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Designing A Practical Remote-Control Vessel Using LA Antenna Radio Frequency

Abstract: One of the developments in the technology field is remote control using both wires (wired) and without wires (wireless). Wireless power can be done using signals such as infrared, bluetooth, radio frequency, and Wi-Fi. Remote control using radio frequency signals is very interesting because it can reach far distances without spending money. The purpose of this study is to develop a design and analyze the effectiveness of remote control of ships using radio LA antenna frequencies. Wireless radio frequency signals combined with Arduino can control the propeller and rudder so that the boat can be controlled remotely. This research uses a prototype method in the form of a control ship. The result of the study is that wireless remote control of the vessel can be done in open and closed spaces so that in the future it can be realized for absolute equipment control. The control on this prototype uses an LA antenna and no LA antenna. The result of the study is that the use of LA antennas is more effective than without LA antennas, in which the control distance in an enclosed space (with obstructions) without an LA antenna is as far as 100m and 500m when using an LA antenna. While the control distance in open spaces (without obstructions) without LA antennas, ships can be controlled up to distances of 1000m and 1300m when using LA antennas.

Keywords: *radio frequency, arduino, effective, antenna LA*

INTRODUCTION

Indonesia is an archipelagic country with a coastal length of 81,000 km with 70% of its sovereign territory in the form of waters, so that efficient long-distance transportation is by sea using ships. Ship accidents in Indonesia are still quite high because on average every month there is at least 1 ship accident, where the number of ship accident cases from 2015 to 2021 is 158 cases (Pahlevi, 2021). Compared to all accident cases, 72% occur due to human error (Anonymous, 2022). In order to reduce accidents caused by human error, it utilizes technological development to replace conventional control into remote control. Remote control is divided into two, namely wireless or wired. Wireless control is done by sending information data or control using infrared, bluetooth, Wi-Fi and frequency radio waves (Jin-Shyan Lee et al., 2007). Remote control using radio frequency waves has advantages over others because the range is longer than using infrared and bluetooth and does not require costs like Wi-Fi (Zandbergen, 2021; AjishAlfred, 2022),.

The application of remote-control using radio frequency waves has been done by other researchers. In 2020, research has been conducted on wheelchair control based on head movement. The equipment used is a *gyroscope* sensor, Arduino microcontroller, nRF 24L01 as a sender and receiver of frequency radio waves and a motor as a wheel drive

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(Nursab, 2020). Another research in 2020 is remote control of food grilling via radio frequency waves using a keypad. It used an Arduino Mega 2560 microcontroller and Arduino Uno as a controller, a keypad as an input for commands to the controller, an nRF module as a sender and receiver of frequency radio waves, a DC motor as an actuator for flipping and lifting the grill, temperature sensor to detect the temperature of the grill, and LCD to display the temperature of the grill (Nur et al., 2020). Meanwhile, in 2021, research was carried out on remote control of flood victim evacuation boats through frequency radio waves using remote controls. It made use of Arduino Uno as a controller, DC motor as a boat drive actuator, servo motor as a boat steering actuator, nRF as a frequency radio wave receiver, and 4-channel RF remote control as a controller and sender of control via radio frequency waves (Khoeruzzaman & Eko Budihartono, 2021).

Based on the background and previous research, the researchers conducted research related to designing remote control devices through effective frequency radio waves by adding LA antennas. This research is applied to remote control of ship control.

METHODS

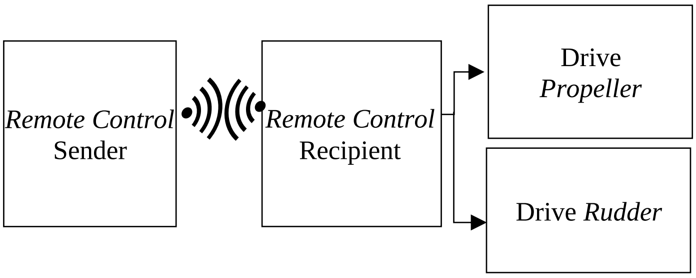

Figure 1. Block Diagram

The research method used is to implement directly to control the ship prototype from a miniature ship (Woodacre et al., 2015) measuring 80 cm long and 20 cm wide in the form of a series of controls from remote control transmitters and receivers located on the ship (Ashrafiuon et al., 2008). The system in the study can be seen from the block diagram in Figure 1 above, in which the remote control transmitter sends command data to the propeller and rudder through frequency radio waves, while the receiver remote control receives command data from the frequency radio waves which are then processed to drive the propeller in the form of a DC motor and drive rudder in the form of a servo motor. The function of the propeller is to drive forward or backward of ship propulsion, while the rudder functions is to drive to the right or left of the ship.

The design of the transmitter remote control system as shown in Figure 2 consists of a propeller and rudder controller in the form of a joystick for propeller and rudder controllers, a power supply in the form of a battery, NRFL01 to transmit data via frequency radio signals, an Arduino Nano type microcontroller, and an OLED LCD to display the remaining battery and position joystick.

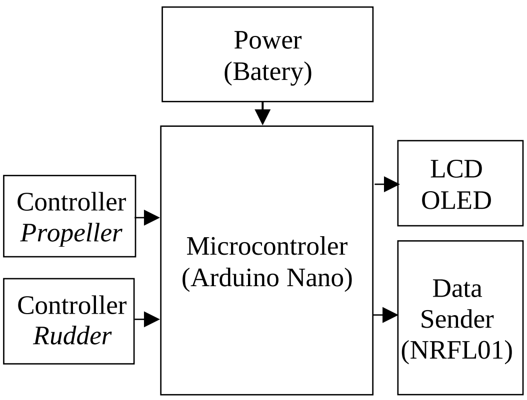

Figure 2. Sistem *Remote Control* Pemancar

The series of components in the transmitter remote control system according to the designed transmitter system can be seen in Table 1, Table 2, Table 3, and Table 4.

Table 1. Joystick 1 With Microcontroller

Pin Joystick 1	Pin Mikrokontroler
VCC	5 V
GND	GND
VRx	A0
VRy	A1
SW	D7

Tabel 2. Joystick 2 With Microcontroler

Pin Joystick 1	Pin Mikrokontroler
VCC	5 V
GND	GND
VRx	A3
VRy	A2
SW	D8

Tabel 3. NRF24L01 Transmitter With Microcontroller

Pin NRF24L01	Pin Mikrokontroler
VCC	5 V
GND	GND
CE	D3
CSN	D4
MOSI	D11
MISO	D12
SCK	D13

Tabel 4. OLED With Microcontroller

Pin OLED 0.96”	Pin Mikrokontroler
VCC	5 V
GND	GND
SDA	A4
SCL	A5

The design of the receiver remote control system as in Figure 3 consists of NRFL01 to receive data from the sender's remote control via frequency radio signals, power supply in the form of batteries, Arduino Nano as a microcontroller, DC motor as propeller drive, and servo motor as rudder drive.

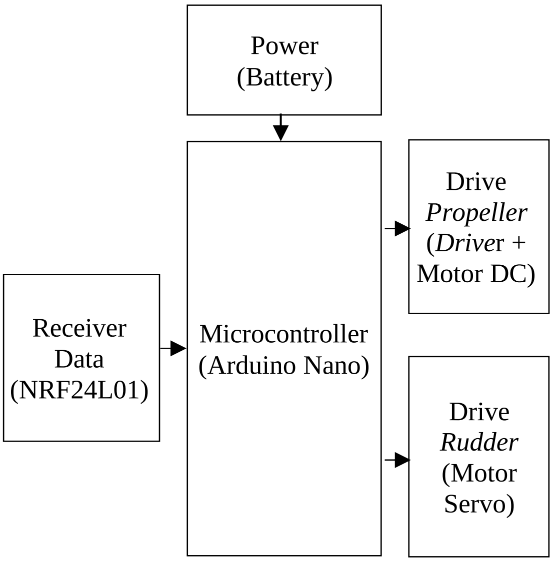

Figure 3. Receiver Remote Control *System*

The series of components in the receiver remote control system, namely the circuit between the NRF24L01 components, DC motors and servo motors with microcontrollers can be seen in Table 5, Table 6, Table 7, and Table 8.

Table 5. NRF24L01 Receiver with Microcontroller

Pin NRF24L01	**Pin Microcontroller**
VCC	5 V
GND	GND
CE	D3
CSN	D4
MOSI	D11
MISO	D12
SCK	D13

Table 6. DC Motor Circuit With DC *Motor Driver*

Pin Motor DC	**Pin *Driver* Motor**
Positif	OUT1 Positif
Negatif	OUT1 Negatif

Table 7. *DC Motor Driver With Microcontroller*

Pin *Driver* Motor	**Pin Mikrokontroler**
VCC	5 V
GND	GND
EN A	D6
IN 1	D4
IN 2	D5

Table 8. Servo Motor Range With Microcontroller

Pin Motor Servo	Pin Mikrokontroler
VCC	5 V
GND	GND
Signal	D3

The study was conducted by comparing the control distance between the ship as a receiver (receiver) with the remote control as a sender (transceiver) without an LA antenna and using an LA antenna (Le et al., 2016) mounted on the remote control to determine the effectiveness of remote-control devices via frequency radio waves (Miądlicki & Pajor, 2015). The LA antenna is mounted on the NRF24L01 component in the sender's remote control. In addition to comparing without an LA antenna with using an LA antenna, the study compared the effectiveness of distance control in enclosed and open spaces (Hunter et al., 2015).

RESULTS AND DISCUSSION

Before taking data in this study, testing each hardware is carried out first to ensure that all hardware used is functioning properly so that the data obtained is appropriate (Benbarrad et al., 2021). Hardware testing carried out are DC motor testing, servo motor testing, and NRF24L01 testing. After the test, the data test is carried out as a whole to get the data analyzed and discussed (Kasperovich & Hausmann, 2015).

DC Motor Testing

DC motor testing to test motor speed control by providing PWM value input from the microcontroller through the DC motor *driver. PWM values* of 10 and 75. The results of the test are seen in Figure 4 and Figure 5.

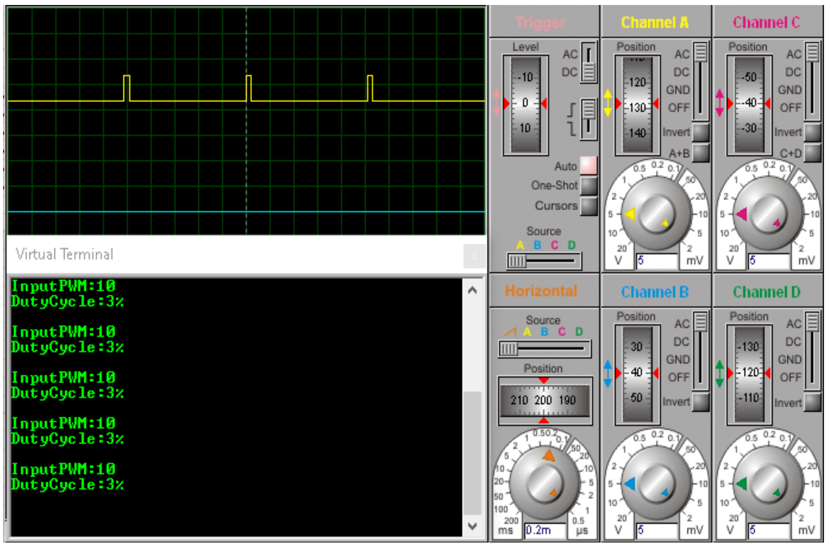

Figure 4. Testing with PWM 10

Based on Figure 4, it can be seen that DC motors are given a PWM input value of 10 out of a maximum of 255 (dutycycle 3%). It made the DC motors do not rotate. Based on Figure 5, the DC motor is given a PWM input value of 75 out of a maximum of 255 (dutycycle 29%) where the DC motor starts spinning slowly. So, it can be concluded that DC Motors can work well and according to design.

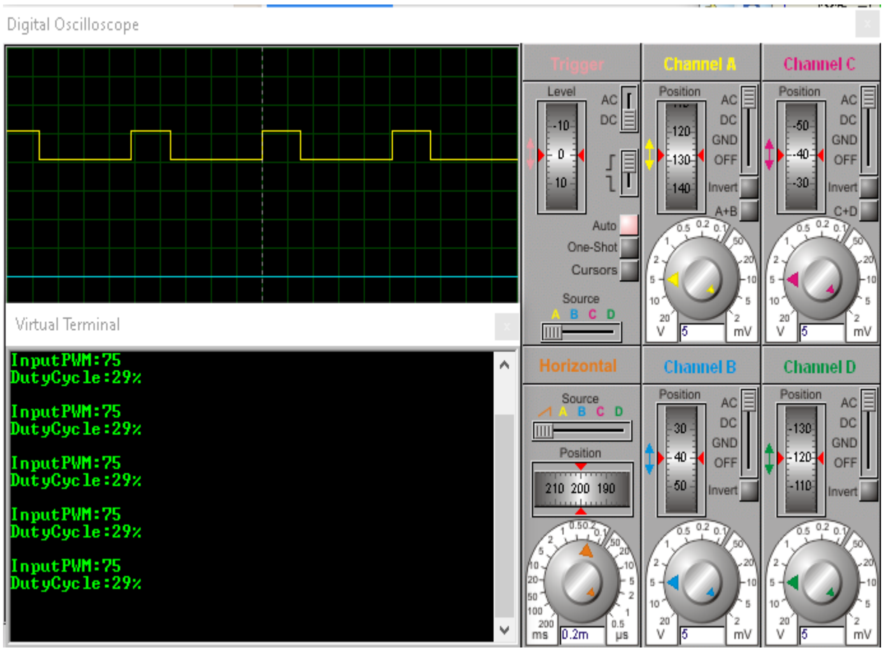

Figure 5. Testing with PWM 75

Servo Motor Testing

Servo motor testing is carried out by inputting PWM values that have been converted into angular values using libraries on Arduino. The angle values given for testing are 1000, 1000 and 00. The results of the test can be seen in Figure 6, Figure 7, Figure 8, Figure 9, Figure 10, Figure 11.

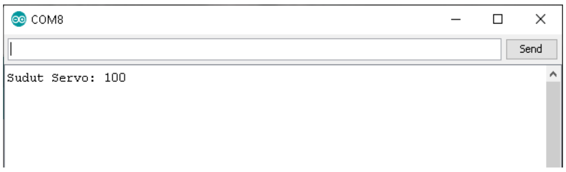

Figure 6. Corner Command 100^0

Figure 7. Corner Command 180^0

Figure 8. Angular Servo Motor Position 100^0

Figure 9. Angular Servo Motor Position 180^0

Figure 10. Corner Command 0^0

Figure 11. Angular Servo Motor Position 0^0

Based on Figure 6 to Figure 11, it can be seen that the servo motor can move according to the commands of the microcontroller both 1000, 1800, and 00. So, it can be concluded that the servo motor can work well and according to design.

Testing NRF24L01

The testing of NRF24L01 radio communication module is carried out by checking the communication between the receiver on the ship and the transmitter on the remote control. NRF24L01 on the remote control will send data coming from the joystick module then sent to the NRF24L01 on the side of the ship. The test results can be seen in Figure 12.

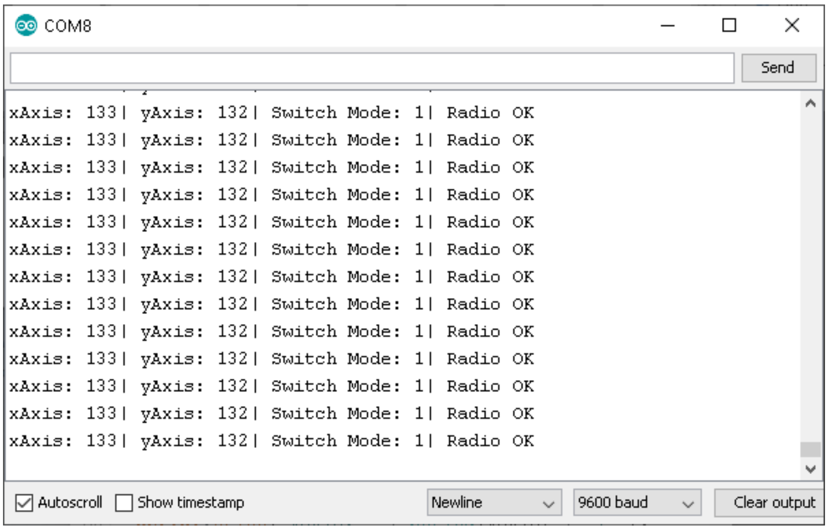

Figure 12. NRF24L01 Test Results

From the test results, it can be seen that the transmitter has successfully sent data to the receiver with the value shown in the serial monitor on the receiver as in Figure 12.

Overall Testing

Figure 13. Overall Testing

The overall test was conducted by moving the vessel remotely using a remote control mounted LA antenna and without an LA antenna. The test location was carried out in two different places, the first was carried out in a closed room with a barrier in the form of a room wall and the second was carried out in an open space, namely in a river that had sufficient length and width for distance testing and maneuvering testing. The maneuvers carried out are straight, turn right, and turn left. The overall test results in an open room can be seen in Figure 13.

Based on overall testing, it can be seen that the system can work well, in which the ship can move as instructed through remote control, both when do not use LA antennas and when use LA antennas, as well as both in closed room locations and in open spaces. Results for testing the control distance between vessels with remote controls that do not use LA antennas and use LA antennas in enclosed rooms can be seen in Table 9 and Table 10.

Table 9. Test Results Without LA Antenna in Enclosed Rooms

No	Distance between remote control and Ship (m)	Radio Response Receiver (Ship)
1	100	OK
2	200	Not Responding
3	300	Not Responding
4	400	Not Responding

Table 10. Test Results Using LA Antennas in Enclosed Rooms

No	Distance between remote control and Ship (m)	Radio Response Receiver (Ship)
1	100	OK
2	200	OK
3	300	OK
4	400	OK
5	500	OK
6	600	Not Responding
7	700	Not Responding
8	800	Not Responding

Based on the data in Table 9 and Table 10, it can be seen that using the LA antenna on the remote control is more effective than not using it. When not using an LA antenna, the control distance only reaches 100 meters, whereas when using an LA antenna, the remote-control distance can increase to 500 meters or it increase its effectiveness 5 times.

Table 11. Test Results Without LA Antenna in Open Space

No	Distance between remote control and Ship (m)	Radio Response Receiver (Ship)
1	100	OK
2	200	OK
3	300	OK
4	400	OK
5	500	OK
6	600	OK
7	700	OK
8	800	OK
9	900	OK
10	1000	OK
11	1100	Not Responding
12	1200	Not Responding
13	1300	Not Responding

Table 12. Test Results Using LA Antennas in Open Space

No	Distance between remote control and Ship (m)	Radio Response Receiver (Ship)
1	100	OK
2	200	OK
3	300	OK
4	400	OK
5	500	OK
6	600	OK
7	700	OK
8	800	OK
9	900	OK
10	1000	OK
11	1100	OK
12	1200	OK
13	1300	OK
14	1400	Not Responding
15	1500	Not Responding
16	1600	Not Responding

Based on Table 11 and Table 12, it can be seen that testing in an open room using an LA antenna is also more effective than not using an LA antenna even though the difference in control distance is not as significant as when testing in a closed room. Testing in an open room using an LA antenna, the control distance can reach 1300 meters, while not using an LA antenna, the control distance is only 1000 meters.

CONCLUSION

A prototype remote control of an FA radio frequency vessel has been successfully developed. Wireless control for ships can be done using NRF24L0 via radio waves. The barrier between the transmitter and receiver greatly affects the distance of radio wave communication. Moreover, the addition of an LA antenna can increase the effectiveness of the control distance between the remote control and the ship.

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