Review Article

Prototype of Garbage Picker Ship Robot Using Arduino Nano Microcontroller

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Abstract:

This study aims to create a robot prototype for a garbage collection ship made using an Arduino nano microcontroller. The prototype of this garbage collection robot vessel is controlled by an Android smartphone application that is connected via Bluetooth. The prototype of the robot of the boat was made to deal with piles of garbage that can cause flooding. The method used in making the prototype ship robot along with the controller application begins with identifying the problem, namely the problem of piles of garbage, then needs analysis. Moreover, in this research, what will be developed is in terms of design, ship robot prototype, and ship robot controller design. Next is implementation and testing. The prototype of the garbage collection ship robot uses an Arduino nano microcontroller and in making a controller application using Android Basic 4. Then the trial stage was carried out on an Android smartphone. The results of this study are a prototype ship robot that can move according to commands through a controller application.

Keywords: Android, Arduino Nano, Microcontroller, Garbage picker ship Robot, Garbage collection

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1. INTRODUCTION

Garbage is one of the problems that are often faced by the community. The waste consists of three types, namely organic (wet), inorganic (dry), and hazardous waste. The most common waste floating in the lake is organic and inorganic waste. The form of organic waste is waste that quickly decomposes naturally, while the form of inorganic waste is the opposite of organic waste that cannot rot or is usually called dry waste. Furthermore, one of the most visited natural attractions is Lake Toba, North Sumatra, because of its beauty. Lake Toba, North Sumatra, is also one of the sources of community life around the lake area, such as bathing, washing, and fish farming facilities. But now, many visitors are trivial about the importance of keeping Lake Toba clean. The current condition of garbage around Lake Toba is the center of public attention. The impact will return to the community around the lake if the waste is scattered and poorly managed.

The water of Lake Toba, North Sumatra, has become polluted, and the role of the community is needed to create a clean and healthy environment. But the community is quite difficult because the waves that are not irregular carry the garbage. Therefore, a robotic garbage collection ship is needed to make it easier for janitors or the people around Lake Toba to clean up around Lake Toba. However, due to economic limitations, the author made a miniature form. Andi (2016) researched the mini boat, robot cleaning garbage, and the control system still uses a remote. Because of the explanation described above, the author wants to develop or add an android application feature as a prototype controller for a robotic garbage collection ship in the water. Currently, robot applications

using Arduino are applied to various objects such as robot boats, arm robots, Cleaning Robots, and Car Robots, and several methods using Artificial intelligence (AI) [13], Deep Learning, and Data Mining [6] are applied in them [1,8,9,22,23,24,25,26,27,46,47]. Moreover, the prototype robot cannot be separated from the wireless devices inside, usually using Bluetooth HC-05, WiFi module ESP32, ESP8266, Node32, and LoRa or LoRaWAN [2,17,18,19,20,21,45]; some research uses propagation analysis [14]. This can not be separated from the Internet of Things (IoT) [3] technology, where these Wireless devices connect the prototype, end-node, sensors [4], and Tx or transmitter to the Application server programmed using Python, C++ on the Internet Gateway used, also known as Application. Programming Interface (API). Besides, we call it an Application server such as Thingspeak IoT and The Things Network, which is based on a Website [5,7,16,30,35,37,38,39,40,41,42,44]. Some general cases or studies, such as reading activities [10,11,15], can be assisted by using actuators, Arduino, and the C++ programming language [12], so that books can turn pages using servo motors or actuators; this system is used for people with disabilities, and in completing this project, a method and algorithm [28,29,31,32,33,34,36,43] is needed so that the servo motor can move smoothly, for example using the Proportional Integrative Derivative (PID) Method.

In addition, it is hoped that android applications and these tools can have a good impact. These impacts include helping humans maintain environmental cleanliness and also raising awareness not to let garbage be thrown away, especially in water such as lakes, rivers, or the sea. Still, the trash will be in its place. Based on the research above, the author takes the title "Prototype of a Garbage Collecting Ship Robot Using an Arduino Nano Microcontroller," where controlling the ship robot is used based on Android as the final project.

2. METHOD

2.1. RESEARCH METHOD

The research will be conducted using experimental research methods (trials). This study aims to design a prototype robotic garbage collection ship using an Arduino nano microcontroller and present the Prototype Design of this garbage collection ship robot through several stages. I am starting from the stage of drawing the design until the manufacture. Location This research was conducted at the Pure Sadar Indonesian Business Polytechnic, Jl. Sriwijaya Pematang Siantar

The data collection techniques are carried out by several methods, including the literature study and discussions. The literature study was carried out by reading and understanding various journals and books related to the prototype of the garbage collection ship robot using the Arduino nano microcontroller, as well as visiting various sites that could help in completing this final project. The collection of multiple references at this stage will be the basis for the process of making a prototype robotic garbage collection ship using an Arduino nano microcontroller. And the discussions are held with the supervisor of the Indonesian Pure Awareness Politekpsnik Bisnis Pematang Siantar regularly.

2.2. RESEARCH FLOWCHART

The stages of this research follow the flow chart shown in Figure 1, and this is to facilitate the research process so that it can be done systematically and in detail.

The main problem found in the process of taking garbage in lakes or rivers is still done manually. Picking trash by hand can be exhausting and a high risk that endangers lives. The tool system that will be designed aims to create a robot prototype tool for a garbage collector using an Arduino nano microcontroller that will take out garbage through an Android-based control.

- The hardware needed in this research are:
  1. Laptop/PC
  2. Mouse and keyboard
  3. Software Requirements Analysis
- The software needed in this study is:
  1. Arduino IDE
  2. Android
  3. Google Chrome
  4. Windows 10 pro / Windows 7 ultimate 64-bit.

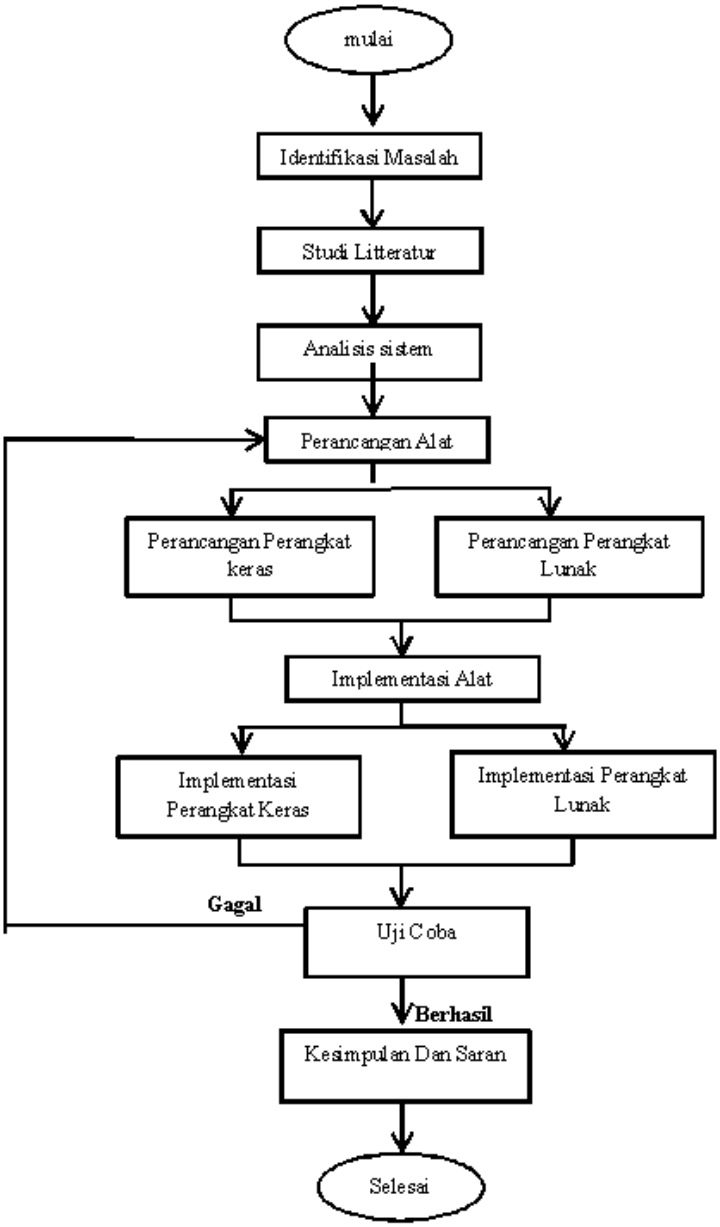

Figure 1. Research Flowchart

In this study, the authors use some equipment and materials to manufacture this ship prototype. The following are the equipment and materials used in table 1.

Table 1. Equipment and equipment materials

Tool	**Ingredient**	**Information**
Microcontroller	Arduino Nano	Quantity: 2 pieces
Servo	Servo sg90	Quantity: 2 pieces
Hull	Styrofoam/cork	
Resource	Baterai lithium 18650	Quantity: 3 pieces
Speed control	Driver Motor L298N	Quantity: 1 piece
Current Regulator	Step Up Dc xl 6009	Quantity: 1 piece
Propeller Machine	Motor DC 5v	Quantity: 2 pieces
Arm Activator	Motor Servo	Quantity: 2 pieces
	Breadboard	Quantity: 2 pieces
Cable	Jumper male-male Jumper female-male Jumper male-female	

In addition to using the equipment and materials in Table 1, the author uses a supporting application in this final project's design. The following applications are used:

1. Arduino IDE 1.6.7
   Arduino IDE is software used to create programs on Arduino Nano. The programs received signals from android smartphones and control systems for arm and propeller movements.
2. Basic 4 Android
   Basic 4 Android is software used to make ship robot control applications via Bluetooth.
3. Hardware Design
   The hardware design on the prototype of the garbage collection ship robot will discuss how the hardware connected to the Arduino nano can work according to its function.

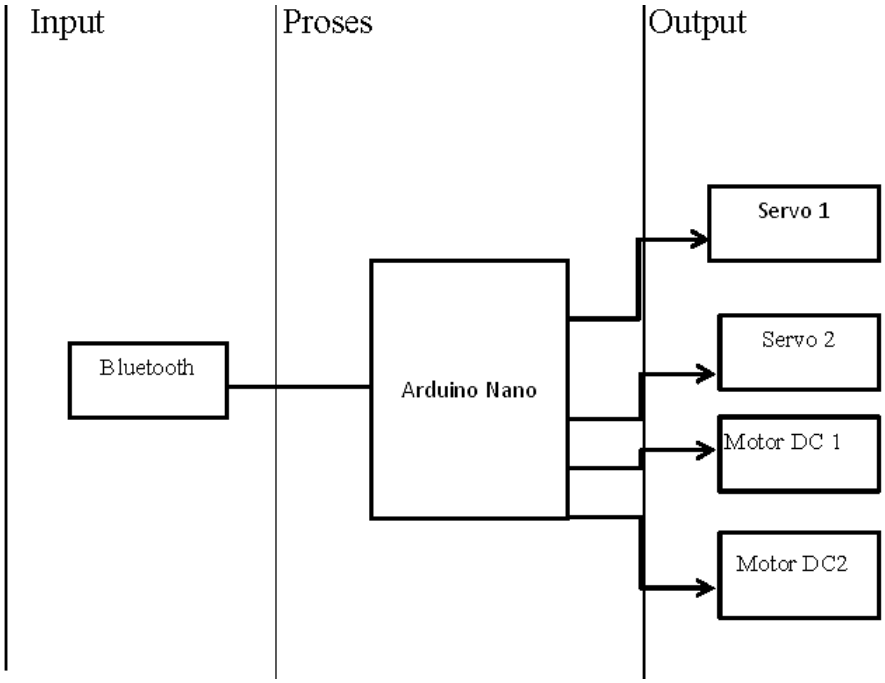

Figure 2. System Block Diagram

The following is an explanation of the system block diagram in Figure 2:
Bluetooth sends user commands (controllers/ship robot controllers) from android phones to ship robots.

a) if the user orders the boat to turn left, then Bluetooth sends a signal to DC Motor 2 (ON)
b) if the user requests the ship to forward, then Bluetooth sends an alert to DC Motor 1 and DC Motor 2 (ON)
c) if the user orders the boat to turn right, then Bluetooth sends a signal to DC Motor 1 (ON)
d) if the user requests the ship to Retreat, Bluetooth sends an alert to DC Motor 1 and DC Motor 2 (ON). The DC Motor turns backward
e) if the user orders the ship to Board, then Bluetooth sends a signal to Servo 1 and Servo 2 (ON)
f) if the user requests the ship to Dismount, Bluetooth sends an alert to Servo 1 and Servo 2 back to the initial degree.

2.3. DEVICE COMPONENT CIRCUIT SCHEMATIC DESIGN

In designing the electronic components of the prototype robotic garbage collection ship using the Fritzing Application. Where the fritzing is a design application of electronic components. Especially the microcontroller, here are the results of the design of the prototype tool for the robotic garbage collection ship:

2.3.1 Arduino-Servo Component Design

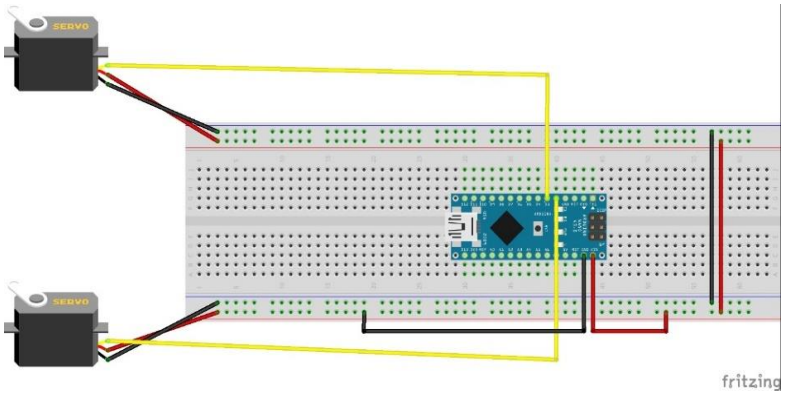

Figure 3. Arduino Components – Servo

2.3.2 Arduino-Bluetooth HC-05. Component Design

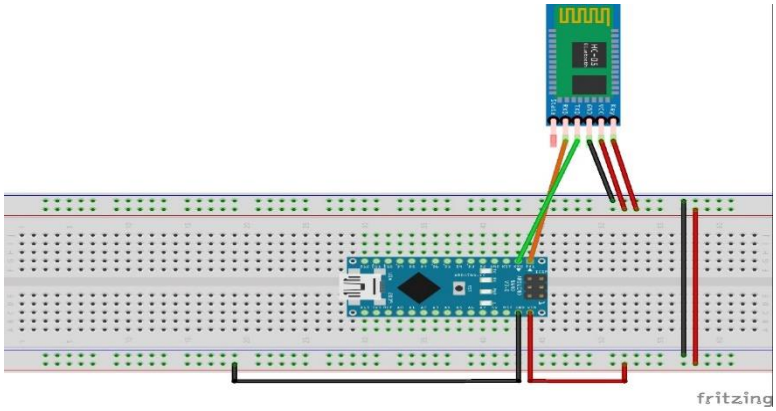

Figure 4. Arduino Components – Bluetooth

Pinout connection configuration:

1. Arduino Pin 8 – TxD pin HC-05
2. Arduino Pin 9 – RxD pin HC-05
3. Arduino 5V pin – HC-05. Vcc pin
4. Arduino GND pin – HC-05. GND pin

Note that at least four pinouts are used for interfacing between Arduino and the HC-05 Bluetooth module, i.e., Vcc, GND, TxD, and RxD. In principle, this module communicates using a serial protocol electrically at the TTL level; therefore, it can be directly connected to Arduino.

2.3.3 Arduino Component Design, L298N Motor Driver, DC Motor

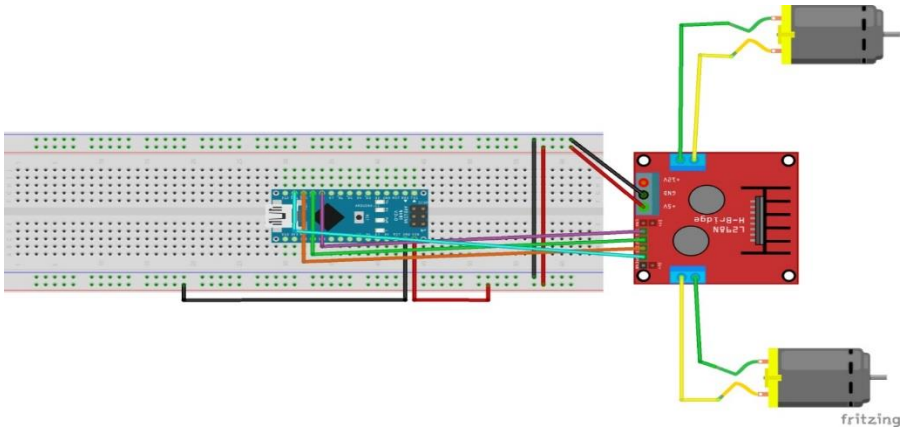

Figure 5. Arduino Components - L298N Motor Driver-DC Motor

The functions of the tools in Figure 6 are:

1. On the arm, 2 Servo Motor sg90 have the same position.
2. On the back of the ship robot prototype, there are 2 DC motors.
3. Motor Driver L298N 1 piece.
4. 'Bluetooth HC-05 1 piece.

In designing the prototype hardware for this garbage collector robot, the author uses Arduino Nano as the microcontroller. Arduino Nano is installed on the ship as a control system for the mechanical movement of this ship. The body of the ship is made of acrylic. The propeller uses a plastic fan driven by a DC motor on the back. The movement of the propeller in the other direction, the author's design conditions, if you turn left, the DC motor to the left is off, and the right is alive, and to turn right, the DC motor to the right is off, and the left is on.

The quote arm will use 2 Servo Motors located at the bottom of the arm. The lower servo motor is used to drive the arm as a whole. The shape of this garbage collector is rectangular and lined with nets, so the water does not enter the trash can on the ship when collecting garbage. Moreover, The design of the ship can be seen in Figure 7.

Pin Description:

1. Enable A: jumper
2. Enable B: jumper
3. Input Logic : A (7,6) , B (5,4)

2.3.4 Overall Component Design

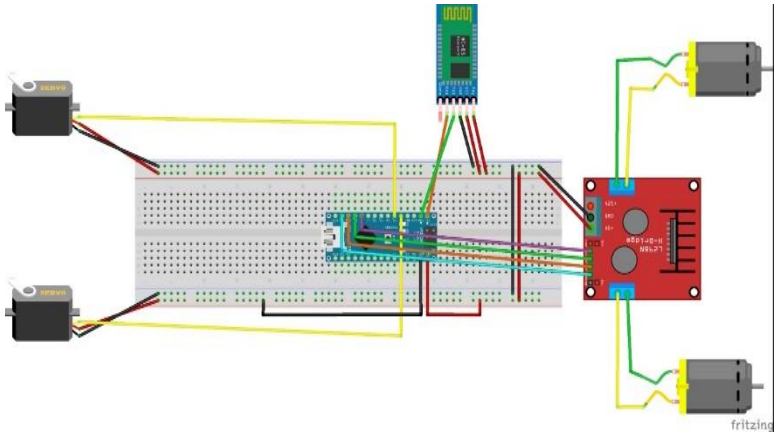

Figure 6. Hardware Design

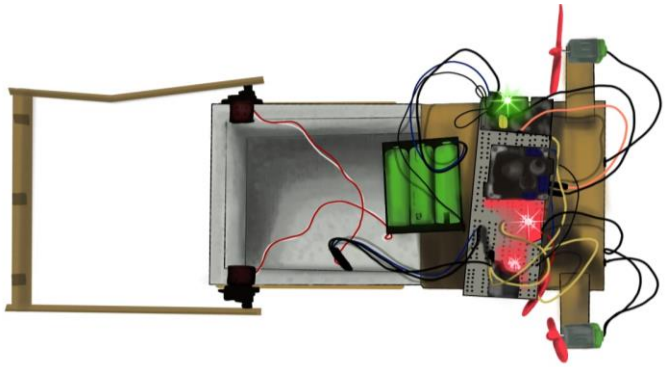

Figure 7. Ship Design

The components needed in the manufacture of propellers are 2 DC Motors. These two propellers are placed on the back of each of the parts, from which a special place will be made for the DC Motor so that it does not allow water to enter. The movement of the DC Motor in the forward condition is that both DC Motors rotate clockwise and reverse both DC Motors counterclockwise. In the use of 2 DC Motors, to turn left, the left DC Motor stops, and the right DC Motor rotates clockwise, and vice versa to turn right.

The components needed in making the sampling arms are 2 Servo Motors and a net. The Servo motor is used for the rotational movement of the garbage picker. Rotational movements are made with up and down forces. The end of the collecting arm will be netted.

2.3.5 Perancangan Tampilan Pengontrol Berbasis Android

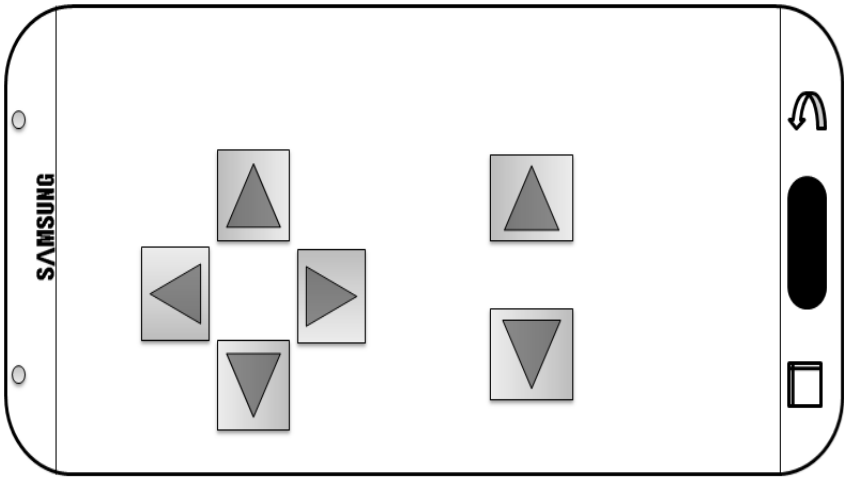

Figure 8. Display of Android-Based Controller

At the software design stage, software design will be carried out using flowcharts in designing the workings of the robot programming tools using Arduino IDE.

2.3.6 Robot Work Flowchart

To describe the flow of the program that was made and as an illustration of how the prototype of the garbage collection ship robot works, a flowchart is used as a tool. The following are the working steps of the tool to be designed, with a note: the DC1 motor is in the left position, and the DC2 motor is in the right position, as follows:

a) Start
b) If the command = = 1, then the DC Motor 1 OFF and DC2 Motor ON (Turn Left Ship)
c) If the command = = 2, then the DC motor 1 ON and DC2 Motor ON (Ship Forward)
d) If the command = = 3, then the DC motor 1 ON and DC2 Motor OFF (Turn Right Ship)
e) If the command = = 4, then the DC1 motor ON and DC2 Motor ON (Ship Backwards)
f) If the command = = 5, then Servo 1 and Servo 2 ON (Garbage collector Up)
g) If the command = = 6, then Servo 1 and Servo 2 ON (Garbage Transporter Down)
h) Done

The working flowchart of the garbage collection ship robot prototype can be seen in Figure 9.

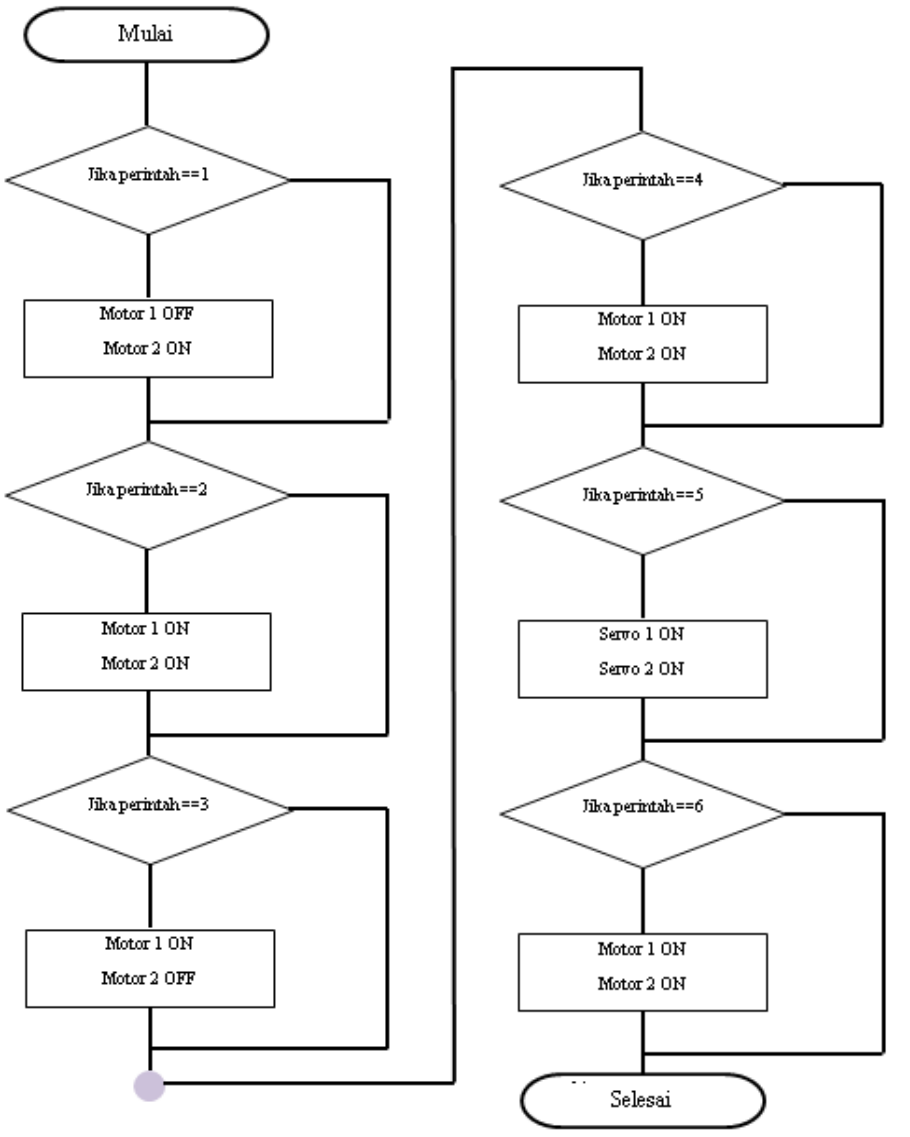

Figure 9. Robot Work Flowchart

3. RESULT AND DISCUSSION

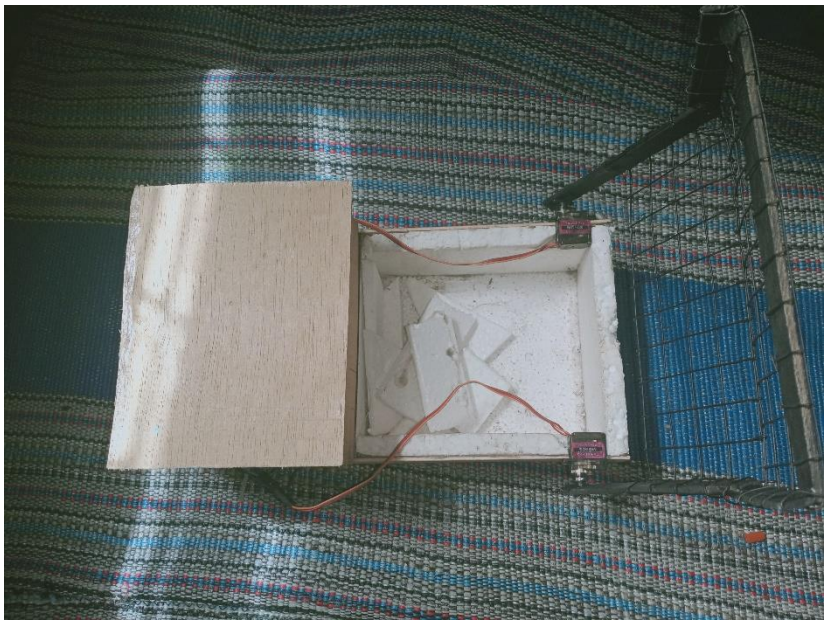

Figure 10. a Robot Desain

At this stage, the hardware design will be implemented, such as the components of the tool frame system. The following is the result of the implementation of the system hardware. The results of the implementation of the ship's robot components as a whole can be seen in Figure 11.

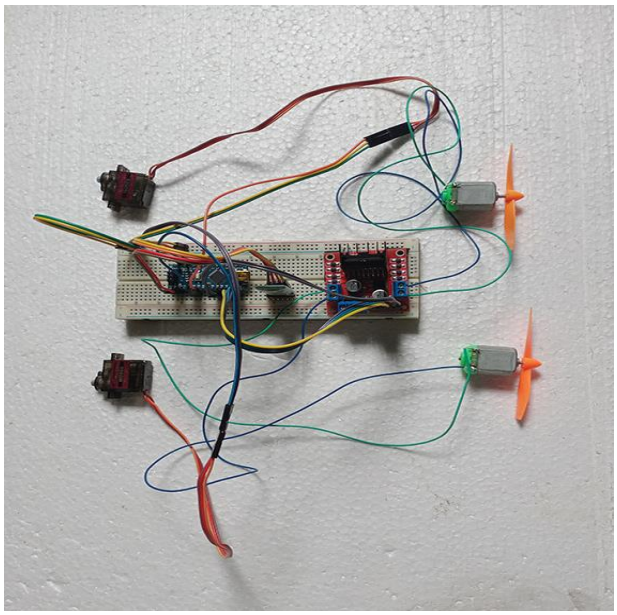

Figure 11. Overall Implementation

The servo component functions as a driving component of the garbage transport arm on the ship robot, the movement of the garbage transport arm is from top to bottom or vice versa. The results of the implementation of the Arduino-Servo component can be seen in Figure 12.

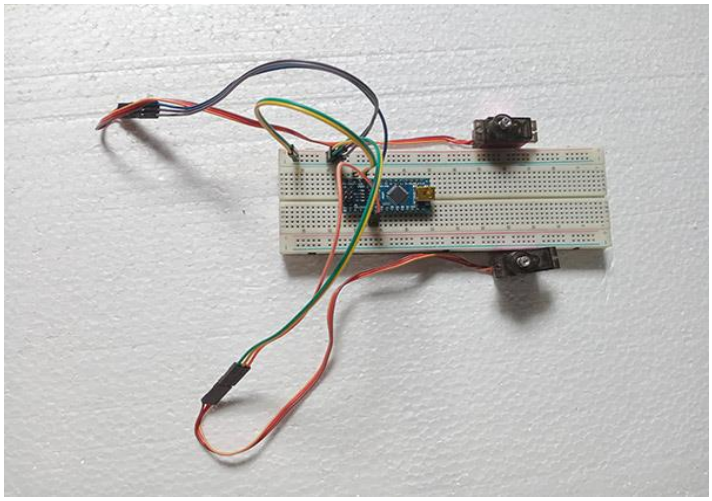

Figure 12. Arduino-Servo Component Implementation

The HC-05 component is a Bluetooth module that acts as an intermediary for communication between applications on Android smartphones and robots wirelessly. The results of implementing the Arduino-Bluetooth HC-05 component can be seen in Figure 13.

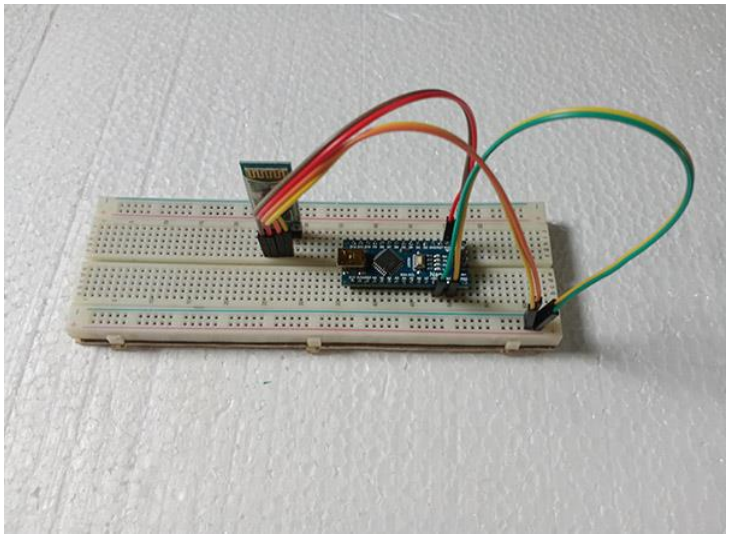

Figure 13. Arduino-Bluetooth HC-05 Component Implementation

Furthermore, The L298N motor driver functions as a component to control the death of a DC motor, a DC motor equipped with a propeller that is useful as a ship robot propulsion on the water. The results of the implementation of the Arduino-Motor Driver L298N component, DC Motor, can be seen in Figure 14. At this stage, the results of the implementation of system software design in the form of applications that control ship robots will be explained. The following are the results of the performance of the robot software.

3.1 Robot Controller Display Implementation

In the implementation of the robot controller, it can be seen several commands that function to control the prototype of the garbage collection ship robot, where the functions are as follows:

1. If the controller presses the forward button, the ship robot prototype will move forward
2. If the controller presses the reverse button, the prototype robot ship will move backward
3. If the controller presses the right button, the prototype robot ship will turn to the right
4. If the controller presses the left button, the prototype robot ship will turn left
5. If the controller presses the up button, the garbage collector goes up (throws the garbage into the boat)
6. If the controller presses the down button, the garbage collector goes down (picks up / picks up trash)

The display of the prototype controller for the garbage collection ship robot can be seen in Figure 14.

Figure 14. Robot Controller Display Implementation

This section will discuss how to control the robot and test the prototype tool for the garbage collection ship robot. At this stage, the servo testing on the robot will be explained, where the servo functions as a driving force for the garbage collection tool on the robot; the test results can be seen in table 2.

Table 2. Servo Testing

No	Name	Order	Information
1	Servo 1	Up	Servo 1 will move up Servo 2 will move up
2	Servo 2	Down	Servo 1 will move down Servo 2 will move down

Bluetooth smartphone android is turned on; after that, look for the HC-05 device, connect the Bluetooth smartphone with Bluetooth HC-05 through the Application that has been built, if the LED light on the HC-05 module is no longer blinking and a connected notification appears on the Application, it indicates the HC-05 module has been activated. Connected to a smartphone. The test results can be seen in Figure 15.

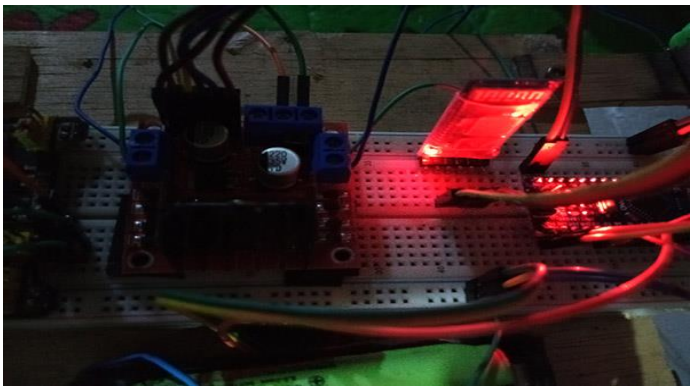

Figure 15. Hc-05 test

At this stage, the L298N motor driver and DC motor testing will be explained, where the L298N motor driver will control the direction of movement of the DC motor. The test results can be seen in table 3. moreover, At this stage, the L298N motor driver and DC motor testing will be explained, where the L298N motor driver will control the direction of movement of the DC motor. The test results can be seen in table 3.

Table 3. L298N Motor Driver Testing And DC Motor

No	Direction	Name	Command	Information
1	Left	L298N	Left	DC motor one will move backward DC motor two will move forward
2	Right		Right	DC motor one will move forward DC motor two will move backward
3	Forward		Forward	DC motor one will move backward DC motor two will move backward
4	Backward		Backward	DC motor one will move forward DC motor two will move forward

At this stage, the robot and controller testing will be explained; if the robot can run according to orders, the prototype of the garbage collection ship robot has been successfully designed. In table 3, the following are the results of the Robot test.

Table 4. Application Testing

No	Button Name	Description / Function	Results
1	Left	Ship turn left	Success
2	Forward	Ship forward	Success
3	Right	The ship turns right	Success
4	backward	Ship back	Success
5	Up	Garbage hauler boarded (throwing garbage on a ship)	Success
6	Down	Garbage picker Down (pick up trash)	Success

After the system has been implemented and has been tested, the results of the implementation and testing will be analyzed for the strengths and weaknesses of the system. Each system design has advantages and disadvantages, as well as the prototype robotic garbage collection ship. Here are the benefits of the robot prototype tool for the garbage collection ship:

1. This series of systems can facilitate the process of picking up waste.
2. An android application controls the prototype of the ship robot, and the robot will run according to the controller's command.

The following are the shortcomings of the robot prototype for the garbage collection ship:

1. The prototype of the ship robot is still in miniature. Therefore, the garbage that can be transported is the size of a matchstick or for a maximum length of 4 cm of waste and a maximum weight of 32 grams.
2. The series of components of the tool still use breadboards and jumper cables; this creates an untidy appearance and sometimes disrupts the tool's performance. As a result, one of the jumper cables sometimes dislodged.
3. The hull is still made of cork or styrofoam.

4. CONCLUSIONS AND SUGGESTION

4.1 CONCLUSIONS

After the prototype of the garbage collection ship robot has been implemented and has been tested, it can be concluded that:

1. The tools that have been produced can be used to help pick up garbage in the water.

2. The ship robot is controlled via an android smartphone, so the ship will move according to the direction of the controller.

3. The collected waste will be disposed of in the trash bin on the ship's robot.

4.2 SUGGESTION

The following are some suggestions that are expected to be applied in future research so that the tool can function better.

1. The prototype of the garbage collection ship robot should detect the garbage itself or automatically without a command from the controller via an android smartphone.

2. The prototype of the garbage collection ship robot should not be made into a miniature again so that it can be applied directly to Lake Toba or river tours so that it can help tourist janitors or the community around the tour to preserve cleanliness.

3. The ship should be equipped with a waste limiting sensor system so that when the garbage bin on the ship is full, the ship system stops.

4. Ships should be able to process their own waste that has been transported into a more valuable product.

5. Ships should be able to sort out organic or inorganic waste.

AUTHOR CONTRIBUTIONS

Conceptualization; Ivana Maretha Siregar [I.M.S], Muhammad Yunus [M.Y], V.M.M.Siregar [V.M.M.S], methodology; [I.M.S], [M.Y], [V.M.M.S]; validation; [I.M.S], [M.Y], [V.M.M.S], formal analysis; [I.M.S], [M.Y], [V.M.M.S], investigation; [I.M.S], [M.Y], [V.M.M.S], data curation; [I.M.S], [M.Y], [V.M.M.S], writing—original draft preparation; [I.M.S], [M.Y], [V.M.M.S], ;writing—review and editing; [I.M.S], [M.Y], [V.M.M.S], visualization; [I.M.S], [M.Y], [V.M.M.S], supervision; [I.M.S], [M.Y], [V.M.M.S], project administration; [I.M.S], [M.Y], [V.M.M.S], funding acquisition; [I.M.S], [M.Y], [V.M.M.S], have read and agreed to the published version of the manuscript.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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