INVOTEK

Jurnal Inovasi Vokasional dan Teknologi

http://invotek.ppj.unp.ac.id/index.php/invotek

Vol. 22, No. 3, Oct 2022

ISSN: 1411 – 3411 (p)
ISSN: 2549 – 9815 (e)

Analysis of Maneuvering Speed of a Passenger Ship Scalability Prototype with a Remote-Control System

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Abstract

They are using a passenger ship prototype as an experiment in control systems. Ship prototype control system with remote control. For this reason, research was carried out on the workings of ship prototypes, maneuver speed, long distance to the ship, and battery capacity expiration time. For this reason, research was carried out on how the prototype ship worked, the maneuvering speed, the remote reach distance to the boat, and the time the battery capacity would run out. The research was conducted using a rope, stopwatch, arc ruler, and test object. Using this tool, the results of the ship's speed when maneuvering at a predetermined angle, the maximum range of remote distance to the boat, and the length of time the battery capacity will run out. The research results tested on the remote control (RC) prototype ship showed the highest maneuvering speed at an angle of 90 degrees, which is 0.407 m/s, and the lowest rate at an angle of 180 degrees, 0.376 m/s. With this, it can be concluded that the smaller the angle of maneuver, the faster the speed of the ship to maneuver, and the greater the grade of the scheme, the slower the rate. Furthermore, the farther the remote control operating distance is from the battery speed, the faster the battery capacity will run out, and the closer the ship's rotational variation distance, the more the battery capacity will run out.

Keywords: prototype ship, remote control, maneuvering angle, maneuvering speed, battery capacity

1. Introduction

Indonesia is a maritime country whose entire territory is surrounded by the sea [1]. The sea is the largest area, about seventy per cent of the country's total area. Territory as a whole does not only cover the sea but consists of islands with territorial boundaries according to existing regulations. The means of transportation used since the first is sea transportation as a liaison between islands with the ship as the means of transportation [2]. Ships are used in logistics for humans as passengers who will move to other places.

In the past, there has been an orientation from marine-focused engineering to modern transportation [3]. Ride in the form of ships with advanced technology has begun to be introduced as a control mode with a remote control system to carry passengers to logistics [4]. Technology development is speedy, so various technologies are created to help humans do many things [5].

A prototype ship is a transportation tool developed in Indonesia with a remote control system or without a crew. The prototype ship serves as a means of defence and transportation of seas, lakes, and rivers. The ship's prototype has been designed to use a remote control to increase users' effectiveness and efficiency [6]. The remote control system itself that is developing can be used in community needs along with other rapidly evolving technologies [7]. The remote control is a tool humans control from a distance [8]. The command is carried out for security, especially on ships as transportation at sea [9].

Control systems on ships are used in various areas with their respective interests and uses, as to several studies that have been done before. Therefore, research related to control, especially on ships, is made to handle it easily.

Pallis et al. developed a prototype control system and operating strategy focusing on seawater temperature for efficient performance in the case of the northern seas. In addition, a micro-scale ship is developed with a design in the engine room [10].

Received date 22/09/2022, Revised date 19/02/2023, Accepted date 09/03/2023

P-ISSN: 1411-3414
E-ISSN: 2549-9815

There is also research on the design of a prototype computer system independently of an unmanned ship model. The designed computer system is expected to be optimal for the planned tasks during the control software test. Furthermore, tests carried out in open water confirmed the correct operation of the computer system and all measuring and navigational equipment built on the unmanned carrier model [11].

As for previous research regarding remote ship operations, namely the monitoring and managing ships remotely so that operators can collect information about ship operations, resource consumption, or health status and order ships to perform specific tasks remotely [12], therefore, the proposed framework identifies human interaction at the remote control centre and the main differences between remote and near-ship operation with a human approach.

One of the papers shows the elements of the ferry prototype. Research with analysis was carried out on the initial design of the ferry by looking for the dangers and risks that will arise from the weather and how to monitor it so that it is controlled as desired [13]. From the results of experimental research for ship applications with passenger transportation designed to focus on safety. The existence of movement control, especially in maneuvers, was developed experimentally [14]. Similarly, Costa et al.'s research value the proof-of-concept of service utility on maritime prototypes utilising ship simulators with their mission to e-navigation [15].

Several previous studies made control systems related to ships and the sea. This study also carried out the design and assembly of a prototype passenger ship control system. Furthermore, the analysis of the results of the control system on the ship has been carried out. The main components of the control system are critical to know.

The remote control is a set of practices, physical structures, and institutions whose purpose is to control individuals' mobility when they are outside the territory of the destination country [16]. The remote control is a device or object used to operate things remotely, while radio control is a controller which uses a radio wave; in the past, controller & control used an MHz AM or MHz band. FM. Characteristics that use long antennas and those that use a channel, namely signals primarily used 25,30,40,45,70,90 MHz, so there is a possibility of clashing signals between one RC and another RC because of the same and usual signal channel problem. The characteristics of using a short antenna are sometimes not visible on the remote or transmitter. They are associated with a receiver connected to the Electronic Speed Controller (ESC) and are also digital so that no one can compete with one ship's signal with another. Remote control has processes and machines that are beneficial for safety and efficiency, and commercial pressures drive the development and adaptation of new technologies [17]. Several remote controls are applied to the ship to control many things to monitor the ship's progress [18].

The battery is a power source needed by the Transmitter and the Receiver. This battery source is required to supply electricity which functions to move components that typically move or operate in the presence of a power source. Batteries are direct current sources used in power centers [19]. The battery system has cells to meet the needs of voltage and power. In addition to the presence of cells, the battery system also contains components such as cell housings, electronic controls, sensors, and other channels to provide a relatively complex configuration so that they are related and form power [20].

A Servo motor is one type of DC motor that uses a feedback system in which a control circuit will inform the position of the rotor on the servo motor. This motor consists of an engine, a series of gears, a potentiometer, and a control circuit. This potentiometer determines the limit of the angle of the servo rotation to show its effectiveness [21]. The universal DC motor model is built based on its control expressed by the backstepping method—a closed-loop system for guaranteed stability [22].

The transmitter is a component that is held by the pilot on the ground to control the aircraft by sending a signal to the receiver. In general, the transmitter works using radio waves. The function of the transmitter is to send instructions to electronic equipment. This tool is an LED (Light Emitting Diode) infrared rays on the remote control plane. The receiver is a signal catcher from the sign we give from the remote (Transmitter) on the ground so that it can be controlled as we wish without cables [23]. The transmitter's light source, either a laser or a light-emitting diode, must be modulated with the communication signal. The receiver is essential to any optical link because its design has a dominant factor [24].

P-ISSN: 1411-3414
E-ISSN: 2549-9815

2. Research Methodology

The design method was used in this study, and further analysis was carried out on the design results. The results of the design to be analyzed must have a clear and directed research flow. Therefore, a description of the research process from beginning to end is made in the form of a research flow to facilitate the design process. Furthermore, it is clearer how the flow can be seen in Figure 1.

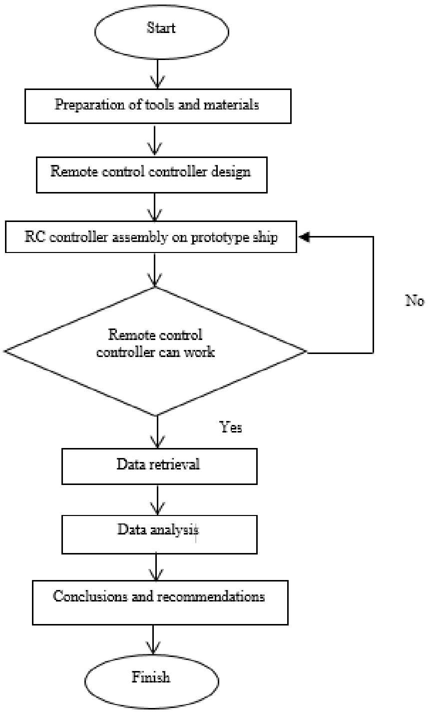

Figure 1. Research Flow

This study must prepare tools and materials to make a prototype control system for a passenger ship with remote control. The tools installed on the instrument as controllers include: a screwdriver, G glue, sandpaper, drill, cloth, scissors, knife, bow ruler, rope, and wood. At the same time, the materials used are remote control (RC) flysky FS-i6 type, 3500 VK servo motor, 11.5 V Lipo battery, cable, transmitter and receiver, propeller, shaft, and DC motor.

In this study, maneuvering data collection aims to obtain results, namely how fast the ship is when performing a turn maneuver using the vector velocity formula and by making the maneuver angle using a rope as an angle determination from left to right or clockwise. The concept of maneuver angle used includes 90^0, 120^0, 150^0, 170^0, and 180^0. Starting with a maneuver angle of 90 degrees with 120 degrees which in the picture looks almost the same and can be seen in Figure 2.

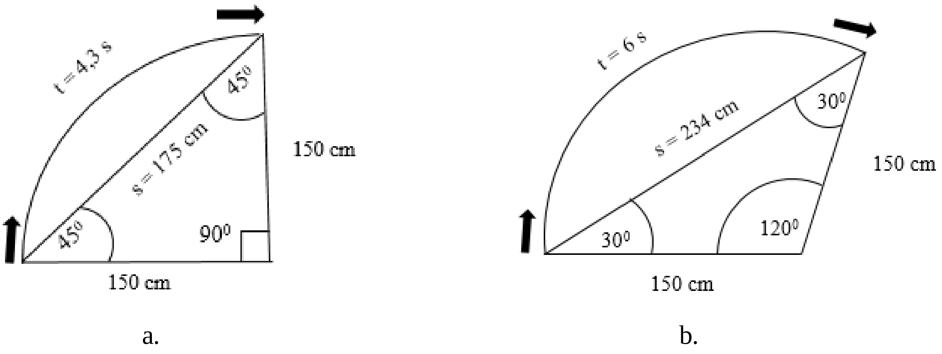

Figure 2. Ship Maneuver 90^0 (a); Ship Maneuver 120^0 (b)

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E-ISSN: 2549-9815

Furthermore, at a maneuver angle of 150 degrees with 170 degrees, it has almost the same appearance, according to Figure 3. So that the control of the ship will be practically the same, only more maneuvers will be carried out for a larger angle.

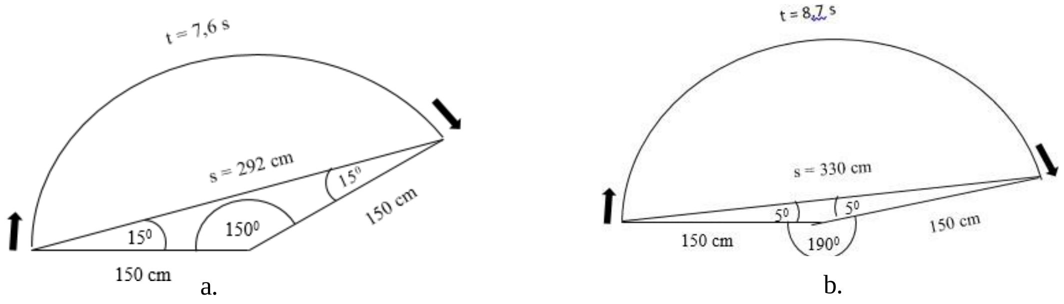

Figure 3. Ship Maneuver 150^0 (a); Ship Maneuver 170^0 (b)

The 180-degree maneuver angle looks very different from the previous angle because the rotation is very different from the start and can be seen in Figure 4.

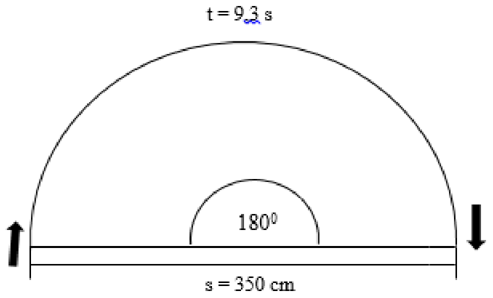

Figure 4. Ship Maneuver 180^0

The test method in this study aims to determine the ratio of battery capacity and how long it will last to use the battery—as well as find out the comparison of results to be obtained. Furthermore, rotation variations are carried out to have a circle diameter of 3 m for the ship's rotation, with the same speed. In rotary motion, the remote control operation of the ship's cycle is carried out within a distance of 5 m, 10 m, 15 m, 20 m, and 25 m to see how far the control points are from the outside of the ship. At a distance of 5 m, it has a control point distance with 2 m overboard rotation; at a distance of 10 m it has a 7 m point control distance, as seen in Figure 5.

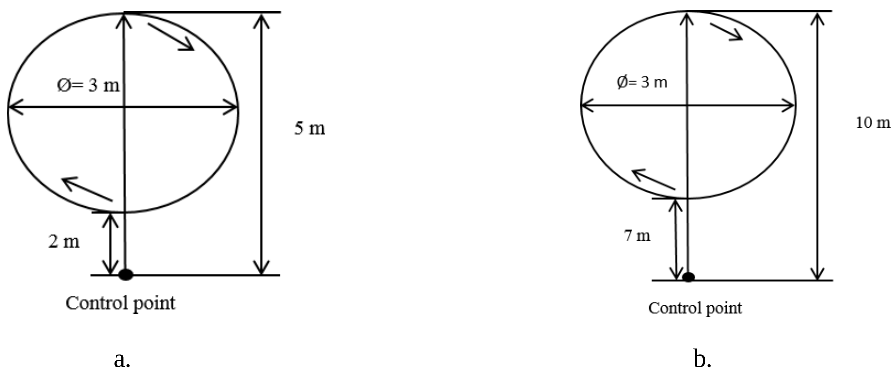

Figure 5. Variation of Spinning on Distance 5 m (a); Variation of Spinning on Distance 10 m (b)

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Figure 6 shows a distance of 15 m, a point control distance with 12 m overboard rotation and a distance of 20 m has a distance of 17 m control points.

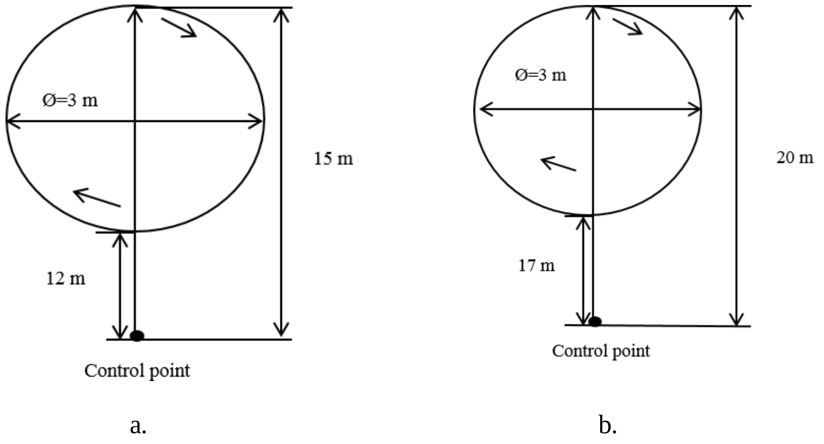

Figure 6. Variation of Spinning on Distance 15 m (a); Variation of Spinning on Distance of 20 m (b)

Figure 7 shows a distance of 25 m has a distance at the control point to the outer rotation of the ship 22 m.

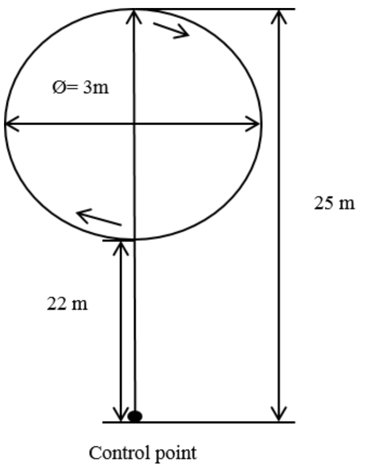

Figure 7. Variation of Spinning on Distance 25 m

2.1 *Instrument Design and Assembly*

Design by planning the layout of the materials and tools used in assembling the instrument. Instrument assembly begins by inserting the supplied devices, such as the servo, receiver, and battery. Then the components are made using cables to become one, as shown in Figure 8.

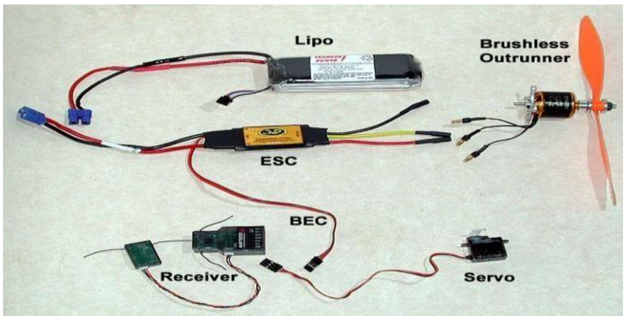

Figure 8. Assembling the Prototype Ship Instrument

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2.2 Instrument Placement

Install components from the servo motor on the back of the ship with cables, then attach the DC motor or dynamo to the boat with glue and rope. Furthermore, all components have been installed to form a vessel; more details are shown in Figure 9. Its dimensions with scalability are 1:5 to the actual size.

Figure 9. ShipRoof Placement

2.3 Data Retrieval

Data retrieval can be done at the time of testing. This data retrieval includes several tests, including prototype ship maneuvers and RC operating distance range. After the data collection is obtained, we can consider whether it is feasible. When the ship is maneuvering, data retrieval uses meters, ropes, and stopwatches. Then the operating range of the RC to the receiver is by using a meter. The formula for finding the speed is:

$$V = \frac{S}{t} \tag{1}$$

Where V is the object's speed (m/s), S is the distance or displacement travelled by the object (m), and t is the time reached (s). Furthermore, data collection by preparing tools including rope, wood, ruler, stopwatch, scissors, a set of RC boats, and an RC remote control.

2.4 Data Analysis

In analysing the data, testing the prototype ship maneuvers at turning angles of 90^0, 120^0, 150^0, 170^0, and 180^0. The more significant the displacement angle, the faster the ship's speed, or the smaller the displacement angle, the slower the ship's speed. Testing the operating range of the transmitter to the receiver on the battery capacity of 100%, 75%, 50%, or 25%, whether the content is the same result. Next, compare the rotation variation to when the battery capacity runs out.c

3. Results and Discussion

The ship always has a control system. There are studies with systems on ships with nonlinear stabilisation control strategies [3]. Supported by making ship prototypes by demonstrating at a remote control centre and monitoring [12].

This research designs and makes a ship prototype by how it works, starting from a transmitter or remote control that the pilot holds on land to control the ship by sending a signal to the receiver using radio waves. Then the receiver catches the signal from the remote (Transmitter)—the receiver in the prototype ship controls the ESC, servo, and motor electronically. ESC serves to regulate the speed of the engine. When the receiver receives information from the transmitter that the ship will go at a certain pace, the receiver will command or send data to the ESC to control the rotational motion of the motor. Then when it is about to turn, the receiver commands the servo to move as instructed by the transmitter to turn right or left. Furthermore, data collection and analysis can be carried out.

In this study, in collecting maneuver data, it is necessary to carry out a turning maneuver using the velocity vector formula and by making a scheme angle using a rope as an angle determination, with the length of the rope making this angle 1.5 m long, and the ship's maneuver rotation is from left to right or in the same direction clockwise. The use of a remote control makes the researcher try to adjust the

P-ISSN: 1411-3414
E-ISSN: 2549-9815

angle of the maneuver to produce a maneuvering speed so that the difference is not big or close to the same. Then, the results of the maneuver angle are shown according to the value of each speed and in more detail in Table 1.

Table 1. Maneuver Speed Comparison Against Each Angle

Maneuver Angle (^{0})	Maneuver Speed (m/s)
90	0,407
120	0,390
150	0,384
170	0,379
180	0,376

In maneuvering a ship, an experimental arrangement consists of navigation and control platforms from the prototype ship [25]. From the table of ship maneuver speed results, it is known that the smaller the angle of a maneuver performed, the faster the speed of the ship to operate, and conversely, the greater the grade of the shipping scheme, the slower the speed of the ship to maneuver, but for large maneuver speed there is not too big a difference in the value of each maneuver angle due to the effort to use the remote control in maneuvering the ship. The force of the water load on the ship can influence the difference in each maneuver angle.

The test was carried out ten times at each distance of 26 m, 30 m, 37 m and 50 m to obtain the results of using battery capacity. In testing the distance based on the battery capacity in Figure 10, namely, the more battery capacity, the farther the remote-control operating distance from the ship can be taken, which is because when the position of the battery capacity is more, the energy is the ability to send information or signals from the transmitter (RC) to the receiver (ship) is still excellent and affordable. On the other hand, the smaller the battery capacity, the closer the remote-control operation distance to the boat will be.

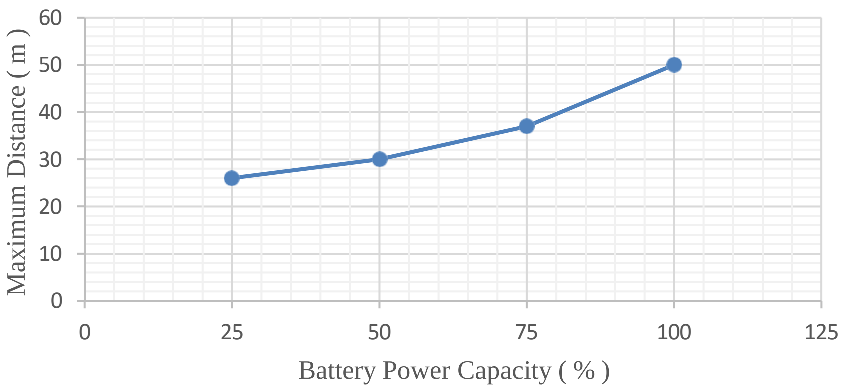

Figure 10. Graph of Battery Power Capacity Against Maximum Distance

The comparison of the battery capacity time in the rotating variation from its maximum distance is that the farther the remote-control operating space is from the ship's rotation, the faster the battery power capacity will run out. The closer the remote-controlled working distance to the ship's process is, the longer the battery power capacity will be used. This is because when the remote control operates on a distant boat, the energy released by the battery to send information/signals to the receiver is more extraordinary; therefore, the battery capacity will run out quickly. Furthermore, it can be seen in Table 2. Figure 11 describes a straightforward graph of the remaining battery capacity compared to the working distance from the ship.

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Table 2. Maneuver Speed Comparison Against Each Angle

Maximum distance (m)	Spin Variation Time (minutes)
5	6,22
10	6,03
15	5,50
20	5,42
25	5,35

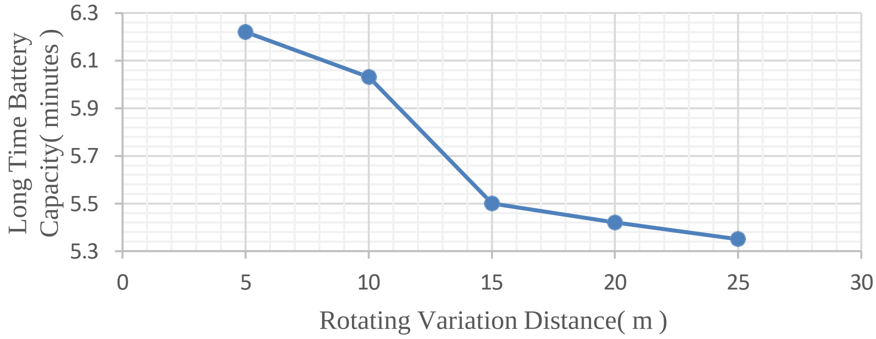

Figure 11. Graph of Battery Power Capacity in Variations Rotating Against Maximum Distance

4. Conclusion

Based on testing of the RC control system on the prototype ship that runs and turns, the highest maneuvering speed at an angle of 90 degrees is 0.407 m/s, while the lowest maneuvering speed is at an angle of 180 degrees, which is 0.376 m/s. Therefore, in the range achieved to increase the battery speed, the closer the long-distance range to the ship is achieved with the battery increase game, which is stated that the farther the remote-control operating distance is from the battery speed, the faster the battery capacity will run out. Likewise, the closer the ship's rotational variation distance, the more the battery capacity will run out.

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