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Ball collecting and sorting robot

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DISCLAIMER

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Abstract

This project is considered very important because it reduces people's effort in games that contain balls. This idea came to reduce human effort, by creating a robot capable of collecting balls. The robot is capable of move on its own in an autonomous manner, and it can also be operated wirelessly. Our project detects existing ball objects and collects them to specific known point , it can be used to help Tennis and Golf players to collect balls while they are training or playing matches.

The most important things to cover in this project for us is making a little car that has an arm, and collect balls then sort them based on color.

In this project we will use Dc motors for the wheels, servo motor for the arm , Ultrasonic Sensor ,2 ring on the robot to put the balls , controlling robot movement and collecting balls process using Arduino, color sensor.

1 Introduction

1.1 General background

Collecting the balls during practice sessions or after matches in tournaments can be rather time-consuming in sports like tennis and golf. We propose a robotic approach to this problem, whereby we automate the procedure of collecting the balls. The objective of this project is to devise a robotic system that will be capable of moving on a playing field either wirelessly or autonomously, locating and collecting the balls, and then organizing them based on their color. It aims to provide a more effective and less labor some way for coaches and sportsmen to retrieve balls.

The miniature car would be the basis of the system, where DC motors will provide the movement, a servo motor to move an arm in order to pick up the balls, and an ultrasonic sensor for object detection. Moreover, the robot will have a collection box installed so the balls can be kept there temporarily. The controlling of the robot will be based on an Arduino platform, with a color sensor for the detection and sorting of balls. For easy handling.

This idea can be further applied to both tennis and golf training because of its creative and practical approach to managing the retrieval of the ball with a minimum amount of physical work.

1.2 Objectives

The major objective of this research is to develop a ball collecting robot , smart robot to collect balls manually using esp32 WiFi html ,css and JavaScript page to control the manual and automatic mode:

- 1- **Movement Control:** to enable the robot to perform a movements using 4 dc motors , we can control this dc motors can in manual mode by the buttons in the web page and we can click in the automatic on button in the page to turn on the auto mode and the dc motors will do the following the Arduino will take data from ultrasonic and then move the wheels according to it.

- 2- **Arm control:** to make the base of the arm go to left and right and the arm part of the arm move the arm up and down and make the claw part of the arm open and close , in this part we use 3 servo motors to control this 3 parts of the arm, we can control the arm by the web page or from the auto mode.

- 3- **Color sensor:** color sensor here is important in auto mode to see if the ball is red for example or green if red the arm will take the ball and then put the green balls on The balls are placed inside a basket attached to the robot and the red balls in another basket On the opposite side of the robot also attached to the robot.

- 4- **Ultrasonic sensor:** By cooperating with the color sensor, it will determine the color of the ball and its location.

- 5- **Complete Integration:** To combine all of these features into a single multitasking robot that effectively integrates hardware and software, achieving the goal of becoming an interactive user friendly robot assistant.

1.3 Significance

Ball collecting robot we can use it in many applications:

It can be used to reduce the effort spent collecting balls in tennis and golf matches and to determine the color of the ball and place it in the appropriate place.

1.4 Organization of the report

This report is organized showing a comprehensive overview of ball collecting development and capabilities. It is divided into several chapters, each focusing on different aspects of the project:

1. **Introduction:** This chapter provides the general background, objectives, and significance of the project. To set the context for the reader.
2. **Literature Review :** In recent years, the use of autonomous robotic systems has gained a lot of attention and is used in a wide range of fields, from manufacturing to healthcare to sports. Among the applications in sports training, the concept of a ball-collecting robot that would mainly take over the task of retrieving balls from the practice and game areas is definitely one of the potential use cases for this technology. This part of the publication will take a deep dive into the most relevant technologies and pieces that are crucial to the design and function of such a robot.
3. **Methodology:** in This chapter materials and components involved, also the design and construction process, software development, and constraints. It provides a complete explanation of how ball collecting robot was built and the reasons behind the choices made.
4. **Results & Discussion:** This part presents the results of the project. It provides an analysis of how well the ball collecting robot meets its objectives and the potential impact of the project.
5. **Conclusion :** This final section summarizes the project. It draws conclusions based on the final results. It also offers future improvements and work.

By organizing the report in this manner ensures that each aspect of the ball collecting robot development is completely covered. It remains easily accessible to the reader.

2 Literature Review

In recent years, the use of autonomous robotic systems has gained a lot of attention and is used in a wide range of fields, from manufacturing to healthcare to sports. Among the applications in sports training, the concept of a ball-collecting robot that would mainly take over the task of retrieving balls from the practice and game areas is definitely one of the potential use cases for this technology. This part of the publication will take a deep dive into the most relevant technologies and pieces that are crucial to the design and function of such a robot.

2.1 Robotic Movement and Control:

A key aspect of a robot that is to collect a soccer ball is that it needs to autonomously tour the field. This is often done by the use of direct current motors, which supply power to the wheels and provide the necessary locomotion. The mobile robots are powered by the DC motors, which is one of the reasons why they are efficient and controllable, as the motors are used to act on them. The motors can be controlled by means of manual inputs i.e. a web-based interface or autonomously by means of predefined paths or sensors inputs.

2.2 Object Detection and Sorting

The capability of a robot to detect and pick balls autonomously is another very crucial functionality of the robot. Sensors like ultrasonic are used to detect objects from within a certain range. The ultrasonic sensors send out sound waves and they then measure the time it takes for the sound to bounce back, allowing the robot to determine the distance to the objects around it, including balls. Once the ball is detected, the robot can then use a robot-arm to pick it up.

The color detection component is yet another important factor used for sorting of the balls. A color sensor, for example, TCS34725, can identify the color of the balls with the help of which the robot can sort them into different compartments. Its value, of course, appears in the games, such as tennis or golf, where you can use different balls for various purposes, or you could also have access to training equipment actually if you organize well.

2.3 Robotic Arm for Object Manipulation:

A mechanical arm is an essential gadget that holds balls and transfers them to their destinations. The arm is usually made up of several areas, each of which is managed by a servo motor. Servo motors are the most appropriate to control movement, especially in the case of rotation because it is the best way to do it. Hence, it is widely being used in applications where the arm is required to move in precise directions such as picking a ball up from the ground and placing it into a bucket, among others.

The parts are as follows: the base is the bottom part that spins the arm in a criss-cross manner, the upper part is the next movable part which moves the arm in the up and down direction, and the last is the claw or gripper which changes its state from being unpowered or powered so that it can catch the balls. These movements can either be hand-controlled or automated, depending on the mode of operation. To give the arm lift-balance, albeit agility speaks and performs more natural movements is the design challenge.

2.4 Integration of Sensors and Control Systems:

To work correctly, the robot may need to consolidate multiple sensors and actuators into one comprehensive system. The core part of a robot is the Arduino board or anything of the like that governs the actions of the robot, such as taking the readings given by the sensors and sending out commands to the motors. The microcontroller task calls for it to be multitasking and among these major duties, it has to control the wheels for motion, work the arm for ball collecting, and at the same time read color sensors that do the sorting.

By using an algorithm, the robot in the autonomous mode can perform task that interprets available data from various sensors to decide what its next action will be. For instance, if the ultrasonic sensor locates an object, the robot may halt or change direction. In the same way, if the color sensor identifies a red ball, the hand can move according to the command of placing it into a certain container. Meanwhile, in manual mode, users can send signals via an interactive web interface and alternate between monitoring the movement of the wheels and controlling the arm.

2.5 Practical Applications in Sports

Robotic systems that automate duties such as collection of balls can greatly relieve physical input in sports such as tennis and golf. Athletes devote much practice time towards the recovery of balls, leaving less time available for the development of their sport specific skills. The ball-collecting robot offers an effective solution to this, especially for activities that require repetitive behavior, and has potential to enhance productivity during training sessions.

2.6 Gaps and Contributions

Despite progress, high costs and complexity limit access to advanced robots. Integrating multiple functions into a simple user-friendly system is also challenging. Our robot addresses these gaps by:

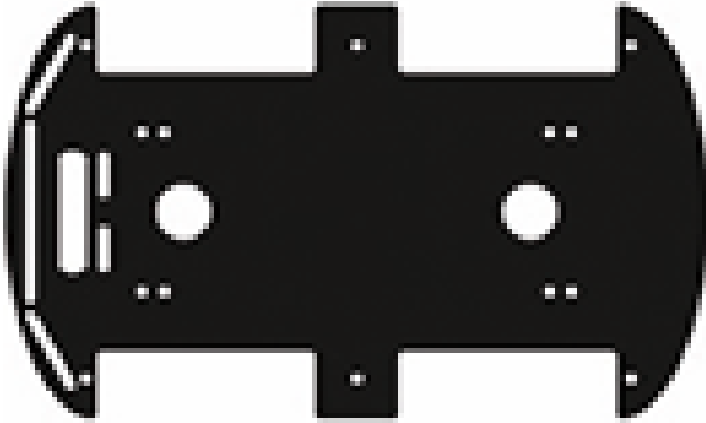
- Being affordable and having it built using common components.
- Combining color detection, movement control.
- Offering an easy-to-use web interface for control.

3 Methodology:

3.1 Materials and Components

3.1.1 3D Printed Design

We have 2 base like in the following photo



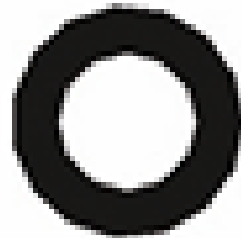
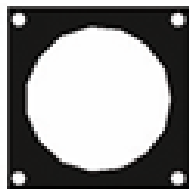
Between the 2 of the above I have a copper pillar and empty between the 2 bases to put some motors and other things we will talk about it later in this report.

The following design is for the arm you can see the photos bellow:

We have 3 parts of the arm:

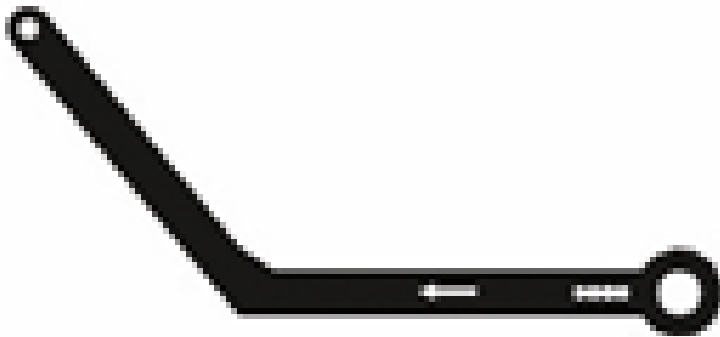
1. **Base:** to make the arm move left and right and the following is the design of the base .

The following design for making the base of the arm moving easily:

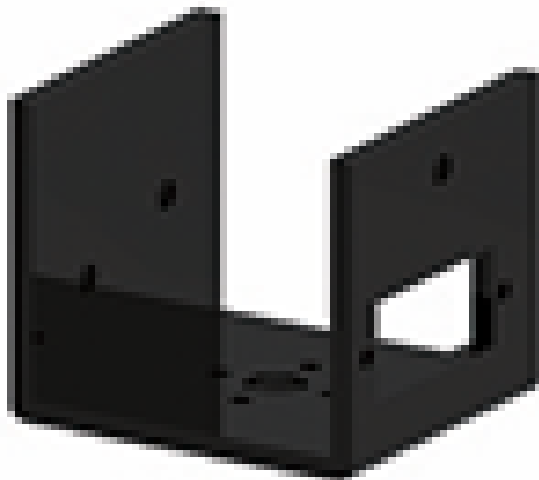


2. **the Arm part of the arm:** we use this part to move the arm up and down.

We have 4 of the following to make the arm can hold the ball and move up and down:



The following photos is the design for the servo bracket to put servo in the empty place to make the arm move up and down.



3.claw part of the arm:

this part to hold the balls and we design it as follows:

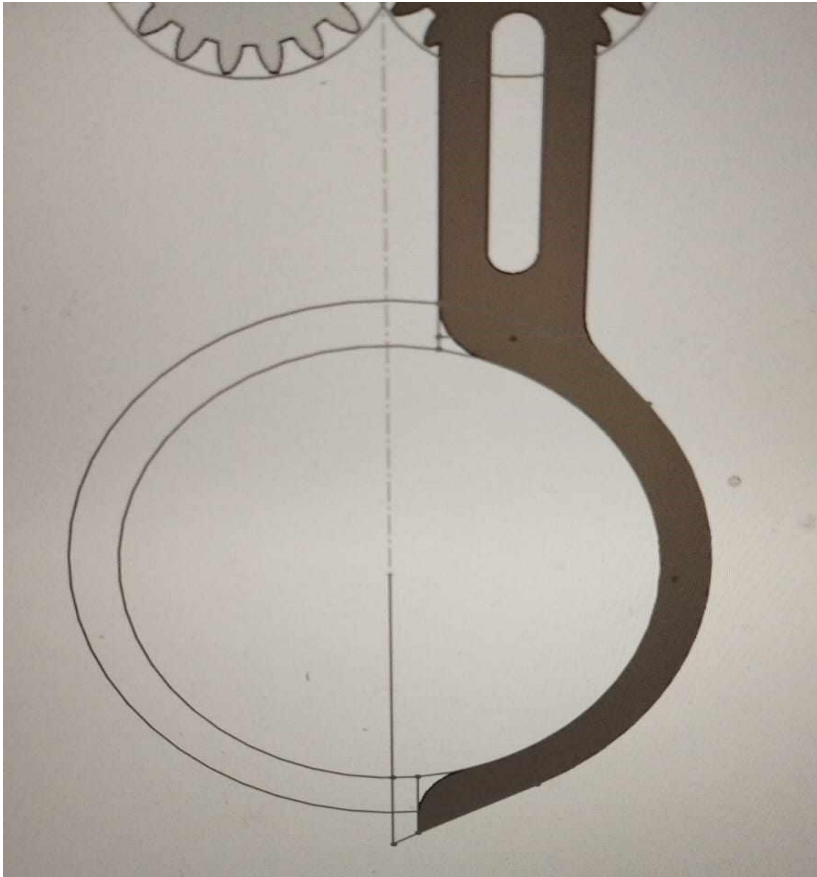
we put the following to hold the claw and the servo of the claw:



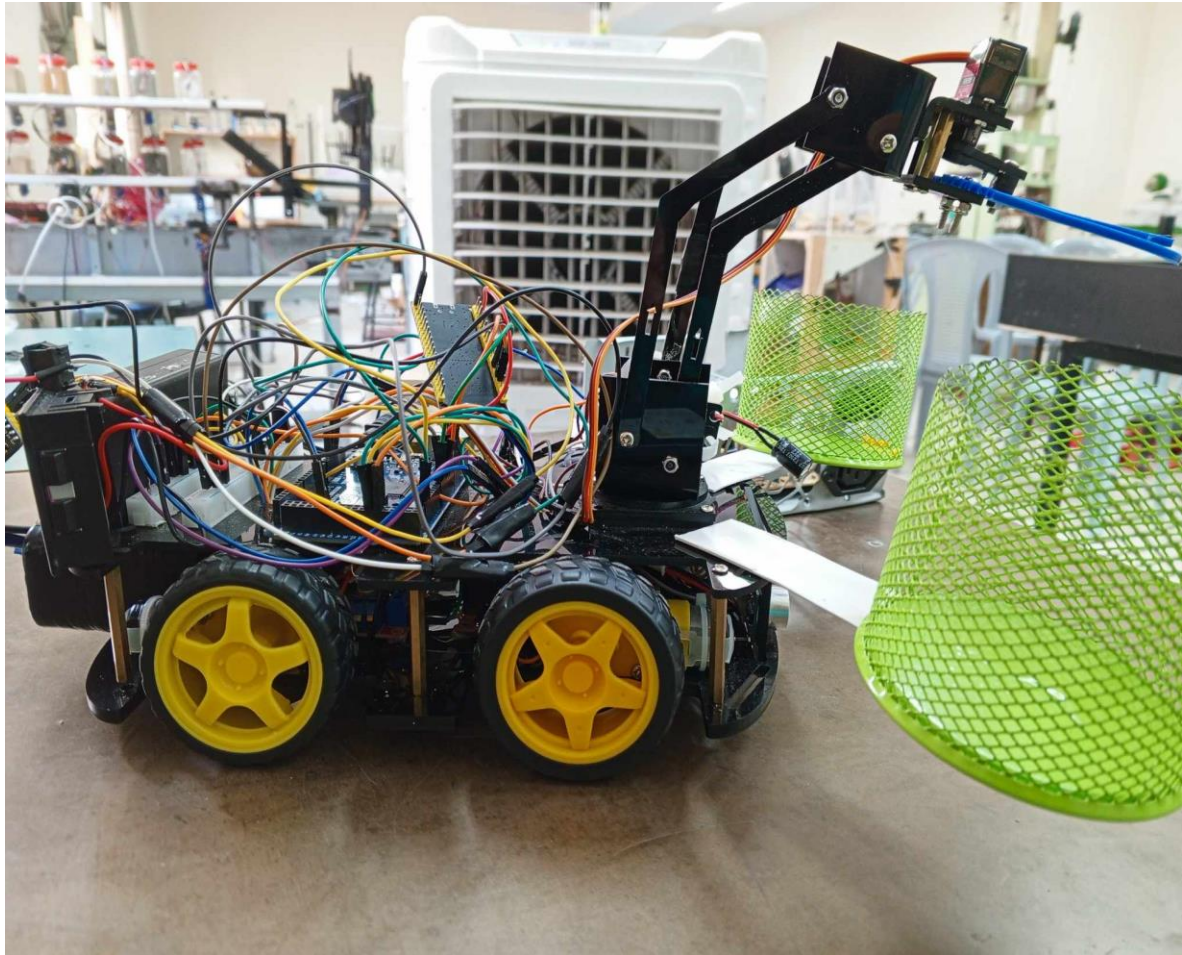
we put the servo to control the claw part here in the empty place as the following photo:



And the claw as in the following photo:



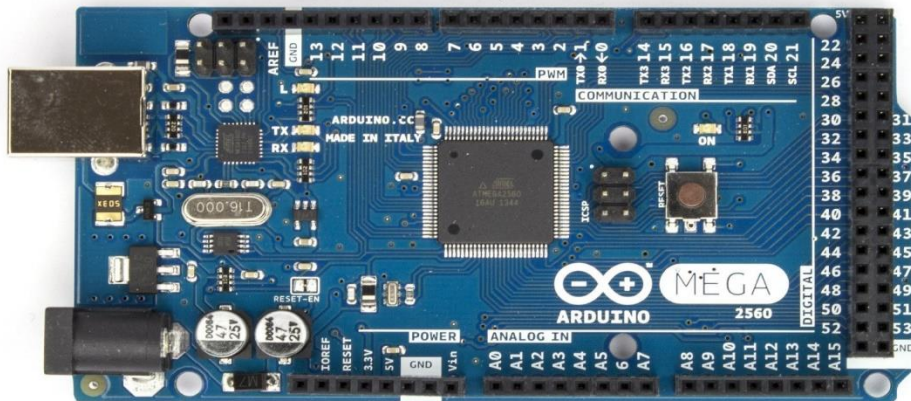
From the following photo you can see the whole design of the robot:



As you see in the photo above this is the whole 3d printed you can see the 2 bases and the copper pillar between them ,and you can see the arm design

3.1.2 Arduino mega

To control the arm and the wheels depend on the commands , the Arduino take the commands from the esp32 module from the rx and tx pins.



3.1.3 ESP32 module

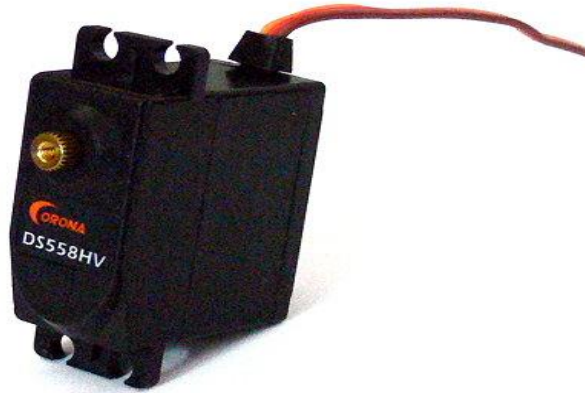
We use this esp32 module to make the esp32 broadcasts its network , we made a web page in the esp32 module network when I click in on particular button the esp32 will send command to the Arduino mega .



3.1.4 DS558HV (servo motor) and MG90S (servo motor)

DS558HV:-

- Quantity: 1
- To make the arm part of the arm move above and down.



Mg90s:-

- Quantity: 2
- To make the base of the arm move left and right .
- To make the claw of the arm open and close.



3.1.5 Ultrasonic

it's used to measure the distance between the ball and the car.



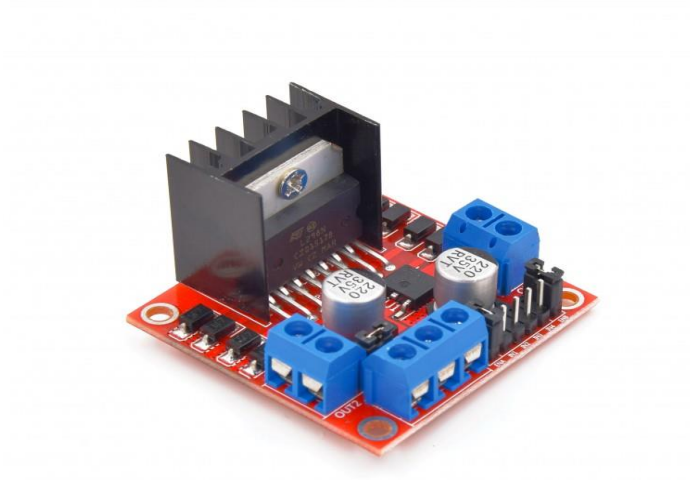
3.1.6 DC motors

- Quantity: 4
- The dc motors for the wheels to make them move forward or backward or left or right.



3.1.7 h bridge L298N

- Quantity: 2
- To make controlling the motors easier by making the motors reverse the direction of the current, so the direction of rotation is reversed according to the required commands.



3.1.8 TCS34725 RGB sensor

- Quantity: 1
- To detect the color of the ball if the color is green or red the arm will hold the ball and put it in the ring, we have 2 rings if the color is red the arm will put the ball in the ring specified for the red color, if the color is green the arm must put the green balls in the specified ring for the green color, else the arm will not hold.



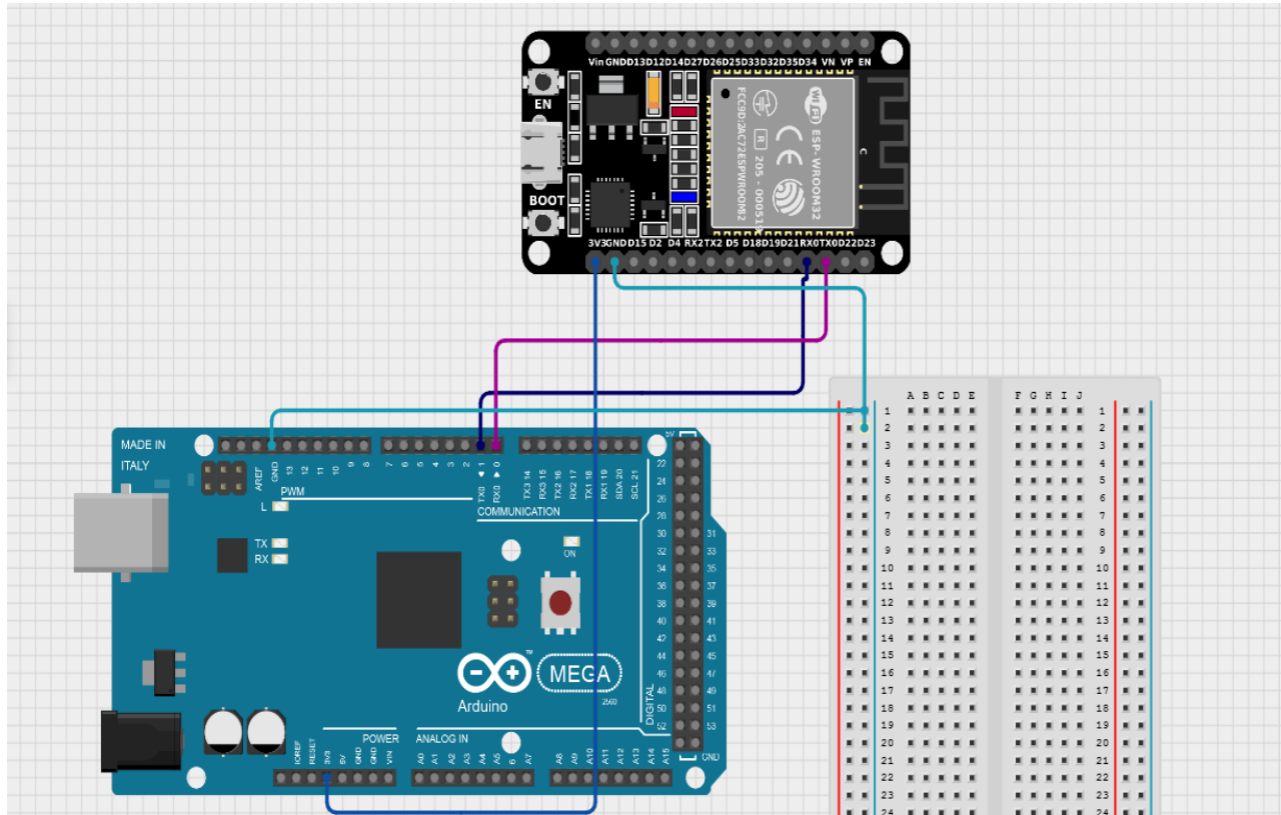
3.1.9 Lithium battery's

- Quantity: 8
- 2 for the Arduino cause the Arduino take 5 volt.
- 6 for the h bridges cause every h bridge take 12 volt .

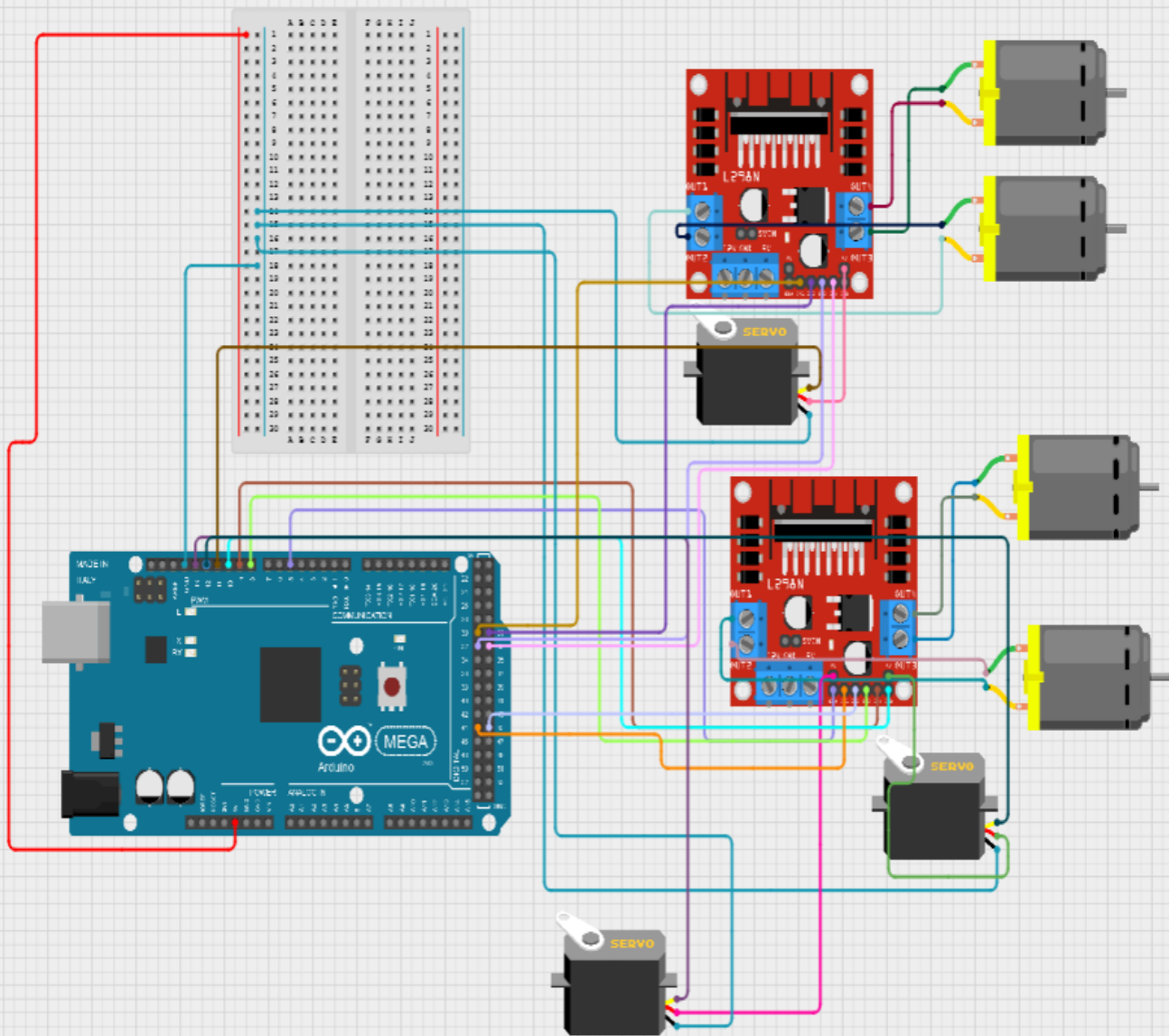


3.2 Design and Construction

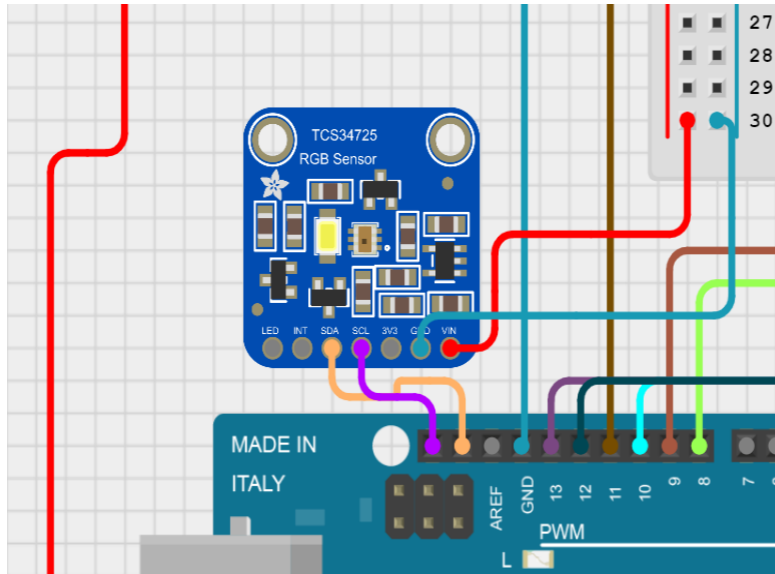
3.2.1 Connections between Arduino and esp32 module:



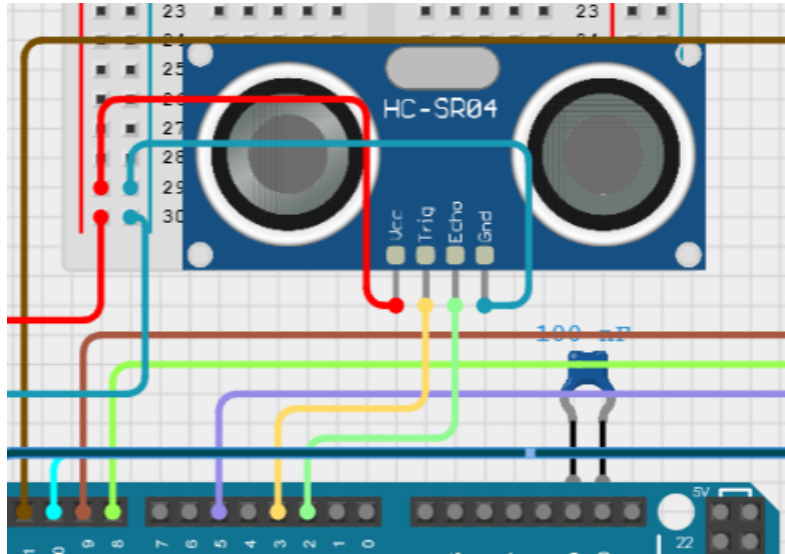
3.2.2 The connections for the dc motors and servos with h bridge and Arduino:



3.2.3 Color sensor with Arduino mega:
SCL with SCL , SDA with SDA ,VCC and GND as follows :



3.2.4 Connections of the ultrasonic sensor with Arduino:



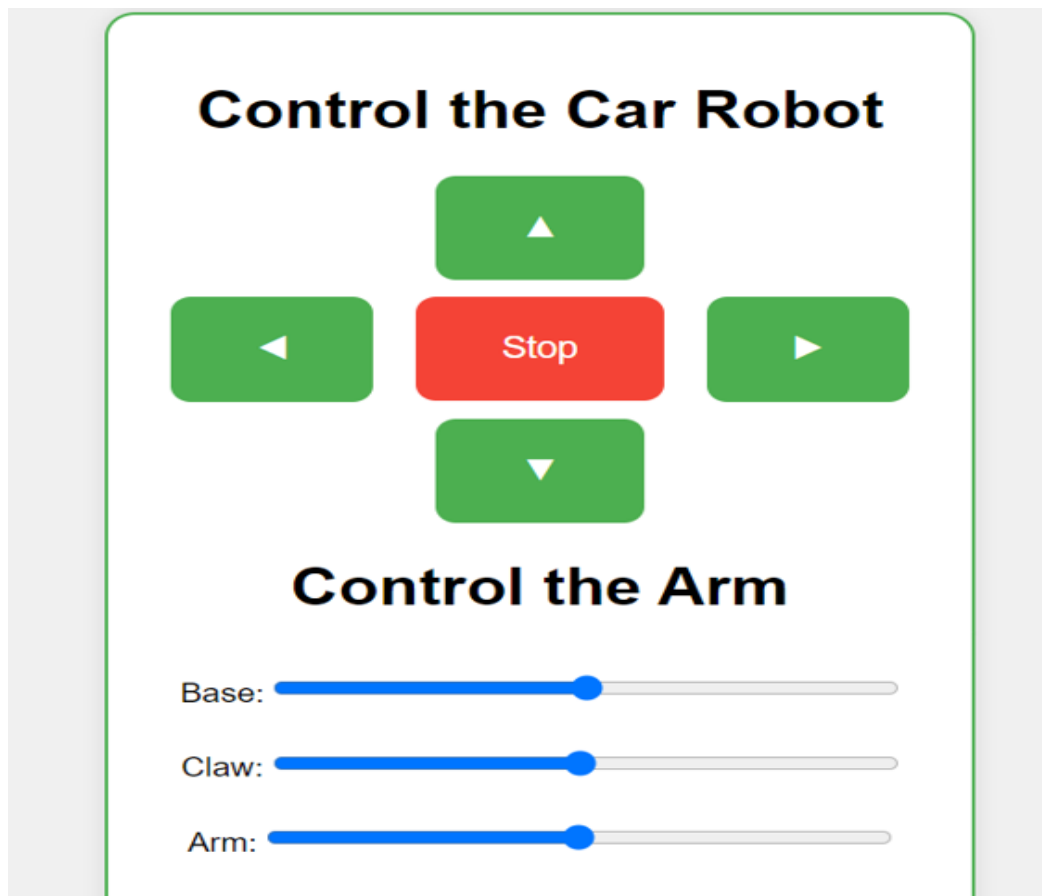
3.3 Software Development

The software development of our robot is divided into two parts:

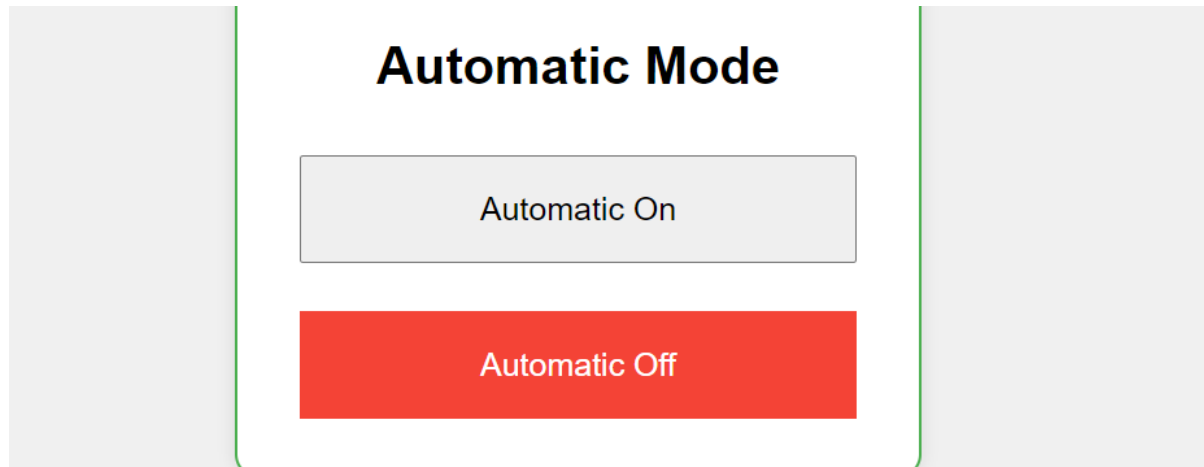
3.3.1 Esp32 code part:

We made HTML, CSS and JavaScript page when I click on specific button a command will sent to the Arduino mega and the Arduino mega will execute the command .**The esp32 module broadcast its own network .**

this is the page we made to control our project:
the following buttons for the manual mode:



The following buttons for the auto mode:



3.3.2 Arduino code:

Through the Arduino code, we did the following: The robot scans its surroundings and performs 10 cycles. During these turns, he may see an object if the distance between him and the object is 12 to 15 cm, which is the length of an arm. He lowers the arm down and brings the ball closer so that the claw is not closed at the highest level, as the color sensor is placed on the claw. The color sensor sees if the ball is red or green. He picks it up, closes the claw completely, then lifts the arm up and puts it in the appropriate basket. If the color is not green or red, the claw is not fully closed. Then the arm rises and continues searching for balls. After it completes 10 revolutions, it advances a little and then rotates again.

3.4 Constraints and Considerations

- **Economic Constraints:** We used affordable components to make it fit the limited budget available to us, for example we used a color sensor instead of using a Raspberry Pi due to its very high price.
- **Manufacturability:** Designing our robot to be easily assembled and replicated using readily available components at any time giving it the potential for the future upgrades.
- **Time Constraints:** We had a limited time to complete the entire project, starting from designing the body of our project, all the way to interconnecting the parts of the project and making the robot integrated in functions and writing the code.

4 Results & Discussion

4.1 Results

The development and testing of the ball collecting and sorting robot, a multifunctional robot, came out with significant outcomes:

- **Movement Control:** We succeeded in making the robot move forward, backward, right and left in manual mode and in automatic mode.
- **Arm control:** We were able to successfully control the arm manually and automatically. The arm moves right, left, up and down, and the claw opens and closes.
- **Color sensor:** Through the color sensor, we were able to successfully identify green and red balls and prevent the claw from getting stuck on the other colors.
- **Ultrasonic sensor:** As for the ultrasonic device, we were able to make it measure the distance successfully despite the errors that may sometimes occur due to interference in the signal or other reasons that we could not know about.
- **Complete Integration:** All features were seamlessly integrated.

4.2 Discussion

4.2.1 Problem Resolution

The project successfully developed a cost-effective, It saves people time and effort in collecting golf and tennis balls.

4.2.2 Limitations

- **Time :** Lack of time and limited time in which we completed this project. The time was two months ,also Batteries need constant charging, and this wastes some time.
- **Performance Constraints:** Ultrasonic is affected by any external signal and difficulty.

5 Conclusion

5.1 Conclusion

our robot successfully integrated movement control, Arm control , Color sensor, and Ultrasonic sensor into a cost-effective and user-friendly robot. Its Effective design and integration strategies for interactive robotics can be achieved affordably while maintaining fully working functionality.

5.2 Future Work:

- **Image Processing Application:** Adding the Raspberry Pi and image processing will greatly reduce the errors of some sensors, such as the ultrasonic sensor and the cooler sensor.
- **Interface Enhancement:** Improving the web interface for our robot, also adding more functionalities that can be done within its capacities.
- **CAR size:** Enlarging the size of the car as a whole and the arm to fit larger balls in the future, as this robot becomes suitable for other games such as football.