpeed produced a motor speed of 1205.6 Rpm and a Knot difference of 1.7. High-speed measurements using an optocoupler sensor and XSpeed produced a motor speed of 1985.4 Rpm and a Knot difference of 1.2. The optocoupler sensor outputs more accurate readings than the comparison application XSpeed since the Blynk application can display data about both boat speed and motor rotational speed.

**Keywords**: Electric boat; internet of things (IoT); optocoupler; Arduino, Blynk

## 1. INTRODUCTION

Boats are a prominent mode of marine transportation used by tourists and fishermen to carry out their fishing operations [1]. Naturally, there is a chance of mishaps when operating a boat. Boat accidents are caused by a variety of causes, such as unsteady weather, human error, and insufficient boat speed. As a result, a monitoring system was installed on the vessel to keep an eye on its status while it was sailing.

The purpose of this study is to track boat speed and determine the resulting speed from the pace at which the boat is operated. A sensor is required for the purpose of monitoring boat speed in order to identify changes and generate output, which allows the required processing of the resulting data. An optocoupler sensor is one of the sensors used to track speed. Infrared light fluctuations can be detected using optocoupler sensors [2][3]. LED light and a phototransistor are the semiconductor materials used to make this optocoupler. When used together, the LED and phototransistor work as an optical light signal sender and receiver, respectively [4].

This sensor, which creates a propeller to indicate gaps and obstructions, is extensively used to measure an object's distance or velocity. The optocoupler sensor functions by having an open output when it is blocked and a short output when it is not obstructed. The infrared rays will produce electrical pulses when they function in this manner [5]. The information gathered will be used to program prototypes using Arduino software [6] and the ESP8266 nodeMCU will transfer the data to the Internet of Things (IoT) [7] Based on the ESP8266 chip, NodeMCU is an electrical board that can operate as a microcontroller and have a WiFi connection [8]. It has multiple I/O pins, allowing it to be built into an application for controlling and monitoring Internet of Things applications [9][10].

The idea of the Internet of Things (IoT) [11] is to increase the advantages of always-connected internet connectivity. The expansion of Internet connectivity has made it possible for devices other than PCs and smartphones to connect to the Internet. Nonetheless, a variety of actual items will be linked to the internet [12].

The present study introduces novel modifications to electric boats that are outfitted with a speed monitoring system. An optocoupler sensor is used in this speed monitoring design to read the rotation of the BLDC motor [13]. The Arduino processes the data and transmits it to the LCD, which is based on the Internet of Things and works as a system to show data in real-time. using a smartphone for monitoring.

## 2. METHOD

Bedono Village, Sayung District, Demak Regency served as the research site for three months, from October to December 2023. As seen in **Figure 1**. The passenger boat testing location began at the boat berth at coordinates -6.926569, 110.482513 and traveled roughly 1.5 kilometers to the religious tourist attraction of Sheikh Abdullah Mudzakir's burial at coordinates -6.914607, 110.481608.

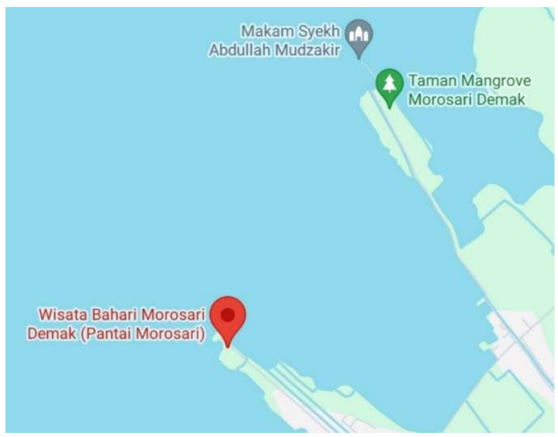


**Figure 1.** Electric boat speed analysis test location

The speed analysis of electric boats utilizing an optocoupler sensor was the focus of this investigation. The tools required for this investigation are a multimeter and a tachometer. MV MPPT 90Volt, Arduino, NodeMCU8266, Optocoupler Sensor, LCD 16x2, and Blynk are among the materials required for this study.

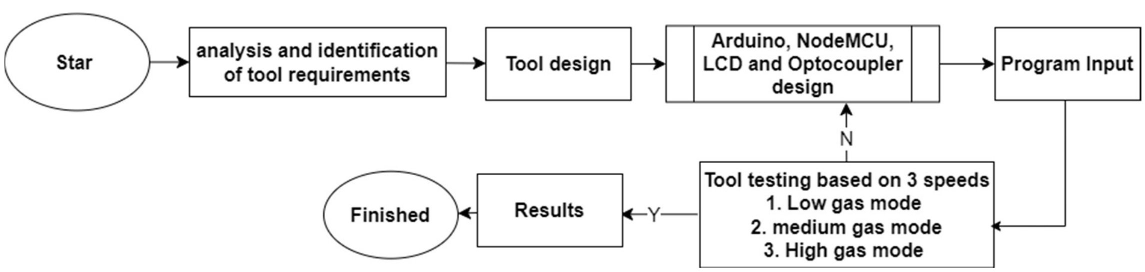


**Figure 2**. Research flow scheme

The research flow diagram is depicted in **Figure *2***, wherein the analysis and identification of tool requirements in the optocoupler sensor system as a speed analysis on Internet of Things-based electric boats is the first step that is completed. Prior studies on speed analysis employed the Hall effect [14], but since this approach could not be continuously observed, it was thought to be less successful. As a result, optocoupler sensors were used in this study's speed analysis. This tool's manufacture and design phase seeks to guarantee that the system functions as intended, from building the structure to planning where the supporting parts should be placed on the passenger boat. The stage of planning for Arduino, NodeMCU, LCD, and Optocoupler describes how to create the program and arrange the components of the speed monitoring system, which is the main component of the data reading system. The process of entering speed reader data into a program—that is, the optocoupler sensor's speed detector—that was designed as an output process is known as the program input stage. This tool's testing phase involves reading the motor rotation at three different speeds: low, medium, and high. After that, the data will be analyzed to identify the knots. **Figure 3** displays the block diagram for calculating an electric boat's speed using an optocoupler sensor

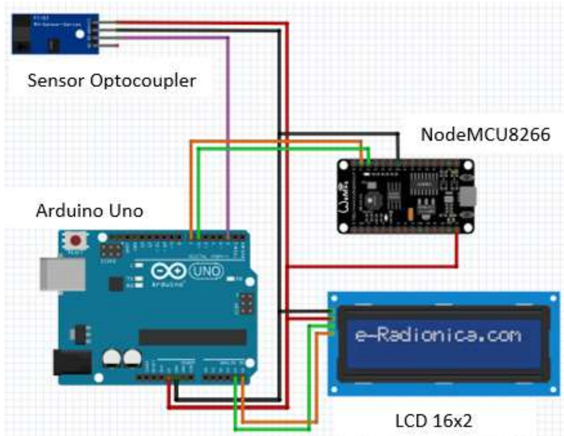


**Figure 3.** Designing the speed of an electric boat using an optocoupler sensor

The design scheme for the speed of an electric boat using an optocoupler sensor is shown in **Figure 3**. Analysis of the speed of an electric boat using an optocoupler sensor as input and using Arduino Uno and NodeMCU as a programming microcontroller or as data processing and LCD as data output.

The optocoupler sensor will read the rotary encoder rotation through encoder pulses and will send data to the Arduino to be displayed on the LCD (Liquid Crystal Display) screen [15] in the form of RPM data and Knot data.

Additionally, the NodeMCU8266 is a microcontroller that works with the Internet of Things (IoT) Blynk to transmit data via WiFi signal. The electric boat's speed may be tracked in real time with Blynk.

The data displayed on the LCD and manual measurements using a tachometer to measure motor rotation and XSpeed to calculate knots will be used to obtain the measurement data results. For every experiment, this measurement was performed five times. The formula for utilizing an optocoupler sensor to convert an electric boat's speed from RPM to knots is as follows.

$$Knot = \frac{\left(\frac{Rpm}{10000} x\ phi\ xpropeller\ hole\right)}{1{,}15078} \quad (1)$$

## 3. RESULTS AND DISCUSSION

### 3.1 Measuring the speed of an electric boat using an optocoupler sensor

The reading of pulse signals by the optocoupler sensor on the rotary encoder is shown in **Figure 4**. When the motor rotates, the encoder will rotate according to the motor speed being run. After that, the optocoupler sensor will read data signals from the encoder hole reading and will be transmitted via Arduino to process the data so that it can be read on the LCD screen.

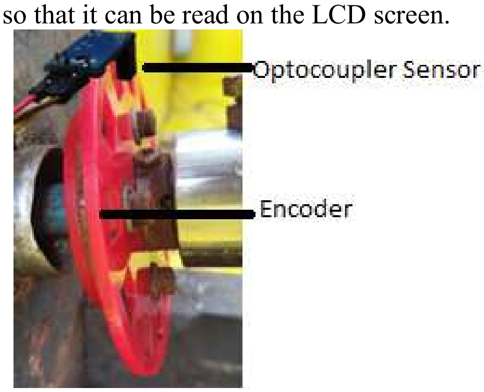


**Figure 4.** Reading the pulse signal by the optocoupler against the rotary encoder

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In this research, speed testing was carried out on electric boats using an optocoupler sensor with gas level treatment to determine the RPM and Knots on electric boats. The measurement results are shown in **Table 1**. Results of measuring the speed of the electric boat at low speed.

**Table 1.** Speed measurement results at low speed.

| Test | Measurement using an optocoupler sensor | |
|---|---|---|
| | Knot | RPM |
| 1 | 2,9 | 887 |
| 2 | 3,1 | 942 |
| 3 | 3,0 | 927 |
| 4 | 3,1 | 956 |
| 5 | 3,2 | 978 |
| Average | 3,1 | 938 |

The results in **Table 1** show that measuring the speeds of the boat at low speeds using an optocoupler sensor produces a motor rotation of 938 Rpm with a speed of 3.1 Knots. The measurement results are shown in **Table 2**, the results of measuring the speed of the electric boat at medium speed.

**Table 2.** Speed measurement results at middle speed.

| Test | Measurement using an optocoupler sensor | |
|---|---|---|
| | Knot | RPM |
| 1 | 5,0 | 1520 |
| 2 | 4,7 | 1435 |
| 3 | 5,4 | 1655 |
| 4 | 5,4 | 1658 |
| 5 | 5,4 | 1660 |
| Average | 5,0 | 1585,6 |

The results in **Table 2** show that measuring the speeds of the boat at medium speed using an optocoupler sensor produces a motor rotation of 1585.6 Rpm with a speed of 5.0 Knots. The measurement results are shown in **Table 3**, the results of measuring the speed of the electric boat at high speed.

**Table 3.** Speed measurement results at high speed.

| Test | Measurement using an optocoupler sensor | |
|---|---|---|
| | Knot | RPM |
| 1 | 6,1 | 1890 |
| 2 | 6,7 | 2067 |
| 3 | 6,4 | 1983 |
| 4 | 6,6 | 2035 |
| 5 | 6,3 | 1952 |
| Average | 6,4 | 1985,4 |

The results in **Table 3** show that measuring the speeds of the boat at high speed using an optocoupler sensor produces a motor rotation of 1985.4 Rpm with a speed of 6.4 Knots. The following is a summary of the results of measurements using the Optocoupler sensor comparing the speed of boats that were treated in the form of variations in low speed, medium speed, and high speed, shown in **Figure 5**.

The results in **Figure 5** show that the difference between low speed and medium speed is an average of 1.9 knots. Meanwhile, the average difference between medium speed and high speed is 2.5 knots. Based on previous research, according to Winarko, a comparison of speed based on frequency produces a difference between frequencies of 10 Hz and 20 Hz, on average, 0 knots apart. frequencies of 30 Hz and 40 Hz and 50 Hz are on average 2.2 knots apart [16]. The use of an optocoupler sensor produces higher knots compared to the use of a hall effect sensor. So it is more relative and efficient to use an optocoupler sensor to detect the speed of an electric boat.

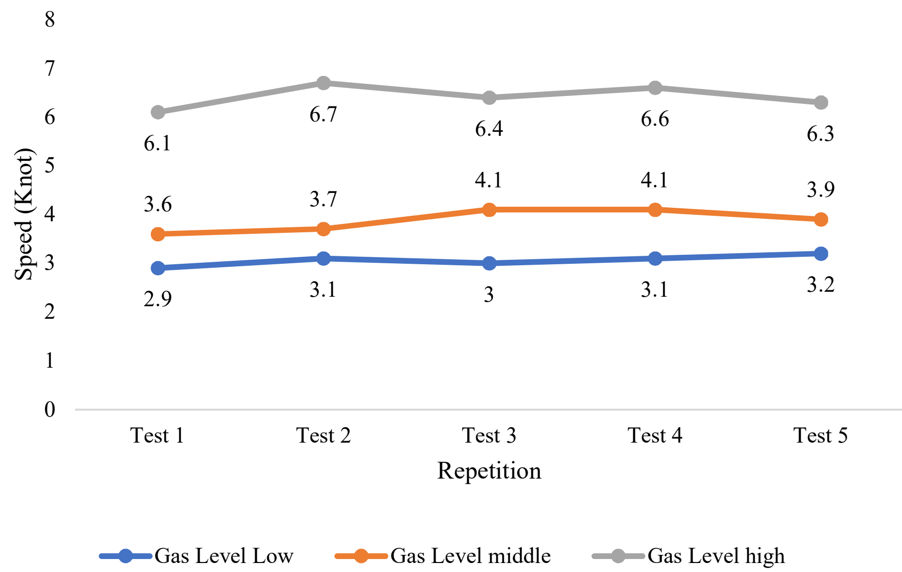


**Figure 5.** Comparison of low-speed, medium speed, and high-speed variations

The following is a summary of the results of measurements using the Optocoupler sensor comparing the rotational speed of electric motors treated in the form of low-speed, medium-speed, and high-speed variations, shown in **Figure 6**.

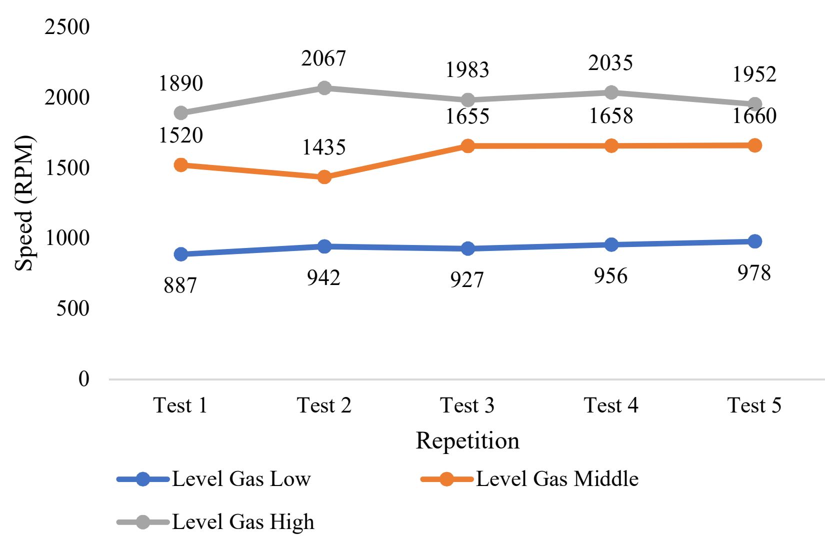


**Figure 6.** Measurement results using an Optocoupler sensor of motor rotation.

The results in **Figure 6** show that the difference between low speed and medium speed is on average 1585.6 Rpm. Meanwhile, the average difference between medium speed and high speed is 339.8 Rpm. Based on previous research, according to Syndu, a comparison of speed based on frequency produces an average difference between frequencies of 10 Hz and 35 Hz of 648.2 Rpm. A frequency of 40 Hz produces a speed of 1111.1 Rpm and a frequency of 45 Hz produces a speed of 1173.8 [17]. The use of an optocoupler sensor can detect higher rotation signals. So it is more relative and efficient to use an optocoupler sensor as a motor speed band detector.

3.1. Measuring the speed of an electric boat using XSpeed

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When the boat is moving, XSpeed will show how many knots are detected according to the boat's speed. The following is an image of the display in the XSpeed application when showing the speed of the boat, shown in **Figure 7**.


**Figure 7.** Speed measurement using XSpeed

The following are the results of measuring boat speed at low gas levels shown in **Table 4**

**Table 4.** Results of measuring the speed of an electric boat at low speed.

| Test | Measurement using an XSpeed | |
|---|---|---|
| | Knot | RPM |
| 1 | 3 | 887 |
| 2 | 4 | 942 |
| 3 | 4 | 927 |
| 4 | 4 | 956 |
| 5 | 4 | 978 |
| Average | 3,8 | 938 |

The results in **Table 4** show that measuring the speed of the boat at low speed using XSpeed produces a motor rotation of 938 Rpm with a speed of 3.8 Knots. The measurement results are shown in **Table 5,** the results of measuring the speed of the electric boat at medium speed.

**Table 5.** Results of measuring the speed of an electric boat at middle speed

| Test | Measurement using an XSpeed | |
|---|---|---|
| | Knot | RPM |
| 1 | 5 | 1520 |
| 2 | 5 | 1435 |
| 3 | 6 | 1655 |
| 4 | 6 | 1658 |
| 5 | 6 | 1660 |
| Average | 5,6 | 1585,6 |

The results in **Table 5** show that measuring the speed of the boat at medium speed using XSpeed produces a motor rotation of 1585.6 Rpm with a speed of 5.6 Knots. The measurement results are shown in **Table 6**, the results of measuring the speed of the electric boat at high speed.

**Table 6.** Results of measuring the speed of an electric boat at high speed

| Test | Measurement using an XSpeed | |
|---|---|---|
| | Knot | RPM |
| 1 | 7 | 1890 |
| 2 | 8 | 2067 |
| 3 | 8 | 1983 |
| 4 | 8 | 2035 |

| Test | Measurement using an XSpeed Knot | RPM |
|---|---|---|
| 5 | 7 | 1952 |
| Average | 7,6 | 1985,4 |

The results in **Table 6** show that measuring the speed of the boat at medium speed using XSpeed produces a motor rotation of 1985.4 Rpm with a speed of 7.6 Knots. The following is a recapitulation of the results of measurements using XSpeed to compare the speed of boats treated in the form of low-speed, medium-speed, and high-speed variations as shown in **Figure 8**.

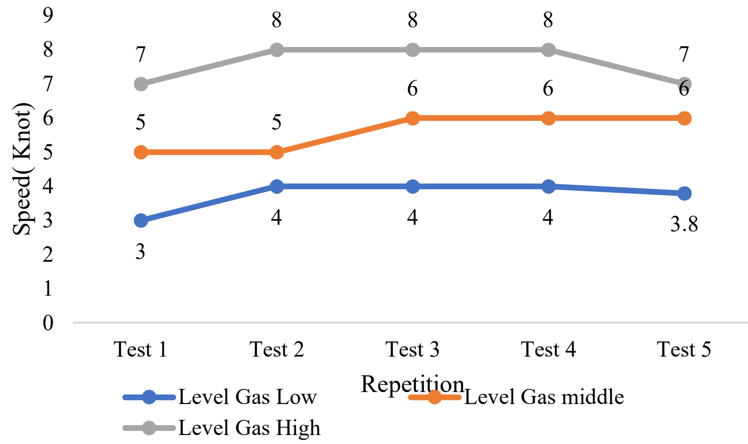


**Figure 8.** Measurement results using XSpeed

The results in **Figure 8** show that the difference between low speed and medium speed is an average of 2 knots. Meanwhile, the comparison between medium speed and high speed is on average 2 knots apart. Based on previous research, according to Winarko, a comparison of speed based on frequency produces a difference between frequencies of 10 Hz and 20 Hz, on average, 0 knots apart. frequencies of 30 Hz and 40 Hz average 0.2 knots. Meanwhile, the difference between the frequencies of 40 Hz and 50 Hz is on average 0.8 knots [16]. The use of an optocoupler sensor produces higher knots compared to the use of a hall effect sensor. So it is more relative and efficient to use an optocoupler sensor.

The following is a recapitulation of measurement results using XSpeed to compare the rotational speed of electric motors treated in the form of low-speed, medium-speed, and high-speed variations, shown in **Figure 9**.

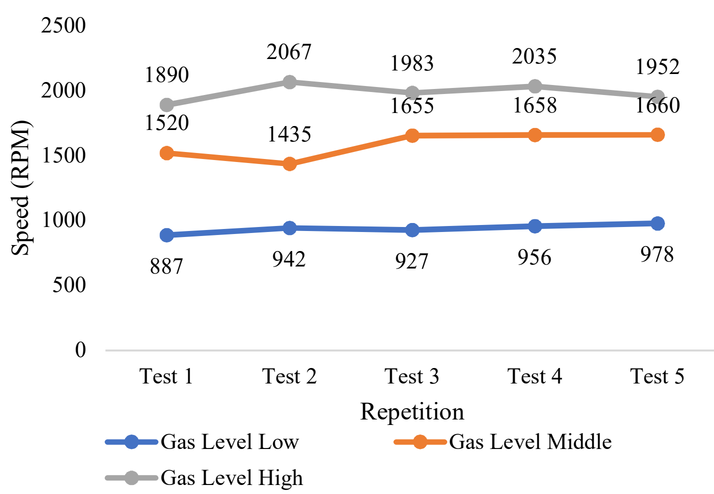


**Figure 9.** Measurement results using an Xspeed sensor of motor rotation on an electric boat.

The average difference between low speed and medium speed, according to **Figure 9** statistics, is 1585.6 Rpm. In the meantime, there is an average 339.8 Rpm difference between the medium and high speeds. According to Syndu, a comparison of speed based on frequency yields an average difference of 648.2 Rpm between frequencies of 10 Hz and 35 Hz based on prior studies. 1111.1 Rpm is produced at a frequency of 40 Hz, and 1173.8 Rpm is produced at a frequency of 45 Hz [17]. Higher rotation signals can be detected by the use of an optocoupler sensor. Therefore, using an optocoupler sensor as a motor speed rotation detector is more appropriate and effective [18].

## 4. CONCLUSION

The use of an optocoupler sensor for speed detection in speed analysis on an electric boat is particularly successful since it allows for remote and real-time monitoring via a smartphone application. An optocoupler sensor and XSpeed, which is used for low, medium, and high-speed treatments, are used to measure the speed of the electric boat. Low-speed experiments using an optocoupler sensor and XSpeed yielded a motor speed of 938 Rpm and a Knot difference of 0.7. Using an optocoupler sensor and XSpeed, the medium speed tests yielded a motor speed of 1205.6 Rpm and a Knot difference of 1.7. Using an optocoupler sensor and XSpeed, high-speed measurements yielded a motor speed of 1985.4 Rpm and a Knot difference of 1.2. Because the Blynk application can display both boat speed data and motor rotational speed, readings from the optocoupler sensor are more accurate than those from the comparison application, XSpeed.

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