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# Remote-controlled Electric Boat Project

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***Abstract*— The document below presents the process of the design and construction of a remote-control electric boat, using tools such as Arduino, Bluetooth, bilge pumps submersible, and recycled material. The objectives include understanding physics concepts such as floatability, resistance, and propulsion, and practicing the brainstorming, the problem-solving, the use of tools such as ChatGPT or online documentation to improve the research of information, and the construction of prototypes. This iteration process concluded with a sustainable and successfully driven boat.**

***Keywords*— *Arduino, Bluetooth, remote-control, PET bottles, boards, battery, current, voltage, pumps, programming, electronics, floatability, connections, circuit, insulation, documentation, ChatGPT.***

## I. Introduction

Vehicles, whether on land, in the air, or at sea, rely on fundamental engineering principles such as propulsion, stability, and control systems. These principles are critical in ensuring efficient movement, maneuverability, and safety across different environments. Maritime vehicles must address unique challenges related to buoyancy, water resistance, and propulsion through fluid mediums. This project focuses on the design and construction of a small-scale, remote-controlled electric boat that accomplishes these principles. Here, the design resulted indispensable, so the team had a model to follow during the construction.

## II. Theoretical framework

### 1. Principles of Electric Propulsion

Electric propulsion converts electrical energy into mechanical energy using electric motors to drive a vehicle. Key principles include efficient torque generation through electromagnetic interactions, smooth control over speed and torque, and fewer moving parts than traditional engines. This technology is valued for its efficiency, reduced emissions, and suitability for various applications, from cars to boats, contributing to more sustainable transportation [1].

### 2. Hydrodynamics and Stability

Hydrodynamics explores how fluids, like water, interact with objects in motion, which is essential for designing vessels that move efficiently through water. Stability in this context refers to a vessel's capacity to return to its original position after being tilted or disturbed, ensuring it remains balanced and upright. Archimedes' principle is key here: it states that any object submerged in a fluid experiences a buoyant force equal to the weight of the fluid it displaces [2]. This principle explains why objects float and helps in designing vessels with appropriate buoyancy and stability to maintain their equilibrium and prevent capsizing.

### 3. Remote control using Bluetooth

Bluetooth is a short-range wireless technology operating in the 2.4 GHz band [3]. It allows devices to connect and exchange data over short distances. In remote control scenarios, Bluetooth facilitates the control of various devices, such as electric boats or home automation systems, by sending commands from a remote control or smartphone. In this case, the boat had a HC-05 Bluetooth module, which works up to 10 meters, approximately.

### 4. H-Bridge Motor Drivers with Arduino

For controlling the motors by logic and not by physical manipulation (such as switches) a motor driver with an integrated H-bridge is needed. The DBH-12 H-bridge is a motor driver module used to control the direction and speed of DC motors through an Arduino. It consists of four switches arranged in an H configuration, allowing the current to flow through the motor in both directions. By using the Arduino to control the input pins of the H-bridge, you can determine the direction of the motor (forward or backward) and control its speed using Pulse Width Modulation (PWM). The H-bridge enables efficient motor control by providing the necessary current and voltage, while the Arduino manages the logic and timing of the motor operations [4].

### 5. Use of ChatGPT and online documentation for engineering

ChatGPT and online documentation are valuable resources in the engineering process. ChatGPT provides instant, interactive assistance for problem-solving, generating ideas, and clarifying concepts [5]. Online documentation offers detailed, authoritative information on tools, standards, and best practices. Together, they enhance efficiency, support learning, and streamline engineering tasks by providing quick access to relevant knowledge and expert guidance.

## III. Methodology

To carry out the project, the following steps were followed:

### 2.1 Brainstorming and first steps

At the beginning, the team started a creative process by generating ideas and writing them in a mental map. Then, the team started getting the materials. Some of the ideas, like the utilization of a L293d driver or the

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construction of the structure with PVC tubes were discarded later.

### 2.2 Mechanical scheme

The body of the boat was done with pieces of a wooden skateboard and a swimming board. A drawing of the idea of the team's boat was essential for the construction.

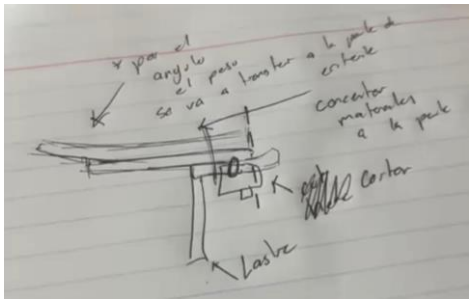

Figure 1. Scheme of the structure

### 2.3 Electronics scheme

The electronics was a keystone in the process, because many electronic components were involved, not only motors and switches but a DBH-12 H-Bridge, a protoboard, a HC-05 Bluetooth module, a 12v battery, a 9v battery, plenty of cables and, of course, an Arduino Uno. TinkerCad was not used because many of the components weren't able there.

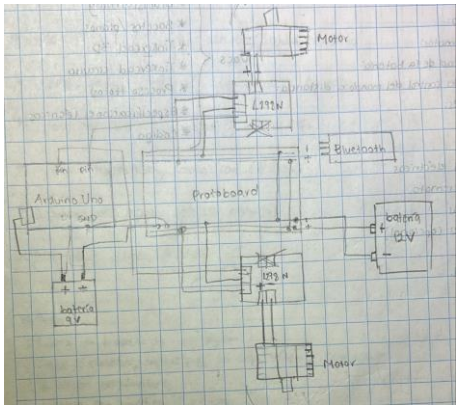


Figure 2. Electric circuit idea

### 2.4 Electric connections

Then, the electric components were assembled with the help of pliers and screwdrivers.

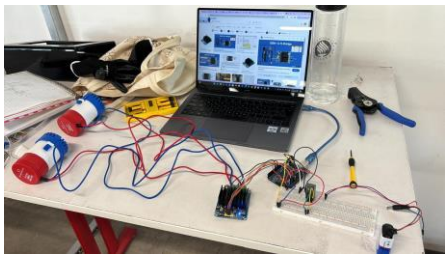

Figure 3. Electronic components already connected

### 2.5 Arduino Code

As an Arduino Uno was used, the program was in Arduino and it's exactly like this:

```
#include <SoftwareSerial.h>
SoftwareSerial BT(10,11);

#define IN1A 3
#define IN1B 5
#define IN2A 6
#define IN2B 9

char tecla1;
char tecla2;

int fixed_speed = 180;

void setup() {

 pinMode(IN1A, OUTPUT);
 pinMode(IN1B, OUTPUT);
 pinMode(IN2A, OUTPUT);
 pinMode(IN2B, OUTPUT);

 Serial.begin(9600);
 BT.begin(9600);
}

void loop() {
 if(Serial.available())
 {
  tecla1 = Serial.read();
  tecla2=tecla1;
  Serial.println(tecla1);
 }

 if(BT.available())
 {
  tecla2 = BT.read();
  tecla1=tecla2;
  Serial.println(tecla2);
 }

 if((tecla1 == 'a')||(tecla2 == 'a')) {
 Serial.println("adelante");
 analogWrite(IN1A, fixed_speed);
```

```
analogWrite(IN2A, 0);
analogWrite(IN1B, fixed_speed);
analogWrite(IN2B, 0);
}

else if((tecla1 == 'd')||(tecla2 == 'd')){
Serial.println("derecha");
analogWrite(IN1A, 0);
analogWrite(IN2A, 0);
analogWrite(IN1B, fixed_speed);
analogWrite(IN2B, 0);
}

else if((tecla1 == 'i')||(tecla2 == 'i')){
Serial.println("izquierda");
analogWrite(IN1A, fixed_speed);
analogWrite(IN2A, 0);
analogWrite(IN1B, 0);
analogWrite(IN2B, 0);
}

else if ((tecla1 =='0') || (tecla2 == '0')) {
Serial.println("stop");
analogWrite(IN1A, 0);
analogWrite(IN1B, 0);
analogWrite(IN2A, 0);
analogWrite(IN2B, 0);
}
else if ((tecla1 =='+') || (tecla2 == '+')) {
fixed_speed = fixed_speed + 10;
Serial.println("fixed_speed");
  if (fixed_speed >= 255)
  {
    fixed_speed = 255;
  }
}
else if ((tecla1 =='-') || (tecla2 == '-')) {
fixed_speed = fixed_speed - 10;
Serial.println("fixed_speed");
  if (fixed_speed <= 0)
  {
    fixed_speed = 0;
  }
 }
}
```

Briefly, it connects to the Bluetooth. The conditionals turn on and off each side of the current for each motor: IN1A is the first entry of the A motor, IN2A is the second entry of the A motor, IN1B is the first entry of the motor B and IN2B is the second entry of the motor B. Depending on the desired movement (forward, righ, left or stop), different instructions are given to the motors. It's important to metion that the commands were given by a mobile app connected via Bluetooth to the Arduino, which gave instructions to the driver, which in turn gave instructions to the motors.

### 2.6 Construction of the structure

After the programming and electronics, the team started to cut the boards and tie them with ropes and girths.

Figure 4. Assembly of the boat

### 2.7 Tests

Three main tests were conducted: the floatability test, the motor test and the Bluetooth connection test. The second one was a little bit complicated because there were many typos on the code but finally, they were all successful.

Figure 5. Floatability test

### 2.8 Decoration and final details

A cardboard was used to decorate the structure and make it look like a fishing boat. Blue lines were painted by the sides, and it had its name "Borregótico" written with lettering.

Furthermore, a plastic Tupper, a cellophane bag, tape and a lot of glue were used to insulate the electric circuit and avoid an accident. Finally, two PET bottles were included to give a better floatability if needed.

## IV. Results

In the trip to the lagoon "La Vega Escondida" the team demonstrated that the constructed boat successfully navigated: it had stability, floated well, followed the instructions given by the mobile app and did not experimented affections on the structure or electronics after its use.

However, during the navigation the team noticed three main aspects that could have been addressed differently for better performance. First, the motors could have been collocated with a bigger space between them and with more precision, so it was controlled more easily. On second place, including the blue components of the bilge pumps submersible could have avoided the contamination of the motors and, with this, a better propulsion. Finally, the team decided to remove the cardboard decoration to prevent it from getting attached to the plants.

Fig. 6. Construction of the electric boat

Fig. 7. Navigation of the boat in the lagoon

## V. Discusion

The results the team got demonstrated that the approach used was effective for the design and construction of small remote-controlled electric boats. The main challenges included programming the Arduino and building a safe structure for the electronic components. This because the team worked with a H-bridge never used by any of the members. However, the team was able to solve all the surging problems.

## VI. Conclusion

This project demonstrated the feasibility of using online documentation, YouTube videos and ChatGPT in the design and construction of an electric boat. Additionally, the conducted tests allowed to verify our success and fails, therefore the team could improve and iterate in the design. This approach can be applied not only to university projects but to any engineering process. AI tools such as ChatGPT represent great opportunities to learn and build projects simultaneously.


## Acknowledgment

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## References


[1] Larminie, J. and Lowry, J. (2012). *Electric Vehicle Technology Explained.* Wiley.
https://www.iqytechnicalcollege.com/BAE%20685-Electric%20Vehicle%20Technology.pdf

[2] CuriosaMente (2022). *El principio de Arquímedes o ¿Por qué flotan los barcos?* [Video]. YouTube.
https://www.youtube.com/watch?v=XoF9s5ODsHI

[3] Intel (2024). *¿Cómo funciona la tecnología Bluetooh?*
https://www.intel.la/content/www/xl/es/products/docs/wireless/how-does-bluetooth-work.html#:~:text=La%20tecnolog%C3%ADa%20Bluetooth%20conecta%20las,frecuencia%20de%202%2C4%20GHz.

[4] DroneBot Workshop (2022). *Driving DC motors with Microcontrollers*.
https://dronebotworkshop.com/dc-motor-drivers/

[5] OpenAI Platform (2024). *Prompt Engineering*.
https://platform.openai.com/docs/guides/prompt-engineering