AN-NAJAH NATIONAL UNIVERSITY

FACULTY OF ENGINEERING
AND INFORMATION TECHNOLOGY

COMPUTER ENGINEERING DEPARTMENT

Hardware Graduation Project:
Pharmabot System

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Dedication

We would like to thank everyone who supported us those who this work won't be done without from friends, family, and those people who made it their life's journey to write articles that help those who are thirsty for knowledge.

Acknowledgment

To all those who helped in making this project possible, to our beloved An-Najah National University and Teachers whom we learned a lot from so we can evolve and benefit our country and community.

To our supervisor, Dr.Luai Malhis who took from his time for us, was supportive, and always showed his trust in us along the way.

To our Families and Friends, who supported us through thick and thin, and never hesitated to give us help, we give a big "Thank You" straight from our hearts.

DISCLAIMER

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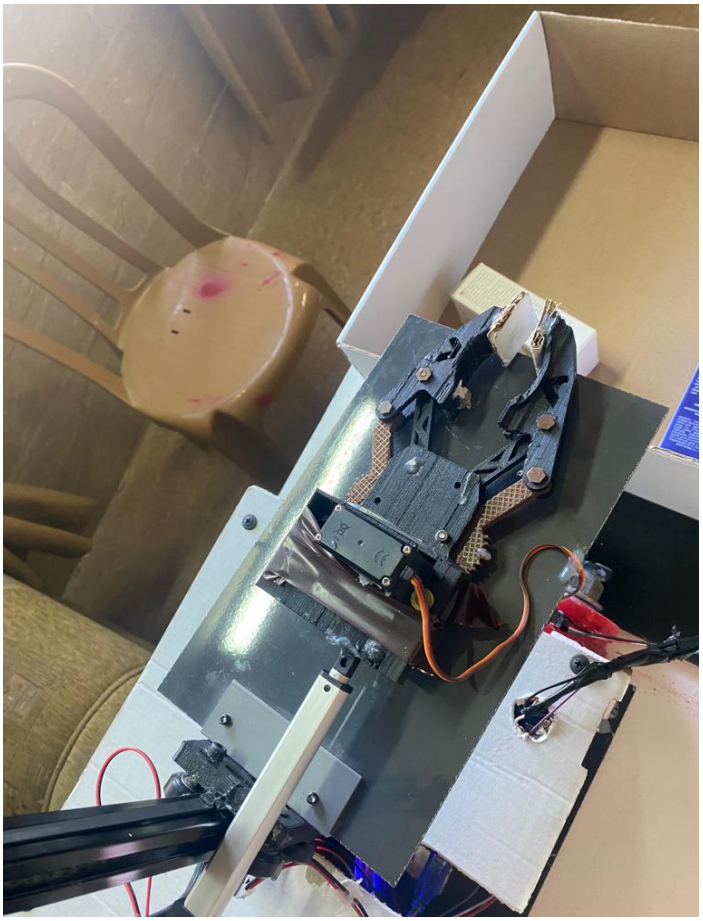
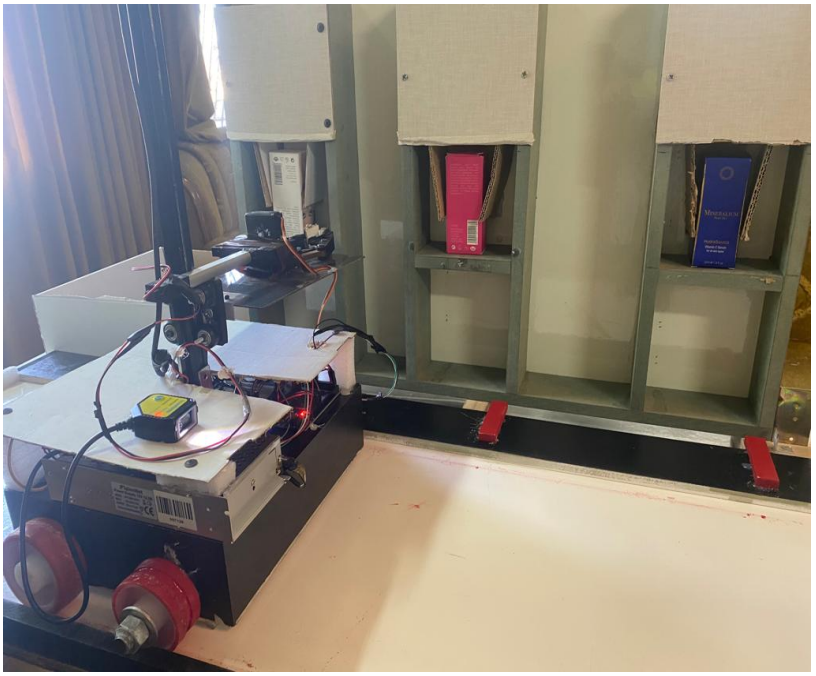




Images of the Shelves:

Abstract

Being able to use your mobile to command a robot that provides assistance in pharmacies and warehouses in general, to decrease the workload, save time, and do the tasks effectively, it was done by using our knowledge learnt in the courses we took related to the hardware department, doing researches about what tools and parts we need to reach our goal and seeking help and knowledge for our piers when needed, and at the end we came up with this project that did it's objected tasks and features like:

- The ability to bring the desired medicine from the shelf.
- The ability to take out medicines and also the ability to insert them into shelves automatically.
- A robotic arm that can hold the medication to be used.
- showing the amount of each medicine available in each shelf.

1. Introduction

1.1 Problem Statement

The "Pharmabot" system project aims to solve many problems for certain groups of society, the most prominent of which are:

1. Employees in general pharmacies, which makes it easier for them to work and sort medicines in their shelves quickly and accurately.
2. Huge pharmaceutical companies, which makes it easier for them to classify and arrange products in warehouses properly, correctly and without complication.

1.2 Significance

The main goal of the project is to build a robot that is able to do the input and output process in a proper and easy way. The project contributes by saving time and effort on producing companies in classifying medicines, in addition to that "Pharmabot" system can be used in more than one form, such as pharmacies and libraries, in general it is used for insertion and removal from shelves.

1.3 Objectives and Scope

The purpose of the project "Pharmabot" system is to deal with the complex input and output process, and therefore requires the availability of the following services:

1. The ability to do operations from the mobile.
2. The ability to select the service to be done, either insert or get a medicine from it's appropriate shelf.
3. The car to be able to go and stop by the appropriate shelf, while the holder is able to move vertically accurately.
4. Return the medicine to the user if the condition is an "get", or inserting the medicine in the shelf if the condition is an "insert" .
5. showing the amount of medicine available on the mobile application.

1.4 Report Organization

- **Second chapter:** In this chapter, we covered the important subjects we learned previously, as well as the external courses and the primary constraints and obstacles we encounter while working on the project.
- **Third chapter (Literature Review):** in this chapter, we cover the part of choosing the project idea, where we got inspiration from and what was our goal of making the project.
- **Fourth chapter (Methodology):** We talked about the mentality through which we built the application, in addition to the features that we offer and the technologies used.
- **Fifth chapter:** we talked about the results, as well as the lessons we learned from working on the project and what future developments that can evolve the project.

2. Constraints and Earlier Coursework

2.1 Constraints

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.

2.2 Earlier coursework

2.2.1 Microcontrollers and PIC

These classes covered the fundamentals of the Arduino, including as basic serial communication and controlling steppers and servo motors.

2.2.2 Networks and Communication and Wireless

We used the HC_05 module to connect the Arduino with the mobile wirelessly.

2.2.3 Critical Thinking and Research Skills

This course has provided me how to conduct research and write a report.

3. Literature Review

When building this project, our thinking was about how to solve the problem of time and accuracy in doing this service correctly, and for this we inspected the work in pharmacies and general stores in our towns to see the work near and know the best possible solution. This can be explained as follows:

3.1 The Regular work in Pharmacy

In the normal situation in drug stores and pharmacies, work in them is easy for a professional pharmacist, but difficult and complicated for a regular employee or a placeholder, and this is represented in the inventory of medicines, as well as knowledge of medicine placement and amount to achieve profit and work on time in a safe and sound manner.

In general, the work is for the customer to come to the pharmacy with a paper from a doctor requesting a specific drug from the pharmacy employee there. He brings the drug from the shelf in which the required drug is located.

3.2 Pharmabot System

But what if the pharmacy had a large size and a lot of customers? How do the employees fulfill the requirements correctly, accurately and quickly?

And in some situations, the pharmacist in not available so someone has to take his place as a placeholder and deal with the customers, but how will he know the places of medicines and the amount available of each one if he doesn't know ?

Here comes the role of our project by working to provide a device that knows the locations and number of medicines and brings the medicine to you after you request it by commanding it on the mobile app, and then the device takes care of all the operations of inserting, getting and counting the amount. saving time and effort.

3.3 Similar Projects

There are some of the projects I saw which had a similar idea of a CNC machine that moved on an X-Y plane while being attached to the shelves, but it seemed to be a good idea to go for at the beginning, but when thinking about evolving and adding more shelves, it seemed like a troublesome and tedious process of adding and increasing length of each axis, so we thought of replacing the X-axis with a moving car that moves on the ground while holding the Y-axis, which makes the idea of adding more shelves simple, just writing extra software codes to optimize it.

4. Methodology

This section contains detailed information about the techniques and methods we used to develop the project, from designing and assembling the mechanical structure to controlling the arm and positioning, the car that moves while holding all other parts as well as how they are linked together to produce the final product.

4.1 Choosing the idea

In the beginning, we did not know what we wanted to do as a graduation project, and there were many ideas on the Internet and many ideas that had been created in the past years by colleagues in the Department of Computer Engineering, and therefore we were rejecting the idea of repeating a project, so we wanted to do a project to be distinguished and was not made Before, that's why we took a lot of time to come up with the idea of the project.

When we were sitting in the university and discussing, the main idea we were looking for is making a project that we would be proud of, but also helps the community and leaves and mark, so we started thinking where our houses or local stores might have a hard time, and immediately thought of sorting products in local stores, then we went more specific to choose pharmacies, because not everyone understands pharmacy and knows all types of medicines, so we need to do something to solve that idea.

The closest idea we got to help is CNC supported design that sorts, inserts and gets medicines from their appropriate shelves.

After we agreed on the idea of the project, we consulted Dr. Luai Malhis about the initial idea and encouraged it and gave us some ideas to improve to general idea by swapping the X-axis with the moving car, which we found interesting and helpful, then the parts were purchasedand built, then we stopped for a while to think about how to get the medicine from the shelf, we saw that the arm is the most appropriate and only solution to do insertion and removal. We also designed the shelves ina way that ensures the success of the entry and exit process easily and properly.

4.2 Mechanical Part

The mechanical component of the project is in charge of moving the car on the ground, the arm along the Y-axis and in and out of the shelves, and this necessitates the presence of motors, belts, and so on to generate movement in collaboration with a controller to direct it. This requires the following steps to be taken:

4.2.1 Mechanical Design

In the first step, we worked on designing the external model of the car and installing the motors and rod, and we needed some 3D-printed bodies to help support the model.

4.2.2 Assembling

It is the part that demands the use of bolts and drill bits to put the components together, and it must be done correctly for the project to function properly.

After we put everything in its place, as shown in the above figure, we began to work on the motors to ensure proper movement and so that there would be no mechanical problems that could disrupt us in the future, such as balance and weight distribution evenly so as not to cause vibrations that would sabotage the project. We also made sure that the arm was working properly, as well as the linear actuator piece.

4.2.3 Parts

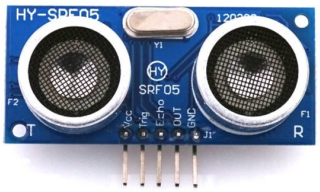
Item Name	Item Image	Quantity
timing belt 6mm width		3m length
ultra sonic sensor		2
Stepper Motor		4
mounting bracket		3
gt2 pulley 16 teeth 3mm		3

Table 4.1: Project Parts

Item Name	Item Image	Quantity
steel rod		length 1m
GT2_Timing_Belt_Idler_Pulley_ 16 teeth 3mm		3
cart wheels		4
claw arm		1
ball bearings		4

Table 4.2: Project Parts

Item Name	Item Image	Quantity
liner actuator 12v 100mm		1
Printing machine to hold stepper motor		1
power supply 12.5A		1

Table 4.3: Project Parts

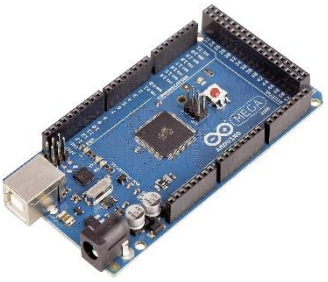
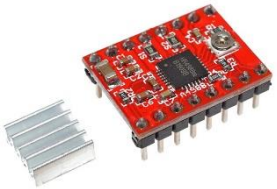
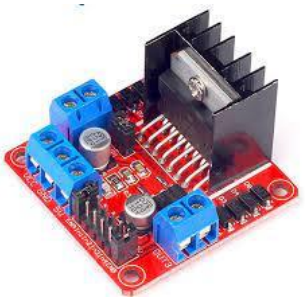
4.3 Controller Part

The controller part is in charge of directing the mechanical part and powering it, and it is made up of Arduino mega:

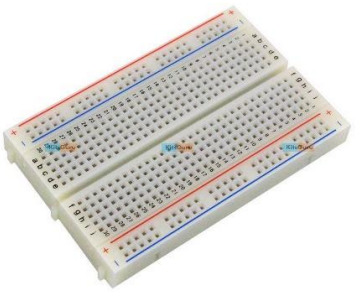
4.3.1 Arduino

We have used the Arduino to control the process of running the motors, to unify some electrical signals and differentiate them from other motors, and to write the code needed to build the project. These are the electronic parts that we needed to run the electronic part of the project:

4.3.1.1 Parts

Item Name	Item Image	Quantity
Arduino mega 2560		1
driver A4988		3
driver dc motor L298N		1
shield stepper driver 42ch		3
module cl4015 (12v-5v)		1

110

Barcode Scanner		1
HC-05 Bluetooth		1
servo motor mg996r		1
Bread board		1
Limit Switch		

Wires		

Table 4.4: Parts

4.3.1.2 Driving Motors

To control the motor, we must use a driver, and for that we used a 4988 driver. To make it easier for us to control with high accuracy, and to protect the motor.

we also used a special shield in that driver to facilitate the process of connecting with the motor and giving it sufficient voltage and to ensure high accuracy.

In order for us to connect the motor with the two-entry coil in the shield driver, where there are four entrances in the shield, especially to the coil, which are (1A,1B,2B,2A) which (1A,1B) mean the first coil, and (2B,2A) the second coil.

To determine the coil, through the wires coming out of the motor, we wrapped each two wires together, and then we twist the motor by hand. If we feel it is difficult to move the motor, these two wires represent a first coil and so on.

Also the shield has 2 input for power supply (12v), input for (step), input for (direction), input for enable, and input for (Vcc,Gnd)-(5v).

Below is a picture of the linking process:

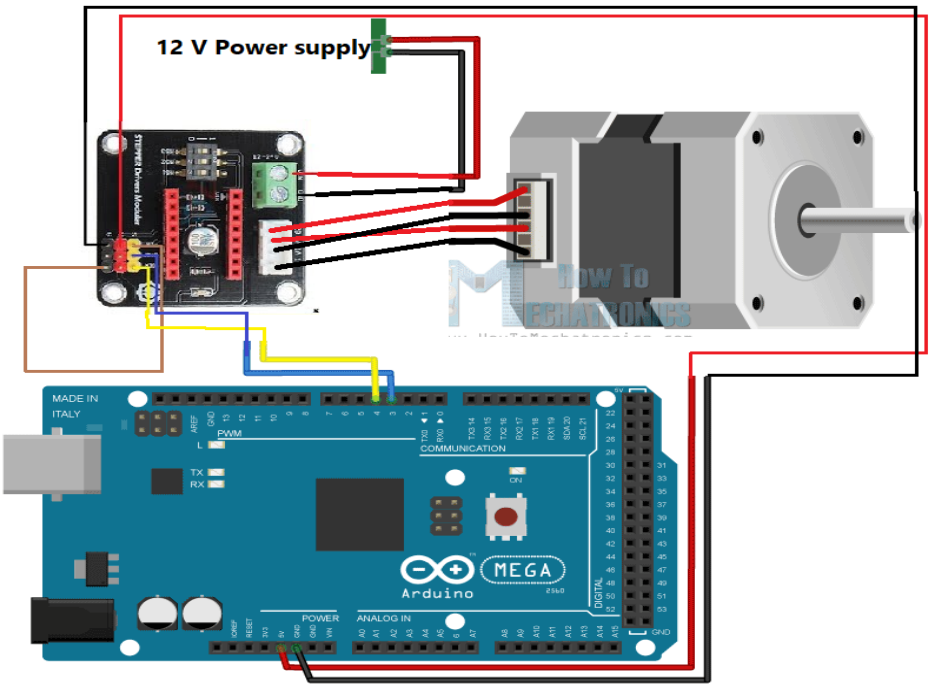


Figure 4.3: Driver Circuit

Moving Stepper motor:

After the connect wire process. through the code, I used the (Stepper.h) library, where this library enables me to create a special object for each motor.
Where this object takes the -Step per revolution that you have installed for all the motors (2500).

Then one of the motors was given a certain number of steps, which is 200 steps. Where the motor moved a quarter of a turn, and thus I was able to know the number of steps required to turn a full lap, which is 800.
In order to move rails, I must know the distance that the belt moves during one revolution.
I counted the number of teeth on the pulley, which is 16, and then I counted these teeth on the belt, and according to this process, the length of the belt for one roll is approximately 32 mm.
Then each 800 steps on motor gave me 32mm on belt.

4.3.1.3 Controlling The Servo motor

We connected the servo motor after looking at its data sheet.
where there are three wires outcome from it, the red represents (Vcc) and the brown represents (Gnd) this wire represent power supply needed to run that motor, which is (5v). And the orange represents (pwm) where it is connected to one of the Arduino outputs to give it the angles of the crisis.
Below is a picture of the linking process:

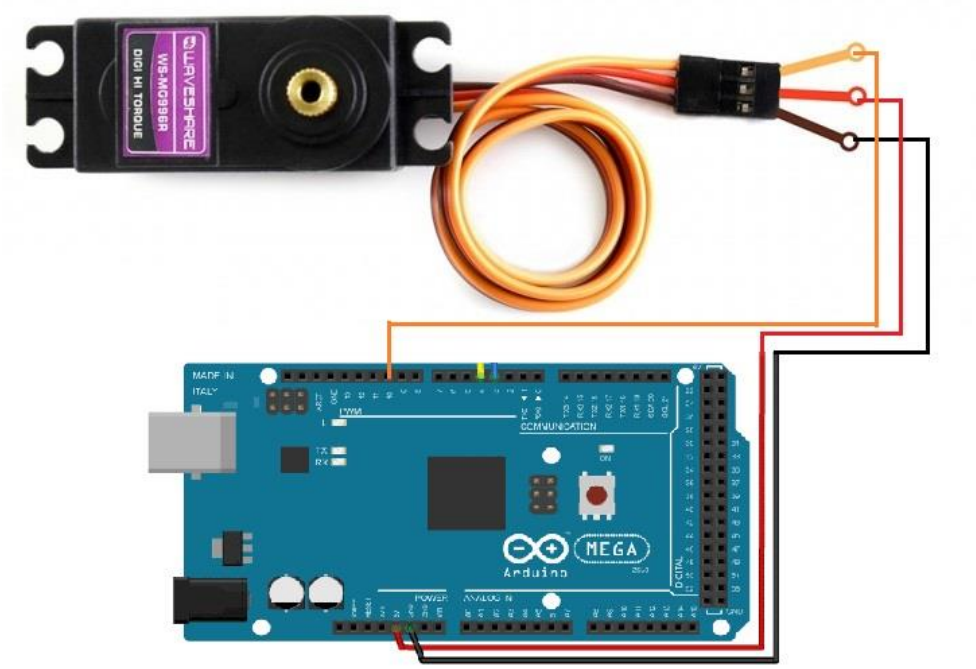


Figure 4.3: servo motor

Moving Servo motor:

We can access the Servo Motor. directly using (Servo.h) library
➔#include <Servo.h>
-we will use a some function the help us to read and write on Servo Motor :
Servo.attach(pin#): to detect which pin (10) is connected with Servo Motor
Servo.Write(angle): to give the angle value to the Servo Motor.

4.3.1.4 Additional features

HC_06 Bluetooth:

We used the Bluetooth as an additional feature to the project, to make input and output through the phone serially.

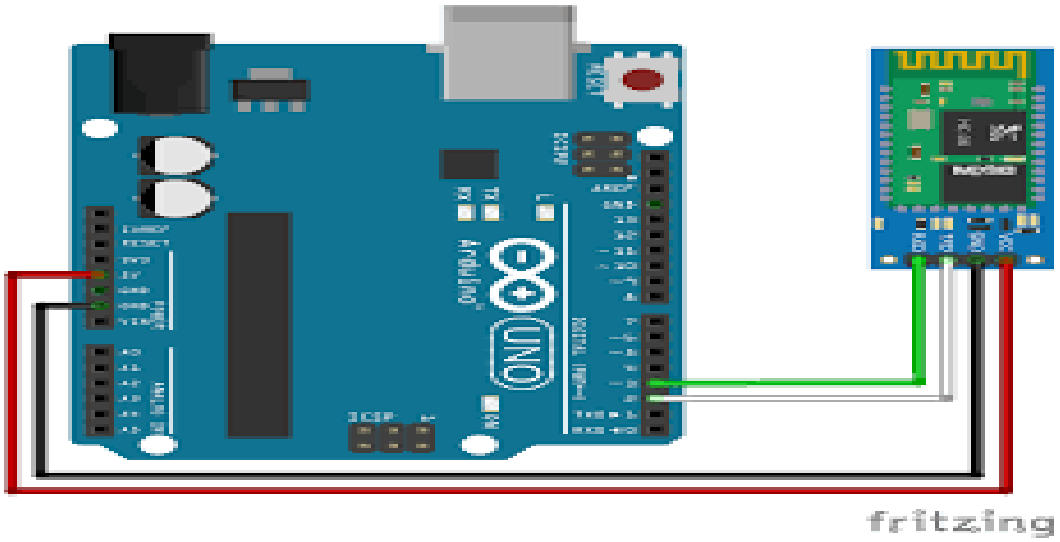
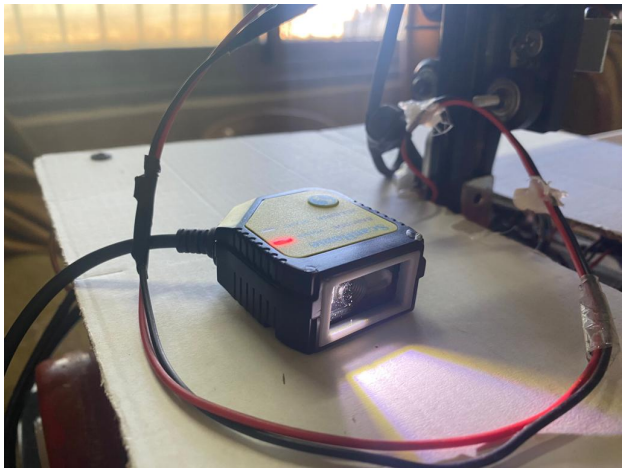


Figure 4.3: HC_06

Barcode Reader:

we added a Barcode scanner that was used in the inserting operation to scan the code of the product and to determine the appropriate shelf for that product.



Limit Switch:

we added limit switch to help in the process of recognizing and stopping at the right shelf.

4.3.1.5 Liner Actuator

We connected the Linear Actuator after looking at its data sheet.
In order to control the Linear Actuator, we must use a driver to give it a signal to exit and a signal to return.
Where two wires come out of the linear that are connect to the driver by (out1, out2).
And connect (in1, in2) to two Arduino output to give signal of linear by it.
Below is a picture of the linking process:

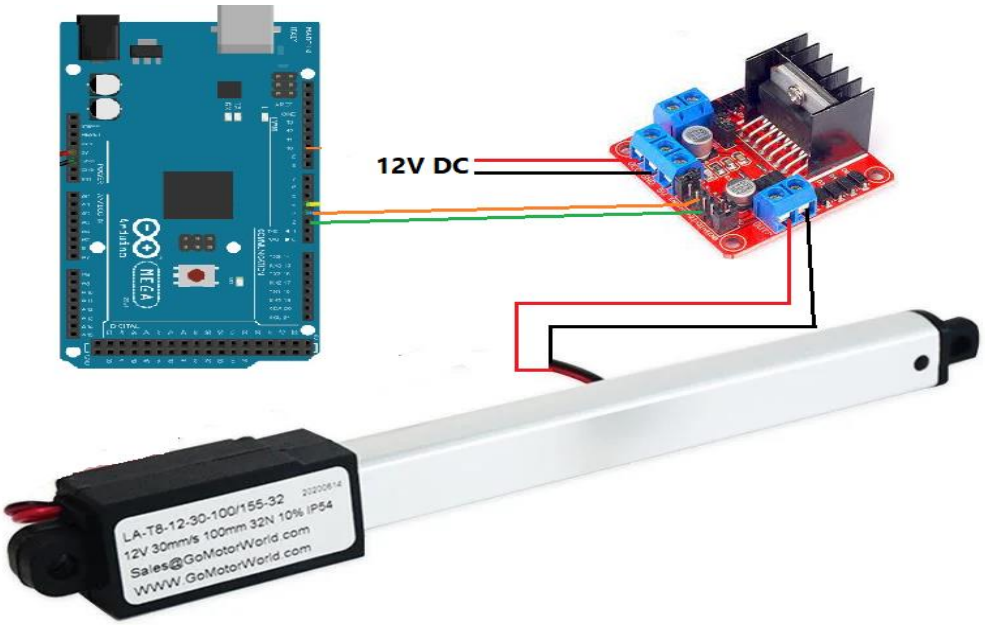
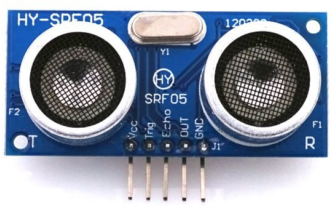


Figure 4.3: linear actuator

4.3.1.6 Ultrasonic Sensors:

The ultrasonic sensors are a type of sensors used to measure distance, so we used them in our project to sense if there's any obstacles on the way and to give a signal if there's any.



5. Results And Problems Discussion

5.1 Drivers

There are many problems that we encountered in building the project, including the problem of drivers, and the problem was that if you touch the drivers with your finger and they are connected to electricity, the drivers are immediately burned, and this problem we faced a lot in the beginning and took us a long time to discover it.

5.2 Designing the Shelves

There was also a problem in how to design the shelves in a way that fit the arm smoothly in and out smoothly, and it took a while until we designed them appropriately

5.3 Broken parts

We encountered some situations where some parts broke and had to replace them, like the Linear actuator which broke and was so hard to find a replacement, and we had to swap some drivers that overheated and broke.

5.4 Car wheels accuracy

we had a big problem in installing the car's wheels and optimizing them, then we face a bigger problem where some wheels were drifitng and cause the car to go in wrong paths, which is very hard to fix, so we decided to look for a different way to fix the problem.

5.5 Final Results

The end result is a fantastic project that works well in the majority of the scenarios we tested and meets all of our objectives.

6. Conclusion

6.1 Summery

We created a mechanical device with excellent capabilities that made difficult work simple. The project may require some improvements that we were unable to complete due to a lack of time, resources, or even knowledge in the hardware department, but the most important part is that we completed a working project with a lot of room for improvement, and we hope to do so in the future. Being a step in the right direction, and our long-term vision for this project is that it's the first in a series of projects to add to and improve upon.

6.2 Improvements

There is a need for some improvements by adding a basket under the arm to be able to hold multiple medicines at once instead of having multiple trips to get them, also there's a room of improvement by adding image processing to recognize to medicine type and their shelves which might be more helpful and effective, and most importantly, look to improve the size and speed of the project.

6.3 Future Work

As for future work, and if this project is implemented on a real and large level, you will need electronic parts that are stronger than the existing ones, we also need the algorithm to go on a complete trip by the device, and in one trip there are more than one input process and more than one output process.

The trip must take place properly and in the shortest way and as quickly as possible (and this shows its importance if the project is applied at the level of large warehouses or large libraries).

6.4 Outcome

We have built an effective device that is convenient to use and can be applied in more than one place, you can use it in pharmacies, producing companies, libraries, supermarkets, and it is also easy to use for anyone and saves time, effort and accuracy.

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