AN-NAJAH NATIONAL UNIVERSITY FACULTY OF ENGINEERING AND INFORMATION TECHNOLOGY COMPUTER ENGINEERING DEPARTMENT

Hardware Graduation Project

Automated Car Wash with Parking System

SUBMITTED BY

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Presented in partial fulfillment of the requirements for the Bachelor's degree in Computer Engineering.

Dedication

To the ones who supported us and fueled our journey—our families, friends, and mentors. This project is as much yours as it is ours. Thank you from our hearts for the unwavering support.

Acknowledgment

We extend our heartfelt gratitude to the entire An-Najah National University community and our dedicated teachers for their invaluable support and guidance. Our sincere appreciation goes to our families and friends who stood by us through thick and thin, providing unwavering encouragement.

A special acknowledgment is reserved for Dr. Suleiman Abu Kharmeh, our supervisor, whose time, support, and trust were instrumental in the success of our project.

Disclaimer

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Car Wash Images

Figure 1: Car Wash

Figure 2: Car Wash

Parking Image

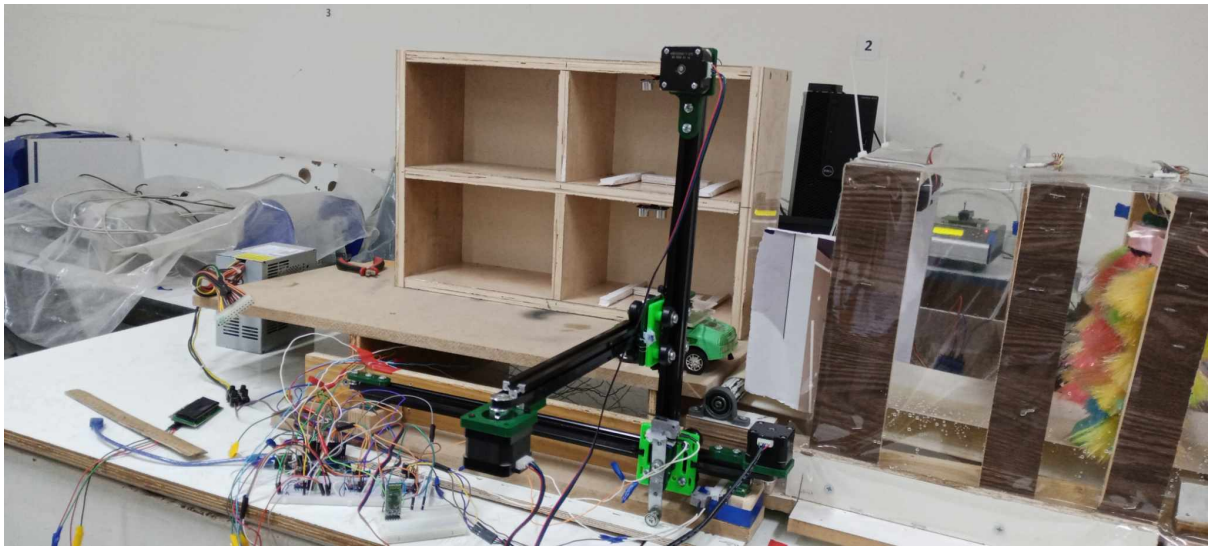


Figure 3: Parking

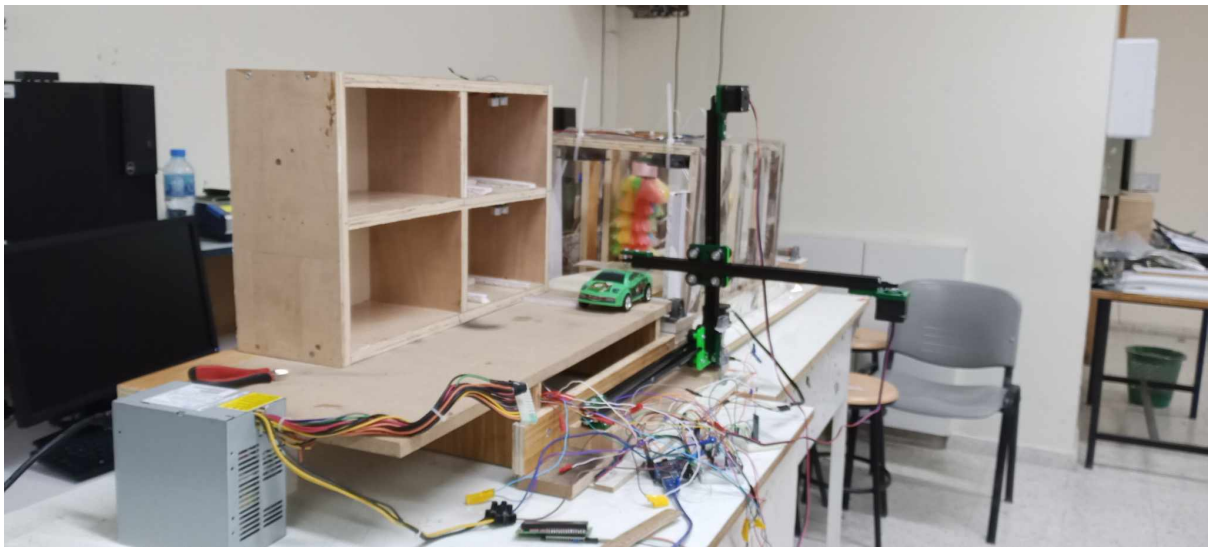


Figure 4: Parking

Abstract

The Automated Car Wash with Parking System project represents an evolution from conventional car wash approaches. While these approaches are time and effort-wasting, this project provides time savings, increases productivity, and eliminates the effort since it is done automatically.

The car wash process involves multiple stages, beginning with the automated opening of the gate using a servo motor. Water and soap are then pumped automatically to clean the car, followed by brushing and concluding with a drying phase. The integrated car parking option comes with a mobile application that allows the admin to efficiently manage customer parking needs. The mobile app displays the current status of parking slots, features a timer for parked cars, and sends notifications to the admin for various purposes.

In conclusion, this project offers a modern approach to car cleaning with an integrated parking solution, addressing the inefficiencies of traditional methods and providing a seamless and convenient experience for both users and administrators.

Contents

1 Introduction

1.1 Problem Statement

In the past, cleaning your car was taking a lot of work. Picture a time when people had to scrub their cars with their hands, using scrub brushes and buckets of water.This old-fashioned way needed a lot of physical effort and took a long time. Car owners or workers had to spend a good amount of time and energy to make sure the cars looked nice.Now, let's jump to today. We have automatic car wash systems that make things easier and faster.However, there's still a big problem: when your car gets cleaned automatically,finding a parking spot is still a bit of a headache.The issue we're dealing with is that automatic car wash systems and parking places don't work together smoothly. The way things are set up now causes problems like wasting space, making it hard for customers, confusing the people working there, and even making it a bit risky for parked cars.Also, we're still dealing with the environmental impact of old style car washes, using too much water.This project wants to fix this by creating a system that combines automatic car washing and parking.The Project aim to make things simple, modern, and good for both people and the environment.

1.2 Significance

The goal of an automated car wash and parking system lies in making things quicker and easier for everyone. This system save a lot of time for people who want their cars cleaned or parked. Also good for the environment because they can use less water. Automated system keep cars consistently clean and shiny without much effort from people. It's a modern and smart way to take care of vehicles. Plus, it can save money by using less manual labor.

1.3 Objectives and Scope

Implementing an automated car wash and parking system aims to achieve several important goals.

1. Efficient Car Cleaning:

   The primary objective is to provide an efficient and thorough cleaning of vehicles using automated processes, ensuring a high standard of hygiene.

2. Cost-Saving:

   The goal is to achieve efficient washing and parking system at a lower cost.

3. Time Saving:

   Automating the system effectively reduces processing time.

4. Reduced Dependence on Human Workers:

   An essential goal is to minimize the need for human labor by design the system in a way that requires very little human intervention.

5. Parking:

   Providing the choice of parking after the car wash to eliminate mandatory waiting, allowing customers the flexibility to leave without delay.

1.4 Report Organization

- Second Chapter:

  Explored important subjects learned previously, along with external courses and the primary constraints and obstacles encountered while working on the project.

- Third Chapter (Literature Review):

  Explored the process of choosing the project idea, gathering inspiration, and establishing the project goals.

- Fourth Chapter (Methodology):

  Discussed the approach taken to build the application, highlighting features and technologies utilized.

- Fifth Chapter (Result and Problem Discussion):

  Explored project results, lessons learned, and potential future developments to evolve the project.

- Sixth Chapter (Conclusion):

  To conclude and summarize, this chapter provides insights into improvements, future work, and the outcomes of the project.

2 Constraints and Earlier Coursework

2.1 Constraints

These are some of the constraints we encountered.

2.1.1 Inexperience

We created many modest demos and tests to ensure that the notion we are going for is feasible. However, all of these testing required time that we could have spent on other things. Even after all of the testing, research, and time invested, we still made certain judgments that are considered safe risks since we couldn't test specific components and couldn't afford for the overall project to fail.

2.1.2 Lack of funds

Some options required additional money to create, making the project more expensive and unaffordable, especially at our budget.

2.1.3 Lack of Mechanical Knowledge

The project involves many mechanical aspects that we only partially understood, but even after all of our study, an experienced mechanical engineer was required to answer some problems and arrange the execution effectively. Considerable 3D printed pieces required some balance and mechanical understanding to repair; thus, the concepts and original drawings were brought to the engineer students for modification.

2.1.4 Lack of Tooling

Some specific tools were necessary to cut, prepare, and assemble all of the pieces, which were either unavailable or too expensive for home usage, so an expert was called in to assist. Some pieces must be printed using a 3D printer. A carpenter was also employed to help with the preparation of the outside model, which was built of wood.

2.1.5 The Situation

As known, considering all the situations we are going through, what makes it harder is that both of us are from different cities, and communication was difficult and risky.

2.2 Earlier Coursework

2.2.1 Microcontroller and PIC

These classes taught the basics of Arduino, like simple talking between devices and how to control motors.

2.2.2 Wireless and Communications

Used the HC-05 module to make the Arduino talk to the mobile without any wires.

2.2.3 Critical Thinking and Research Skills

This class taught us how to do research and write a report.

3 Literature Review

In building this project, our main concern was finding a way to efficiently and accurately provide car cleaning services. To address this, we studied how things are done in our local area, especially in automated car washes, to understand the processes and find the best solutions. Here's why we took this approach:

3.1 The Regular Work in Traditional Car Wash

In a typical hand-operated car wash, the tasks are straightforward for a car washer but can be time-consuming due to the manual effort involved. This is evident in the hands-on handling of cleaning tools, the physical exertion required, and the patience needed to ensure a thorough and careful cleaning process.

Usually, a customer arrives at the car wash and requests a specific cleaning service. The employee then uses their hands and appropriate cleaning tools to manually clean the customer's car, taking the necessary time to ensure a meticulous and quality wash.

3.2 Automated Car Wash with Parking System

Automated car wash systems are a modern way to clean vehicles, making the process much easier and faster compared to traditional hand-operated methods. Instead of doing the cleaning manually, these systems use advanced machines and technology to do the job efficiently. Customers just drive their cars into a specific area, and the automated system takes care of the cleaning. This not only reduces the effort needed but also speeds up the entire cleaning process. Many people like automated car washes because they are quick and convenient, making them popular among busy individuals. Some facilities

even provide parking spaces, allowing customers to leave their freshly cleaned cars while they run other errands. This extra feature improves the overall customer experience and makes automated car wash systems even more appealing.

3.3 Similar Projects

The automated car wash had not been documented in prior research conducted by former students. However, it is noteworthy that the parking facility had been implemented in earlier projects, and thus was taken into careful consideration for this undertaking.

4 Methodology

This section contains detailed information about the techniques and methods used to develop the project, ranging from designing and assembling the stages of the car wash process to implementing CNC for the parking part.

4.1 Choosing the Idea

Initially, the choice for a graduation project was unclear, given the abundance of ideas on the Internet and those previously generated by colleagues in the Computer Engineering Department. Avoiding the repetition of existing projects, the focus was on crafting a distinctive project that hadn't been undertaken before. This process of ideation took a significant amount of time.

Afterward, it was decided to use an automated car wash to save time compared to manual labor, especially since everything is becoming more automated nowadays.

Following that, the idea was discussed with Dr.Suleiman Abu Kharmeh, the supervisor. Dr.Suleiman Abu Kharmeh not only supported the idea but also provided valuable suggestions to enhance the overall concept. Incorporating a parking feature was one of the suggestions, likening it to the way salt enhances the taste of a meal.

4.2 Mechanical Part

The mechanical component of the car wash part is the dc motor in charge of moving the car on the conveyor belt and The parking mechanical component responsible for parking and retrieving the car involves stepper motors that control movement along the 3 axes (X, Y, Z).

4.2.1 Mechanical Design

In the first step, we worked on designing the external model of the conveyor belt and installing the DC Motor to move the car and during the parking phase, we assemble

components of the model responsible for parking, such as Steel Rods, Bore Idlers, Gantry Plates, and more.

4.2.2 Assembling

During the assembly phase, we integrated various components, including the conveyor belt, sensors, pumps, and fans, to create the final design. In the car wash phase, everything was put together to form the complete model. Here is the final design of car wash part.

Similarly, in the parking phase, we assembled the model responsible for parking cars, created parking spots, and installed sensors. Here is the final design of the parking part.

4.2.3 Mechanical Parts

Item Name	Item Image	Quantity
Conveyor Belt		**1**
DC Motor		**1**
Power Supply		**2**
DC Motor		**2**

Table 1: Project Part

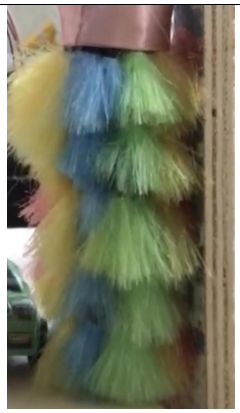
Item Name	Item Image	Quantity
Brushes		**2**
HBridge		**2**
Water Pump		**3**
Water Pump Hose		**-**

Table 2: Project Part

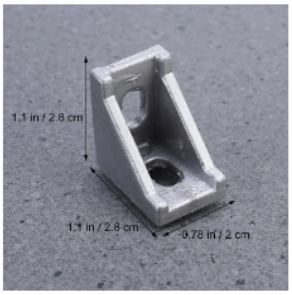
Item Name	Item Image	Quantity
Stepper Motor		**3**
Corner Brackets		**4**
Gantry Plate		**4**
kande openbuilds plastic wheel		**12**
Timming Belt		**3**
Nuts		**15**

Table 3: Project Part

Item Name	Item Image	Quantity
T-Slot Nut		**12**
Saiper Timing Belt		**3**
Teeth Bore Idler		**3**
Steel Rod		**3**
Socket Cap		**15**

Table 4: Project Part

4.3 Controller Part

The controller does two things: it tells the moving part what to do and gives it power. It's made using Arduino Mega and Uno.

4.4 Arduino

We used Arduino to make the electronic component run smoothly. It helps organize electrical signals and write the necessary code for the project. Here are the electronic parts needed for this part of the project:

4.4.1 Electronic Parts

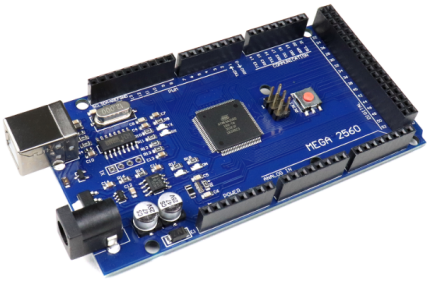
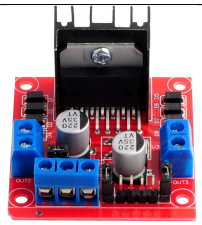
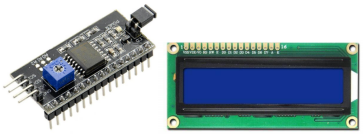
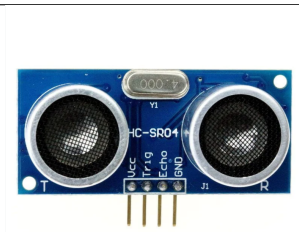
Item Name	Item Image	Quantity
Arduino mega 2560		**1**
HBridge		**2**
LCD_I2C		**1**
Ultrasonic Sensor		**5**
RFID Reader		**1**

Table 5: Project Part

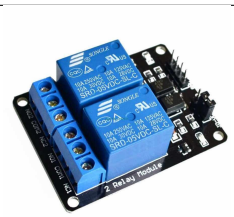
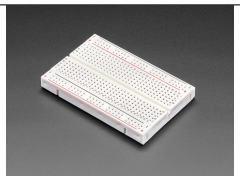
Item Name	Item Image	Quantity
Fans		**2**
Relays		**6**
Limit Switch		**1**
Wires		**-**
Bread Board		**2**
Arduino Uno		**1**

Table 6: Project Part

4.4.2 Driving Motors

To control the stepper motor, we used the A4988 driver. This driver is helpful because it allows for microstepping, making the motor move more smoothly and precisely, while also protecting the motor.

Connecting the motor with the two-entry coil to the driver involves using four pins on the driver labeled (1A, 1B, 2B, 2A). These correspond to the first coil (1A, 1B) and the second coil (2B, 2A). To identify the coils using the motor's wire leads, we paired each set of two wires and manually rotated the motor. If there was resistance while turning the motor, those two wires corresponded to the first coil, and so on.

Additionally, the A4988 driver has various pins including Step, Direction, 12v for power supply, 5v, GND, and other pins like reset, sleep, and enable. Below a visual representation of the wiring components.

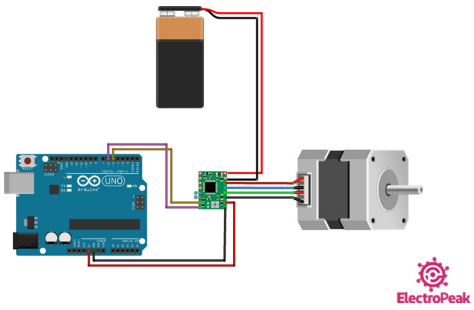


Figure 5: Servo Motor

4.4.3 Controlling the Servo Motor

We attached the servo motor after checking its data sheet. It has three wires coming out of it. The red one is for power (Vcc), the brown one is for ground (Gnd), and this wire supplies the needed power to run the motor, which is 5 volts. The orange wire is for pulse width modulation (PWM), and it's connected to one of the Arduino outputs to control the angles of the servo motor. You can see a picture of how we connected everything below and used it to open and close the gate .

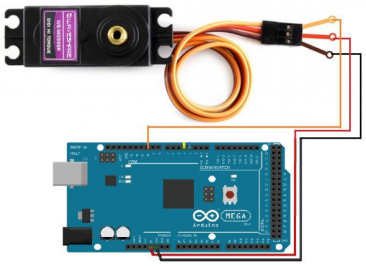


Figure 6: Servo Motor

4.4.4 Water Pump

We used water pumps to pump water from the water tank to the car wash. We looked at how to connect water pumps. The water pump has two wires, and the water pump in our project is 12 volt. First the negative wire was connected to the negative of the 12 volt power supply and connected. Then connect the positive wire of the water pump to the relay, and then connect a wire from the relay to the Arduino to convert the power source from 12 volts to 5 volts to connect it to the Arduino to control the water pumping.

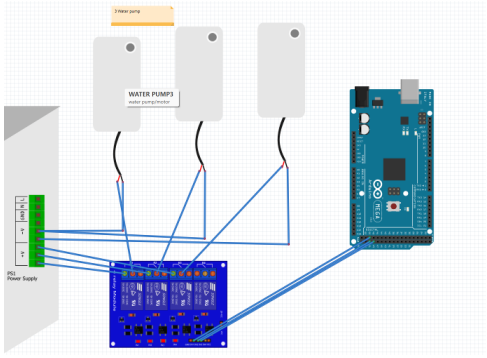


Figure 7: Water Pumps

4.4.5 Ultrasonic Sensors

The ultrasonic sensors, utilized in both the car wash and parking systems, were responsible for identifying when the car reached a particular stage during the car wash process. Moreover, in the parking system, these sensors were employed to ascertain the occupancy status of the parking spaces.

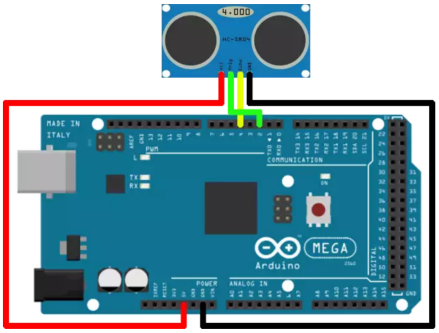


Figure 8: Ultrasonic Sensors

4.4.6 Fans

We used fans to dry the car in the last stage of the car wash. We looked at how the fans are connected. The fans have two wires, but the fans in our project are 12 volts.

First, the negative wire from the fans was connected to the negative in the 12 volt power source, then the wire was connected. Positive from the fans to the relay, then connect a wire from the relay to the Arduino to convert the power source from 12 volts to 5 volts to connect it to the Arduino to control the fans.

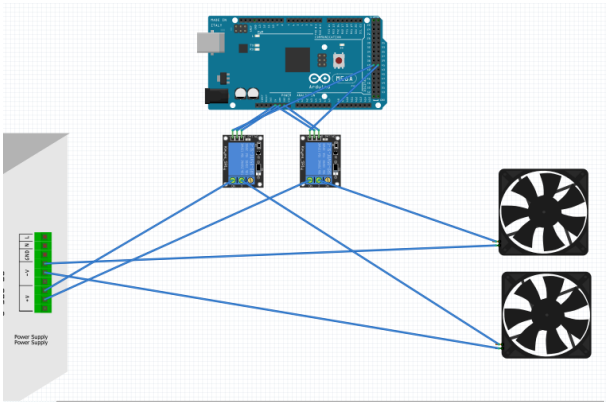


Figure 9: Fans

4.4.7 brushes

We used brushes to clean the car. We looked at how the brushes are connected. The brushes have two wires, and the brushes in our project are 12 volt. First the negative wire was connected to the HBridge. Then connect the positive wire of the brushes to the HBridge, and connect two positive and negative wires from the 12 volt power source to the HBridge, and then a wire was connected from the HBridge to the Arduino to convert the power source from 12 volts to 5 volts to connect it to the Arduino to control the brushes.

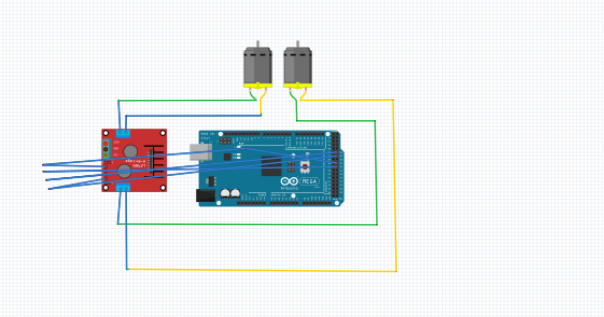


Figure 10: Brushes

4.4.8 DC motor

We used DC Motor to move the Convoyer Belt. We looked at how the DC Motor are connected. The DC Motor have two wires, and the DC Motor in our project are 12 volt. First the negative wire was connected to the HBridge. Then connect the positive wire of the DC Motor to the HBridge, and connect two positive and negative wires from the

12 volt power source to the HBridge, and then a wire was connected from the HBridge to the Arduino to convert the power source from 12 volts to 5 volts to connect it to the Arduino to control the speed of DC Motor .

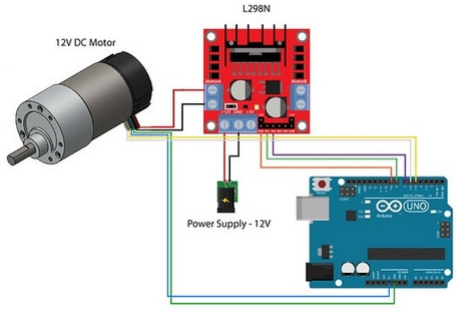


Figure 11: DC motor

4.4.9 Limit Switch

A limit switch typically consists of a movable lever or button that, when pressed or released due to a mechanical interaction with the system it monitors, causes a change in the switch's electrical state.

Limit switch was added for parking part , to help the model to back to origin spot, where the model always start from that spot.

The limit switch we used is simple were two pins one is COM connected to the ground and the second pin is NO (Normally Open) connected to Arduino pin. Below a visual representation of the wiring components.

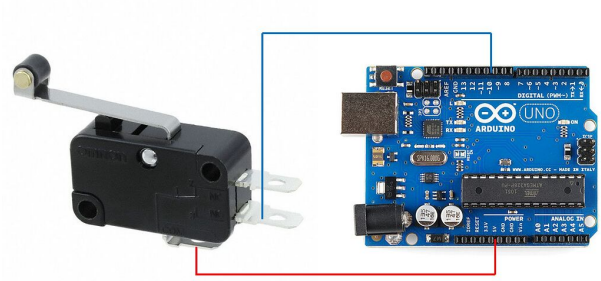


Figure 12: Limit Switch

4.4.10 HC_05 Bluetooth

The HC-05 Bluetooth is an additional feature we have added. The HC-05 Bluetooth module allows wireless communication between an Arduino and other devices, enabling remote control or data exchange by establishing a Bluetooth serial connection.The serial connection are established between the application we made and the arudino to control

part of the project. HC-05 Bluetooth has 4 pins , two pins for 5v and GND , the other two pins are TX,RX.TX of HC-05 module connect with RX arduino pin and RX of HC-05 module connect with TX arduino pin. Below a visual representation of the wiring components.

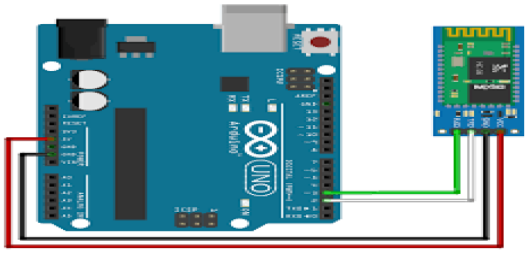


Figure 13: HC_05 Bluetooth

4.4.11 RFID Reader

An RFID reader for Arduino is a handy tool that helps people easily use RFID technology in their project , It works with Arduino microcontrollers, reading information from RFID tags using radio waves. With libraries available , the main in our project used it when read the tag send to servo motor to open the gate and after some delays the gate close .

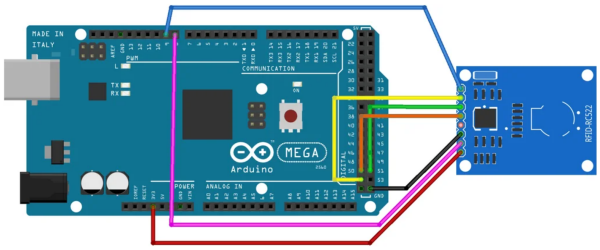


Figure 14: RFID

5 Result and Problem Discussion

5.1 Drivers

We faced various problems while working on the project, one of them being an issue with the drivers. If you touched the drivers with your finger while they were connected to electricity, they would quickly burn out. Figuring out and solving this problem took us a long time in the beginning.

5.2 Designing the Park Part

We also had trouble figuring out how to design the parking section so that it could smoothly take the washed car, park it, and return it easily. It took some time, but eventually, we came up with the right designs.

5.3 Replacing some broken parts

We faced situations where certain parts broke and needed replacement. We also had to change some drivers that got too hot and broke.

5.4 Ultrasonic Sensor

A problem occurred with the ultrasonic sensor due to its significant role in the project, particularly in the car washing segment. The sensor is employed to detect when the car reaches the necessary stage. However, over time, it starts providing inaccurate readings, adversely impacting the car washing process.

5.5 Final Result

The automated car wash with parking system works really well in various situations we tested. It goes beyond our expectations, doing a great job in cleaning and parking cars. It's dependable and efficient, making it a reliable and convenient solution. This success is thanks to careful planning and hard work during development.

6 Conclusion

6.1 Future Work And Improvements

For Futuer work and improvments there is a several things we have to talk about.

- Image Processing :

  Instead of using the sensors to detect the car movement and which stage it reached , using image processing will provide more accurate detection and provide more feature to implement.

- Water Recycle :

  Recycling the waste water to use it back again or benefit from it in another aspect such as crop irrigation.

- Pipeline Car Wash :

  instead of wash only one car in the time , and reserve the whole system for it , we can wash several cars simultaneously , where every car in different stage .

6.2 Outcome

We have built an efficient automated car wash with parking system project. It sped up the car cleaning process, saving time for both customers and the business. The automated parking system made finding a parking spot easy and hassle-free. Customers were delighted with the quick and efficient service, making the project a success in improving overall satisfaction.

7 Work Chart

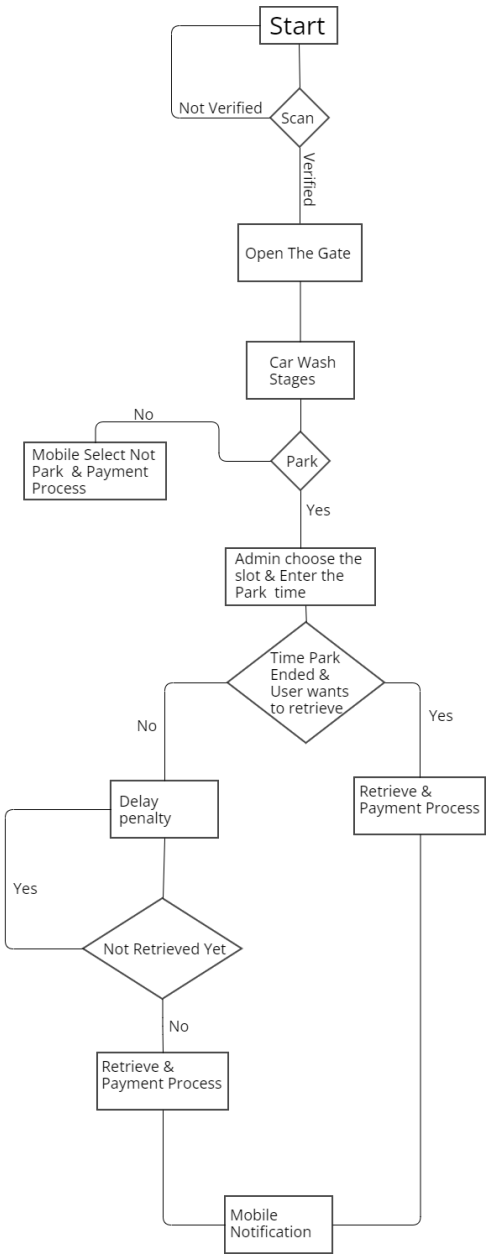


Figure 15: Work Chart

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- Ultrasonic Sensor:
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