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THE SEA DEPTH CONTROL AND MONITORING SYSTEM ON SHIP PROTOTYPE

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ABSTRACT

With Indonesia's very geographical position, it does not rule out the possibility that the conditions of the docks at the Indonesian Navy bases have varying depths depending on the tides and contours of the underwater land. Changes in the contour of underwater land in several regions of Indonesia are rapidly changing due to several reasons, for example earthquakes, climate change, changes in current patterns, sedimentation, global warming and so on. A safe and efficient berthing process is the key to carrying out the KRI's main tasks. The success of this berthing process depends not only on the skills of the ship's crew, but also on a deep understanding of the depth of the sea around the pier. A vehicle or tool is needed to help measure sea depth, especially around the pier, which can be monitored directly with a control system. The method used is a qualitative descriptive approach through trial and error techniques. By carrying out various kinds of experiments and measurements on components and analyzing the results in accordance with the applied theory. The control system uses two push buttons, a joystick, and a potentiometer with Arduino Nano and Uno and the NRF24L01 module shows the reliability of wireless communication at the 2.4 GHz frequency with a range of 90.32 meters in an open environment. Ocean depth monitoring using the NRF24L01 module on the same frequency succeeded in receiving data on depth, position, angle of inclination of the ship, and time per two to three seconds with the same range. Data can be monitored in Excel or graphic format using PLX-DAQ software.

Keywords: *Deep sea, Microcontroller, NRF24L01, PLX-DAQ.*

1. INTRODUCTION

The Indonesian Navy has several bases spread throughout Indonesia. One of the functions of the Indonesian Navy Base is as a KRI anchoring facility, serving and supporting the KRI which will carry out re-supply (bekul). A port building used to dock and moor ships that will carry out resupply (bekul) is a pier. At the pier activities are also carried out to refill fuel for ships, drinking water, clean water, channels for dirty water or waste which will be further processed at the port. With Indonesia's very geographical position, it is possible that the conditions of the docks at the Indonesian Navy bases have varying depths depending on the tides and contours of the underwater land. Changes in underwater land contours can occur in many parts of the pier, such as at the entrance, anchorage area and navigation channels. Changes in the contour of underwater land in several regions of Indonesia are rapidly changing due to several reasons, for example earthquakes, climate change, changes in current patterns, sedimentation, global warming and so on.

A safe and efficient berthing process is the key to carrying out the KRI's main tasks. The success of this berthing process depends not only on the skills of the ship's crew, but also on a deep understanding of the depth of the sea around the pier. The importance of a deep understanding of the depths of the sea is the main driver in preparing this final assignment. By understanding underwater conditions, it is hoped that a tool can be designed that can effectively assist KRI maneuvers at the dock during the berthing process, increase operational efficiency, and ultimately, strengthen national security resilience.

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Based on the study of the problems above, the author has the idea to create a design for a sea depth detection ship with a control system, especially in the dock area. So it is hoped that it can monitor sea depth levels directly. Using the acoustic method, this tool uses sonar. Sonar is a method that uses sound propagation in water to determine the whereabouts of objects below the surface of the water area. In general, the working system of sonar equipment is to emit a sound source that will spread in the water. This sound will be reflected by objects in the water and received back by the sonar system. Based on calculating the speed of sound propagation in water, the location of the object in the water can be determined as to its distance from the sound source.

1.2 Formulation of the problem

Based on the background stated above, the formulation of the problem in this research is

a. How to design and create a control system for controlling a sea depth detection ship ?

b. How to monitor sea depth and display depth?

1.3 Research purposes

The aim of the problem formulation above raised by the author is as follows:

a. Create a control system to control sea depth detection vessels.

b. Monitoring sea depth using LCD and PLX-DAQ software.

1.4 Benefits of Research

The benefits obtained from writing this final assignment are as follows:

a. Theoretical Benefits

To apply the knowledge that has been obtained while studying at the Naval Technology College.

b. Practical Benefits

1) Makes it easier to monitor depth levels in the dock area and can be monitored directly.

2) Reduce the risk of accidents (running aground) during the KRI docking process.

3) Providing innovation in the use of microcontroller systems with sonar as a learning medium for the process of modernizing the security and monitoring system for the Indonesian Navy's defense equipment .

1.5 Problem Limitations

In completing this final assignment, the author set boundaries to be more focused and the problem was not too broad. The limitations of this problem is about using the software used is Arduino IDE and PLX-DAQ Measuring sea depth using SBES active sonar *(singlebeam echsounder)*.

2. LITERATURE REVIEW

2.1 Microcontroller

Microcontroller is a small computing device that integrates a processor, memory, and input/output peripherals on a single chip. One popular microcontroller platform is the Arduino Nano. Arduino Nano is a microcontroller board based on the ATmega328, has a small size and is flexible for various electronics projects and embedded systems. Arduino Nano is a variant of the Arduino family that uses the ATmega328 microcontroller. Arduino Nano has a small size which allows it to be used in projects with limited space. Key features of the Arduino Nano include:

a. Microcontroller: ATmega328
b. Operating Voltage: 5V
c. Input Voltage: 7-12V
d. Digital I/O Pins: 14
e. Analog Input Pins: 8
f. Flash Memory: 32 KB
g. SRAM: 2 KB
h. EEPROM: 1 KB
i. Clock Speed: 16 MHz

Microcontroller has a Harvard architecture that separates lanes and memory for instructions and data. This allows the CPU to access instructions and data simultaneously, increasing execution speed. The ATmega328 also comes with a rich instruction set and features such as:

a. Timer/Counters: 8-bit and 16-bit timers that can be used for timing or as a PWM signal generator.

b. USART: Serial synchronous Receiver/ Transmitter Unit for serial communications.

c. SPI: Serial Peripheral Interface for communication with high-speed peripherals.

d. I2C: Inter-Integrated Circuit for communication with peripherals such as sensors and external memory.

Development using Arduino Nano is very easy because of the intuitive Arduino Integrated Development Environment (IDE). This IDE supports the C/C++ programming language and provides various libraries to make interfacing with sensors, motors and other devices easier. Programming users can write code in the Arduino IDE and upload it to the Arduino Nano via a USB cable. The Arduino Library provides various libraries that support various functions such as serial communication, signal processing, and sensor interfacing.

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2.2 NRF24L01

The NRF24L01 module is a wireless communication module that uses RF technology VCC: Power pin CE CSN SCK MOSI MISO IRQ: Interrupt pin Initialization: The NRF24L01 module is initialized using the available libraries Data Delivery: The data to be sent is filled into the module's send buffer, and the module is then set to transmitter mode Data Reception: The receiver module is set to receiver mode and waits for data to be transmitted. Once data is received, the module generates an interrupt. Error Handling: The NRF24L01 module has a built-in mechanism for error handling and automatic retransmission if data is not sent correctly.

2.3 LCD (Liquid Crystal Display)

LCD is an electronic component for displaying characters, graphics or letters, where to operate the LCD only requires a small voltage. In everyday life, LCDs are usually found on *the smartphones* we use, digital watches, digital multimeter instruments and also calculators. Each LCD screen matrix is composed of two dimensions which are divided into rows and columns. On an LCD there is *a backplane,* namely rows and columns of LEDs that meet on a flat plane, a transparent electrode layer covers the inside of the inner glass plate. Under normal conditions, the liquid on the LCD is bright in color. After that, when voltage is applied between the electrode pattern and the flat area on the inside of the front glass, certain areas of the liquid will change color to black. The LCD uses pins to operate, including DB0 to DB7 pins, RS pins, R/W pins and Enable pins. The DB0-DB7 pins are the data bus line which functions as a communication line between the microcontroller and the LCD.

2.4 Motor Brushlass DC

In general, a BLDC motor consists of two parts, namely, the rotor, the moving part, which is made of permanent magnets and the stator, the non-moving part, which is made of a 3-phase coil. Even though it is a 3-phase AC synchronous electric motor, this motor is still called BLDC because in its implementation BLDC uses a DC source as the main energy source which is then converted into AC voltage using a 3-phase inverter. A brushed motor system is a type of electric motor that has a relatively simple design and has been used in a variety of applications for many years. When electric current is passed through these coils, they become electromagnets that interact with the stator magnetic field.

Its function is to reverse the direction of the electric current flowing through the rotor coil at the right time to maintain rotor rotation. When the rotor rotates, the brushes provide an electric current to the commutator, which then flows to the rotor coil. When the rotor rotates, the commutator ensures that electric current continues to flow through the rotor coils in the correct direction to maintain rotation. The brushes ensure good contact between the commutator and the external electrical system. When point A gets logic 1 and point B gets logic 0, Q1 and Q4 will be ON, so current will flow to the motor by passing through Q1 and going to Q4, then the motor will rotate to the right. When point A gets logic 0 and point B gets logic 1 then Q3 and Q2 will be ON, so current will flow to the motor by passing through Q3 and going to Q2, then the motor will rotate to the left. When point A and point B both have logic 0 or logic 1, the motorbike will BREAK or brake/stop.

2.5 Motor Servo

Servo motors are a type of electric motor designed to control angular or linear position with high precision. These motors are often used in applications that require accurate control of position, speed and acceleration, such as in robotics, automation systems and motion control. It can be a DC motor or AC motor that functions as an actuator. Generally used in applications that require very precise steps. Servo motors work on the principle of closed feedback. Signal input: The servo motor receives an input signal from the control system, usually a PWM signal. Error correction: The controller compares the actual position with the desired position and calculates the error. Stepper servo motor: Uses a stepper motor combined with a feedback system to increase precision. Generally used in applications that require very precise steps. Servo motors are important components in various applications that require high precision control of position and speed. By understanding the components, working principles and applications of servo motors, we can implement and utilize this technology effectively in various industrial and technological fields.

3 RESEARCH METHODS

3.1 Research design

Research design is a system or framework that will be used to carry out research, and is also a stage carried out in research. Research design provides procedures on how to make a tool and also prepare a plan before carrying out research in the hope that it can be used as a guide in solving all problems in a research.

The system is the elements of a design that are combined with various methods to become a system that can meet certain goals. In this research, several developments were carried out with the aim of creating new innovations with previously created equipment in order to obtain more value.

In this research, a design for a sea depth detection tool will be carried out to support and assist

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the KRI (Republic of Indonesia ship) in maneuvering, this depth measuring tool uses SBES active sonar (singlebeam echsounder) . This tool will be designed by two STTAL students . In this case the authors create a control and monitoring system for sea depth on a prototype ship on the water.

3.2 Research procedure

Procedure is a series of detailed activities regarding the process of executing actions in a standard way so that it gets the same results every time it is carried out (executed). In simpler terms, a procedure is an equivalent that indicates a series of activities, methods, steps, provisions, calculations, processes and tasks to be carried out. held.

In a series of execution activities that aim to achieve desired goals such as results, products or consequences, research procedures are a series of activities carried out by researchers periodically and systematically. Research begins with determining design specifications that meet the specified specifications, selecting the best alternative, and proving that the selected design can meet the specified requirements.

3.3 Time and Place of Research

The time for the final assignment research to be carried out is from January 2024 to June 2024. Meanwhile, the place for carrying out the research is at STTAL (Naval Technology College and Naval Education Command (KODIKLATAL) Bumimoro Surabaya.

3.4 Tools and Materials

Carrying out this research requires several tools and materials to make it easier to design and test research. The tools and materials needed to carry out this research include:

Table 1. Tools Used

No	Component Name	Type/Kind	Amount
1.	Arduino nano	- Atmega328p - Voltage 5V - Number of digital I/O pins 14	1
2.	DC brushless motors	- Oumefar brand - Voltage 12 volts - Shaft diameter 5 mm	1
4.	GPS	- *GPS VK2828U 7G5 LF TTL V.KEL* - *Power 5 Volts*	1
5.	NRF24L01	- Model 24L01 *Freq* ISM 2.4 GHZ - *Max-distance 800m* - Power 1.9 to 3.9 volts	2
6.	LCD	- Interface 12C - PIN Definition GNDVCCSDAS	1
7.	ESC	- Model BDESC-S10- RTR - Tegangan 6-12 V - BEC Output 5V 2A	1
8.	PCB	Merk EC Uk. 20 x 10	1
9.	Motor servo	- Degree max 180 degress servo rotation - Operasi Tegangan 5-7,2 V - Running Cureent 500 – 900 mA	1

3.5 Research Design

This research design is the stage where the planning of existing problems in the field is planned. This design aims to provide a general overview of the operation of the tool system that will be created as a whole which will provide a clearer direction and targets to be achieved so that the research can run well in accordance with what is expected so that the process achieves the objectives of the research in solving problems. can run well, be clear and structured. There are two parts to the research design, namely hardware design *(ha d ware)* and software design *(software).* The design will be

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implemented in several stages. The first stage begins with designing the system design. The second stage is selecting the sensors and devices needed. The third stage, testing each part according to its function. The next stage is assembling the devices that have been tested according to the system design. Finally, test the system functionality.

3.6 Control System Hardware Design

In hardware design, it explains all the devices needed to realize ideas in solving existing problems into a system which is depicted in the form of a block diagram. The design and build process system *hardware* Control using Arduino Nano and Uno *microcontrollers* begins with determining and analyzing design materials which include: Arduinon Nano , Arduino Uno, *PCB board* , push button, LCD, *Brushless* DC motor, ESC, servo motor and NRF24L01 module. The next step is to prepare the design materials by complying with the technical specifications for the required design materials, then each component is tested partially by looking at the input or output of each material being tested. If the material test results are in accordance with specifications, the next step is to assemble the system components control , if the test results are not appropriate then the component will be analyzed again until the results are in accordance with specifications.

3.7 Control System Software Design

The implementation of the software design is carried out on the Arduino IDE software, which is one of the platforms *software* for programming a system using *a microcontroller* such as Arduino Nano . The initial stage in *software design* is to create *a flowchart* which functions as a reference and correction if an error occurs during program execution.

3.8 Ocean depth monitoring design

The sea depth monitoring system aims to measure and observe water depth conditions in the sea in real-time. The use of the NRF24L01 wireless communication module in this system allows sending sensor data from below the sea surface to monitoring stations on the surface. The modules used are an Arduino nano microcontroller as a data processor from sensors, an NRF24L01 module for data communication and an LCD to display depth, position and tilt angle data as well as PLX-DAQ *software* to display data on a laptop in Excel and graph format.

3.9 Data Collection

Data collection is a process of searching for information and data and instructions needed in a research, so that it can present information that is correct and on target. Data collection is aimed at determining the level of success of system design. In this research, the author carried out data collection using several methods. Among others:

a. Observation Method

This method is implemented by making direct observations of situations in the field that are directly related to this research. Observations were carried out at the STTAL Campus. This activity aims to enable the author to collect some of the information needed to complete the existing data.

b. Interview Method.

The interview method is a method of carrying out interviews or asking questions directly to several sources related to the design of the tool that the author will make. So that this information can strengthen the required data, the interview process will be carried out in February 2024

c. Literature Study Method

This method is a data collection method by looking for references from several books, journals and internet media related to this research. In its implementation, the author carried out this process by looking for several books in shops and using the internet to search for journals related to the design of the tool.

3.10 Data Processing

Data processing is a stage in processing data that has been collected, then processed and applied in a system that is being designed by the author. The data will be sorted and filtered according to the actual situation at this time, then the filtered data will be used as a benchmark for research results. The design of this system will be tested at depths around Lake Kodiklatal Surabaya.

Then the data obtained will be reviewed for improvements, both regarding the system used and the equipment used. After repairs to the system and equipment, trials will be carried out again so that the results will be better

3.5 Operational Definition

Operational definition is the determination of various definitions that will be used by the author in carrying out research. Definitions of concepts that are still abstract become operational which will make it easier to measure these variables. An operational definition can also be used as a boundary of understanding that is used as a guide for carrying out this research activity.

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a. Arduino: Arduino is said to be an open source physical computing platform. Arduino is not just a development tool, but it is a combination of hardware, programming language and a sophisticated Integrated Development Environment (IDE). IDE is a software that plays a very important role in writing programs, compiling them into binary code and uploading them into microcontroller memory.

b. Data communication is the process of sending and receiving data or information from two or more devices (devices such as computers, laptops, printers, cellphones and other communication devices) connected in a network.

c. PLX-DAQ (Parallax Data Acquisition tool) is software that allows users to collect data from microcontroller devices, such as Arduino, and display it in real-time in Microsoft Excel. With PLX-DAQ, data sent from the microcontroller via the serial port can be directly entered into an Excel analysis can also be called data processing which originates from data collection which consists of a series of activities of analysis, grouping, systematization, interpretation and verification of data so that it can be processed into a system that runs according to design. Then the results of this research can create a good system design from the results of hardware design and software design.

4.1 Implementation

In designing a control and monitoring system for sea depth on a prototype ship on the water, there needs to be an analysis of equipment requirements. These needs can be described as follows.

The description of this idea is linked to the results of theoretical studies and other relevant research results, including hardware implementation, software implementation, hardware and software testing, as well as integrated system testing. All the requirements that have been spreadsheet, allowing users to view, analyze, and visualize the data directly.

d. Software, or software, is a collection of instructions, data, or programs that are used to operate a computer and carry out certain tasks. In contrast to hardware, which refers to the physical components of a computer, software is the intangible part consisting of code and data that is processed by computer hardware to perform specific functions

4. ANALYSIS AND DISCUSSION

In this system analysis and testing chapter, the author will discuss the design, implementation and testing of tools that have been created for the control and depth monitoring system on a prototype ship on the water. on design and implementation while the discussion will carry out a study of the test results on each tool used so that good results are obtained and can be used according to their intended use. Data

prepared will be designed to become a control and monitoring system for sea depth on a prototype ship on the water.

4.1.1 Implementation of Tool Scheme

The implementation of the tool scheme is the result of a design process that has been created into a circuit. In the schematic of this tool there are 9 components consisting of power supply, Arduino Nano, Arduino Uno, LCD 20x4, NRF24L0L, Brushless DC motor, ESC and servo motor. The schematic of the tool is arranged according to the working mechanism in parts, so that the schematic of the tool to be made and displays the parts - part of the design of the electronic system and control system for the tool being made, each part explains the positioning arrangement to make it easier to work and check if a problem occurs.

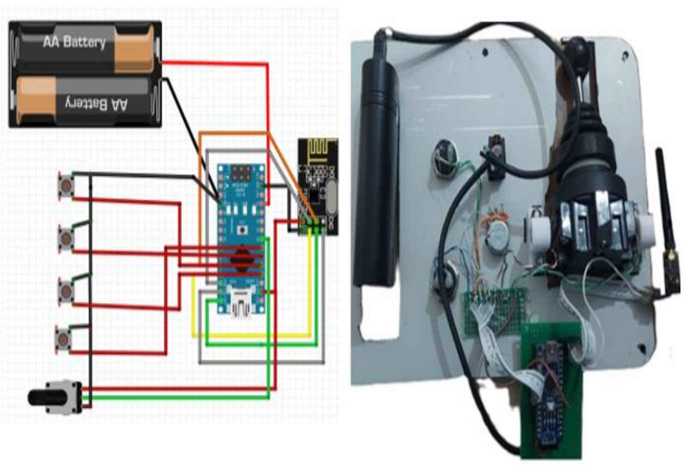

Figure 1. Tool Design

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4.1.2 Implementation of Control System Transmitter Hardware Using the NRF24L01 Module

Control system hardware implementation involves various components and hardware to control and regulate the operation of a system automatically or semi-automatically. At the hardware assembly stage *(Hadware) The transmitter* module used is a 5 volt *battery* , Arduino Nano, four *push buttons,* potentiometer, switch, 20x4 I2C LCD, and NRF24L01 module which is assembled into a tool that will later be used to control ships. Sea depth detection. Implementation of the control system hardware can be done using efficient and effective, ensuring that the system can operate as desired and meet the needs of the intended application.

The parts of the hardware must integrate with each other according to the needs of the tool with the aim of creating a control system and monitoring sea depth on underwater ship *prototypes* . From the series of module systems above, they will then be assembled into one to form a mutually integrated tool. To create hardware *(hadware) transmitter* control system with two *push buttons* (forward, backward) joystick (turn right and left) potentiometer (speed).

Figure 2. Hadware Transmiter Control System
(Source: Processed author)

4.1.3 Implementation of Control System Receiver Hardware Using the NRF24L01 Module

In the implementation *(hardware) of the receiver* control system, the components required are a 6 volt battery *power supply* , Arduino Uno, NRF24L01 module, DS3231 RTC module, *Brushless* DC motor, ESC and servo motor which are assembled into a device that will later be used to receive data from *the transmitter.* for ship movements to detect sea depth. The parts of the hardware must integrate with each other according to the needs of the tool. From the series of module systems above, they will then be assembled into one to form a mutually integrated tool.

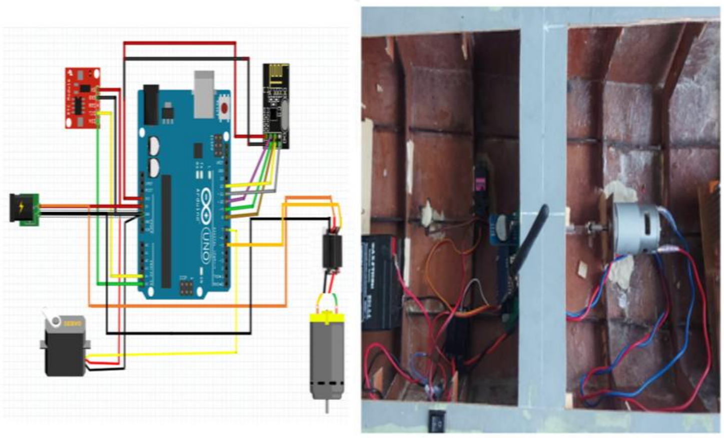

Figure 3. Hadware Receiver Control System

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4.1.4 Implementation of Sea Depth Monitoring

Ocean depth monitoring aims to measure and observe water depth conditions in the sea in real-time. The use of the NRF24L01 wireless communication module in this system allows sending sensor data from below the sea surface to monitoring stations on the surface. The modules used are an Arduino Nano microcontroller as a data processor from sensors, an NRF24L01 module for data communication and a 20x4 I2C LCD to display depth, position and tilt angle data as well as PLX-DAQ *software* for displaying on a laptop or PC.

At the assembly stage of sea depth monitoring, the modules used are Arduino Nano, LCD 20x4 12C and NRF24L01 which are assembled into a tool that will later be used to monitor sea depth, position and tilt angle of the ship. The parts of the hardware must be integrated with each other according to the tool requirements of several series of module systems above, then they will then be assembled into one to form a tool that works with each other.

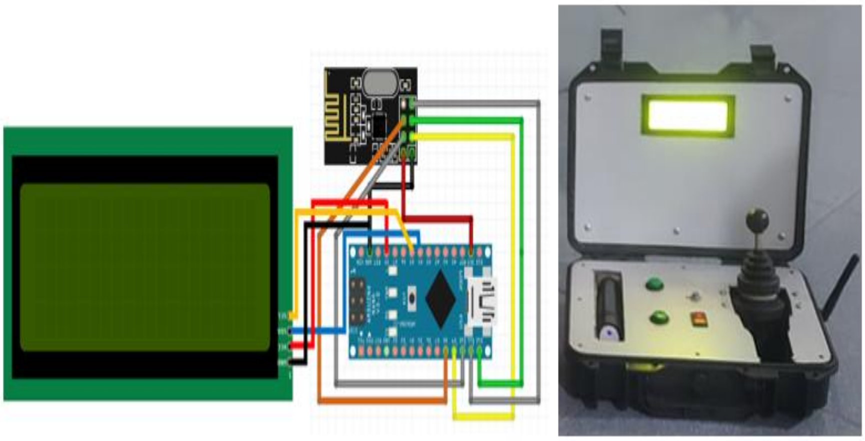

Figure 4. Sea Depth Monitoring

4.2 Testing

In this stage, testing is carried out at the Naval Technology College (STTAL). The materials and tools used during testing are laptops, cameras, depth detection vessels and control systems, which aim to test the results of designs that have been made previously. The following is an explanation regarding the overall integration of the tool.

4. 2.1 Control System Software Testing

The software testing is carried out by testing the performance of the Arduino IDE program to see whether it functions as expected and can also control the ship's movements well. The aim of testing the control system software on the Arduino IDE is to see the connection of the NRF24L01 module and to find out whether the software is working properly. runs and complies with procedures.

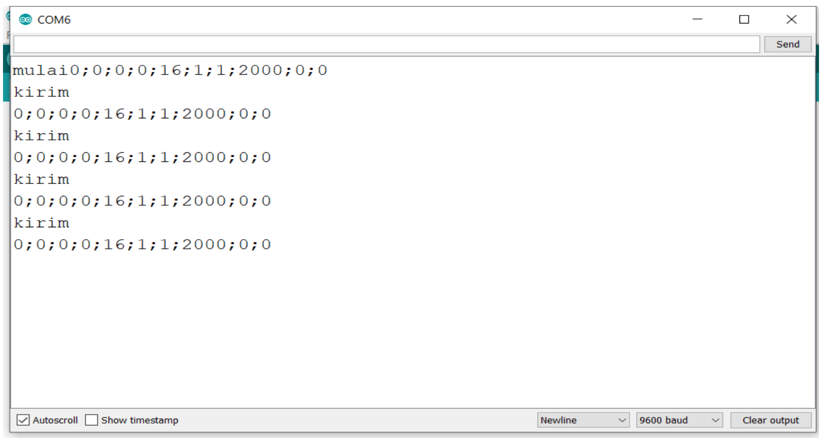

Figure 5. Serial Monitor Transmiter View

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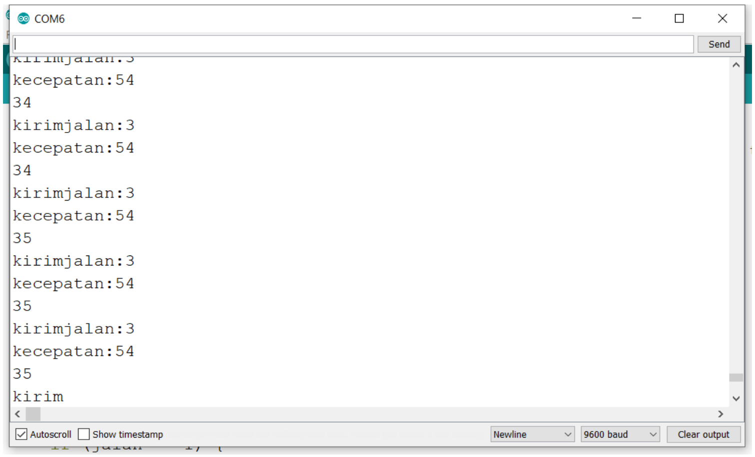

Figure 6. Serial Monitor Receiver View

From figure 5 and 6, the serial monitor display of the Arduino IDE *software* shows that programming on the control system (*transmitter* and *receiver*) is running according to the Arduino IDE programming code procedure. Each *push button* is tested to ensure that when pressed, it produces the correct output in the Serial Monitor.

4. 2.2 Control System Testing

The type of control system used is closed-loop with the NRF24L01 module, signals or commands are sent from the controller to the device being controlled, and the device sends feedback back to the controller to inform the status or results of the commands sent. From the results of testing the control system *software that has been* carried out by the author, it has been running according to the Arduino IDE programming code. The next stage is testing the control system *hardware* where the aim of testing the control system *(transmitter and receiver)* is to ensure and try two *push buttons* , *joysticks* and potentiometers (forward, backward, turn left, turn right, and speed) functions according to the procedure, as is the function of each push button and potentiometer. Ensure that the NRF24L01 module can send and receive data correctly and verify that the Arduino Uno can control the Servo motor, speed and DC *Brushlaas Motor* according to the commands sent from the control system *transmitter* . This control system hardware testing works at the frequency used, which is 2.4 GHz.

Figure 7. Hadware Control System

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Table 2. Deep Monitoring Test

No	Push Button	Function	Information
1	Push Button 1	The ship moves forward	Works fine
2	Push Button 2	The ship moves backwards	Works fine
3	Potentiometer 3	Control speed	Works fine
4	Joystick 4	The ship turns left	Works fine
5	Joystick 5	The ship turns right	Works fine

4.3 Results and Discussion

4.3.1 INA226 Voltage Sensor

The data displayed on the monitoring system is divided into two displays on the LCD showing *longitude, latitude,* depth and time data. while the display on a laptop using PLX-DAQ software displays data on *longitude, latitude, depth* (depth), time and tilt angle where the function of the PLX-DAQ software is to store and display data in Excel and graphic formats.

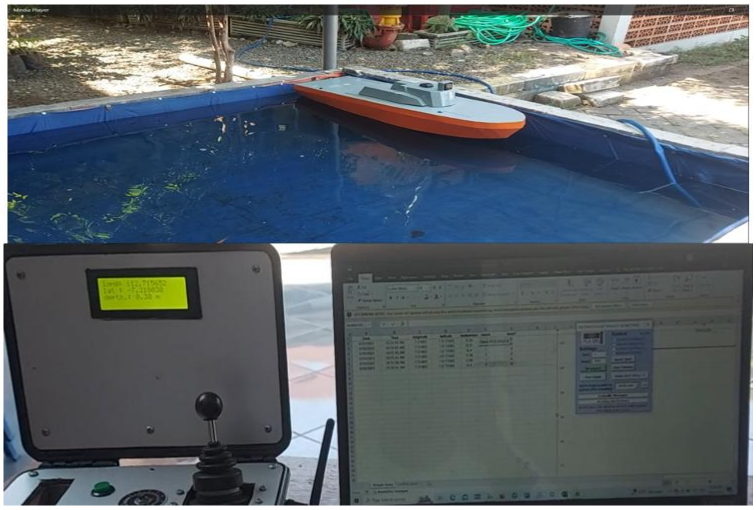

Figure 8. LCD on the control system

In Figure 8, the LCD on the control system shows the reception of data measurement values from sensors on the ship with the depth value received during monitoring, namely 0.38 cm, while for manual measurements it reads 0.34 cm and the first line reads *longitude* , the second line reads *latitude .* , third row *depth* (depth). The display on the PLX-DAQ software shows the receipt of data on time, *longitude, latitude* , depth and inclination angle of the ship and this data is stored in Excel form.

4. 2.4 Control Distance Testing and Sea Depth Monitoring

Testing the control system distance and monitoring distance is necessary to read the response of *the Brushlass* DC motor drive and servo motor as well as reading the data received from the depth measurement sensor, GPS, accelerometer and RTC DS3231 which is located on the sea depth detection ship by operating *the push button* on the control.The purpose of testing the control distance and sea depth monitoring distance is so that the author can find out how far the distance can be connected using the NRF24L01 module as the data transmitter and receiver module. The frequency used is 2.4 Ghz for the node address used in the monitoring and control system is 00. In the ship propulsion system the node address used is 01 while in the sensor the node address used is 02. The following are the results of experiments carried out by the author at Bosem Kodiklatal Surabaya.

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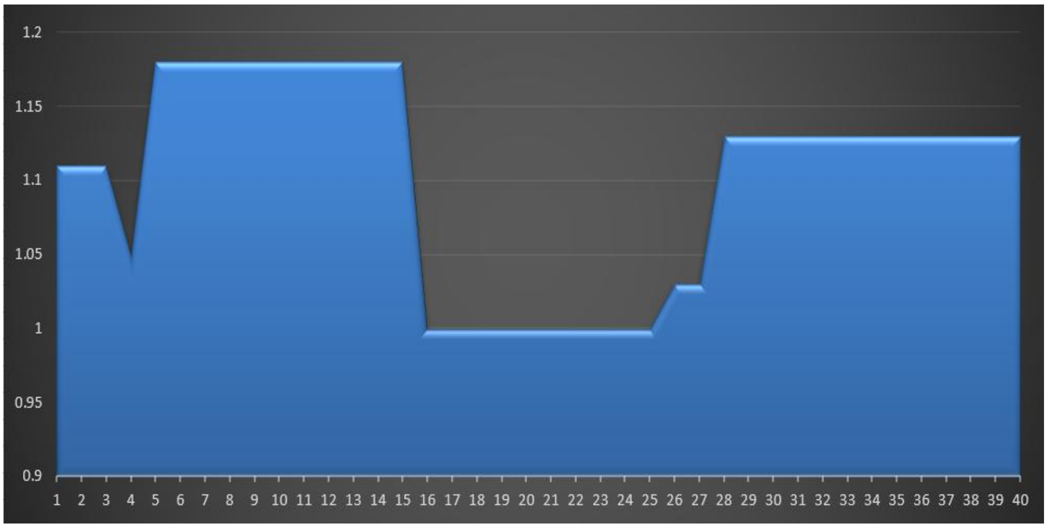

Figure 9. Test result in Bozem, Kodiklatal, Surabaya

(Source: Processed author)

From the test results at Bosem Kodiklatas Surabaya, the author took the initial and final reception positions (*longitude* and *latitude*) as well as several points to plot using the *Google Earth application.*

a.-7.13412-112.43029(control point)
b.-7.13417 - 112.43035
c.-7.228274 - 112.71735
d.-7.228286 - 112.71736
e.-7.228283 - 112.71735
f.-7.228286 - 112.71735
g.-7.228281 - 112.71729
h.-7.22823 - 112.71718
i.-7.228312 - 112.71712

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Figure 10. Positioning Google Earth

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No	Point	Distance (m)	Depth on detection vessel	Connection
1	A - B	8.7	1.05m	Fluent
2	A - C	17.7	1.03m	Fluent
3	A - D	26.7	1.13m	Fluent
4	A - E	39.01	1.22m	Fluent
5	A - F	48.76	1.11m	Fluent
6	A - G	60.23	1.18m	Fluent
7	A - H	77.41	1 m	Fluent
8	A - I	90.32	1.03m	Disconnected

4.3 Analysis and Discussion

Results and discussion of research on control and monitoring systems for sea depth on underwater ship *prototypes* carried out by system testing whole. The results and discussion of the research obtained based on the tests carried out are as follows:

a. Control System *Software* Testing

Testing the control system *software* using the Arduino IDE with the NRF24L01 module shows that this module is a good choice for simple wireless communication applications. With proper handling of hardware configuration and code writing, this module can provide reliable and effective communications in a variety of conditions. Advanced testing may include more in-depth testing of connection stability, data transmission speed, and power savings for battery-based applications.

b. Control system *hardware* testing using the NRF24L01 module

1) *Push button response* and *joystick* : each *push button* or joystick provides correct output on the serial monitor and provides a response to the drive motor and servo motor.

2) Potentiometer: changing the osition of the potentiometer results in a corresponding change in the speed value.

3). Connection: The NRF24L01 module has good range in open spaces, but performance may decrease indoors or with physical obstructions .

d. Sea Depth Monitoring Test Using the NRF24L01 Module

1) Connection: The NRF24L01 module as data communication successfully received data from the depth sensor, GPS, accelerometer and RTC DS3231

3) LCD: On the LCD the control system successfully displays *longitude, latitude data* on the first and second rows, the third row of depth values and the last row of time.

4) PLX-DAQ *software:* successfully displays data on depth, position, slope angle and time in excel and graphic form.

e. Control distance testing and Depth Monitoring

1) Control system distance: in experiments carried out by the author the control system was able to reach a distance of 90.32 meters in an open environment without obstacles.

2) Stability: the transmission connection at short distances is very good but when the distance is above 80 meters the connection starts to falter, data on depth, position, slope angle and average time received is two to three seconds.

3) Data Accuracy: The depth data received has a difference between 10 to 20 cm from 8 measurement points by manual measuring using a pendulum string.and GPSdata has a degree of difference between 1.5 to 2 m from 9 measurement points.

5. CONCLUSIONS AND SUGGESTIONS

5.1 Conclusion

From the results of the discussion in the previous chapter and based on the results of testing and analysis of how the sea depth monitoring and control system circuit works on *the prototype* of a ship on the water , several things can be concluded as follows :

a. control system with four *push buttons* and potentiometers using Arduino Nano and Uno and the

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NRF24L01 module. The frequency used is 2.4 GHz with node addresses on *transmitter* 00 and *receiver* 01. With the ability to select *node addresses* and data rates, this module offers great flexibility in managing interference and optimizing wireless communication performance, capable of controlling and controlling depth detection vessels over the longest distances. 90.32 meters in an open environment without obstructions.

b. The sea depth monitoring system uses the NRF24L01 module with a frequency of 2.4 GHz and the *transmitter node address* 02 and *receiver* 00 receives data on depth, position, angle of inclination of the ship and time per two to three seconds. With a monitoring distance of approximately 90.32 meters. The data is displayed on the 20X4 LCD and on a laptop using PLX-DAQ software. The depth data received has a difference between 10 to 20 cm with an average *error presentation of 14.20% from 8 measurement points.* GPS data has an average distance difference of 1.5 to 2 meters from 9 measurement points. Instability or fluctuation in data may indicate an interruption in transmission or a problem with the sensor itself.

5.2 Suggestion

In this research, there are several things that can be developed to get more optimal results, including:

a. This research is still limited to designing tools so that they can work according to their basic function as a tool. Control and monitoring system for sea depth on *a prototype* ship on the water. To optimize the tool's capabilities, it is necessary to improve the quality specifications of each component used. Choose components with high quality and guaranteed originality.

b. The control and monitoring system for sea depth on the water ship *prototype can be developed in subsequent research to become autonomous* which has the ability without control to detect sea depth

c. *The power level indicator* on *the power supply* (battery) located on the sea depth detection ship does not exist so it is not possible to determine the capability of *the power supply* (battery).

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