Gesture - Controlled Door Opener

- A project by Team Cyborg
(Team 5)

Acknowledgement

I, Shaikh Amaanur Rahman, would like to thank my DIY professors, especially Dr.Abhay Gour, for helping us out and guiding us through our project. It was a great opportunity given to us to work on a project that we had conceived and executed from scratch. All necessary information was given to us, for which I am utmost thankful to my DIY Lab Course professors.

It was an amazing experience working on this project with my team-mates. I am sure all of my team-mates: Dheeraj Chandak, Mrinmay Pal, Nirvik Paul, and G. S. Harshitha, all feel the same. Co-ordinating the tasks among each other and working together to solve problems was an enlightening experience, which I am sure will help us in our careers in the future.

Introduction

Our project, as the title suggests, was a Gesture Controlled Door Opener. It would function as a contactless way to open doors: Hinged Doors, Shutter Doors, and also Rolling Doors. This project was heavily inspired by the current needs of the world, afflicted by the deadly COVID-19 Virus. We realized that although we had implemented masks and sanitizers to prevent the spread of the virus, or in fact, any other contagious diseases, the doors in most hospitals still needed to be pushed or pulled, forcing us to make contact with the door. To prevent this, we decided to build a device aimed at reducing the need to make contact with the door to open them. Although Automatic doors do exist, it would be cumbersome to replace all existing doors with an automatic door. So this device would function to open the doors without changing the parameters of the door.

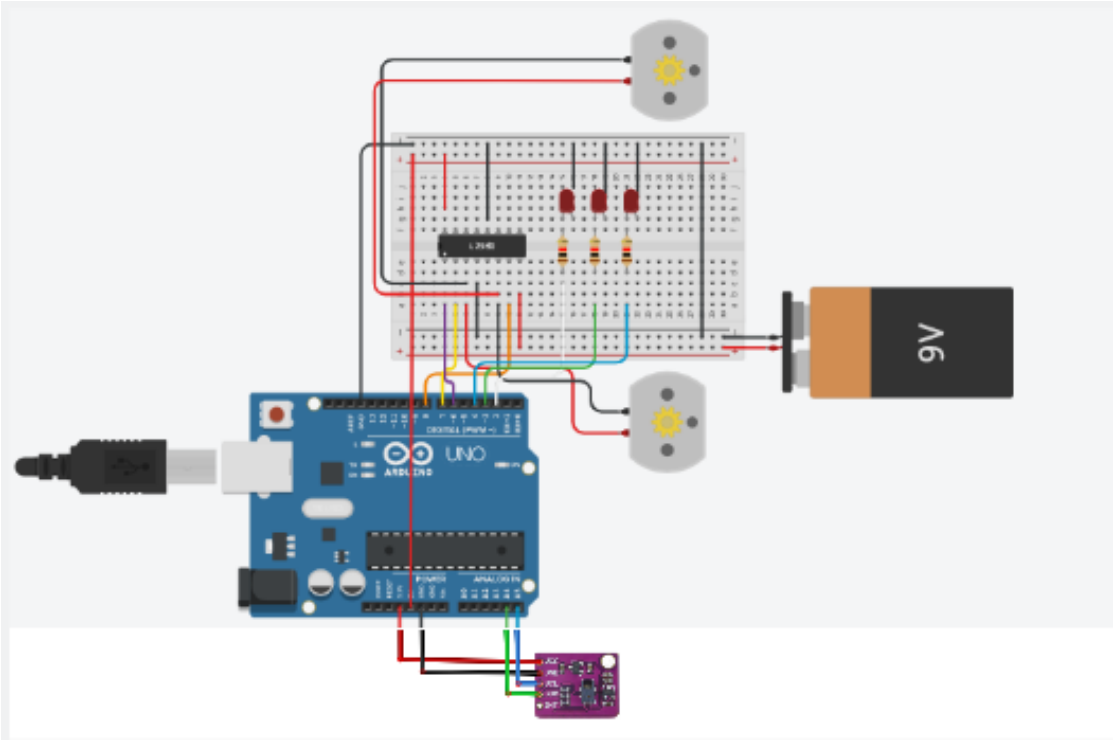
To make the conceived idea possible, we used a gesture sensing device, and two motors. The model made by us is just a prototype, and may not be directly applicable for the heavy doors. While working on this idea, we decided to also implement a lock feature, which could help secure rooms where restricted people were allowed.

Detailed List of Parts Used

We used the following parts to design our working model:

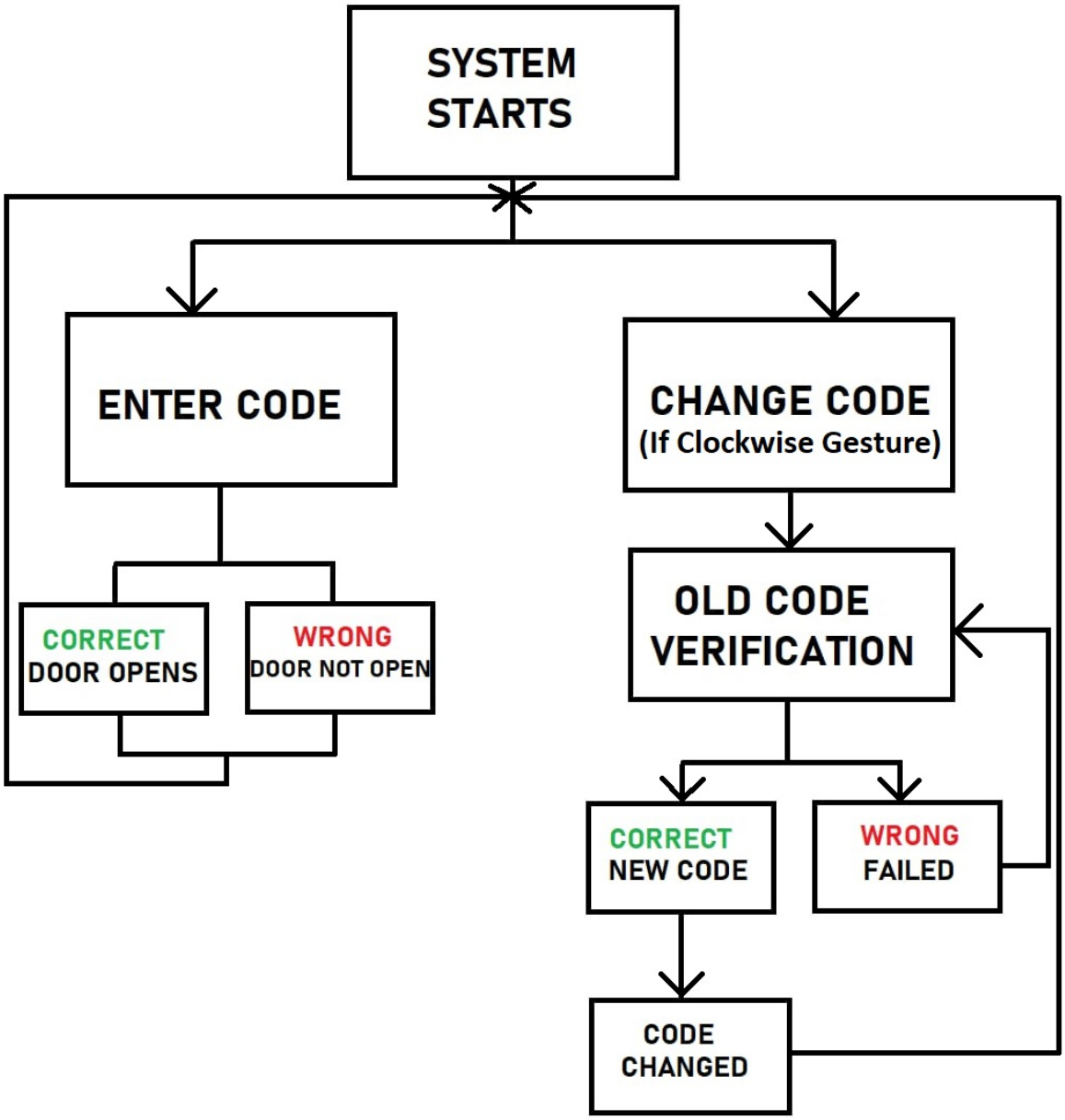
- Arduino Uno Microcontroller Board
- 2 x 12 V Geared DC Motor (200 RPM)
- PAJ7620 Gesture Sensor
- 400 Points Half size Solderless Breadboard
- 170 Points Mini Breadboard
- Jumper wires
- 5V Chargeable Li Battery
- 3 x 3.7V Li-ion Battery
- Li-ion Battery holder

Schematic Diagram Of Circuit



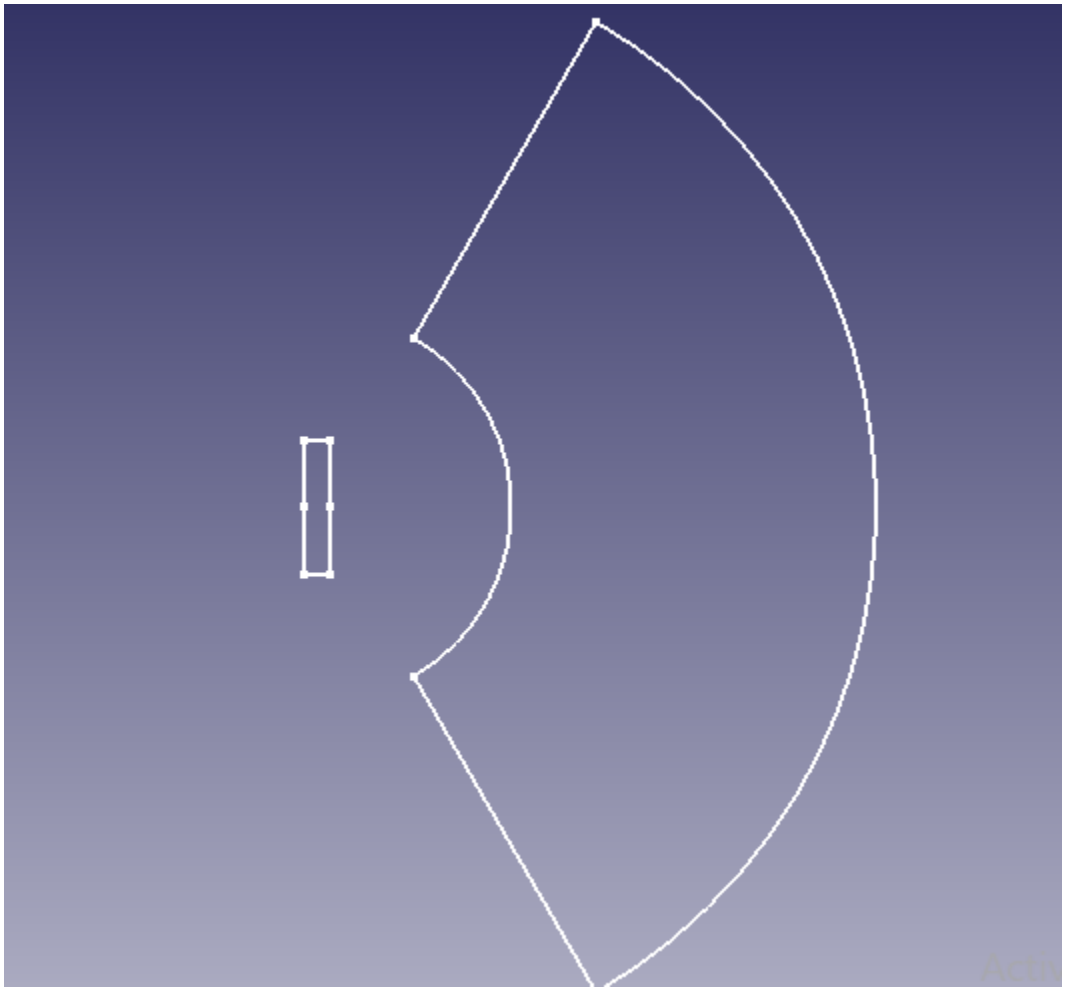
Note: In this figure we have used a 9V battery for the motors, due to lack of a battery holder and li-ion battery design.

Flow of Control In The Device



Mechanism Behind Gesture Sensor

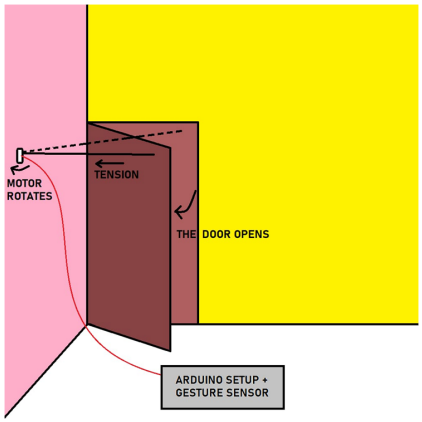
The PAJ7620 Gesture Sensor is an integrated Gesture Recognition System which integrates gesture recognition function and acts as an image analytic sensor system. It can recognize 9 human hand gestures such as moving up, down, left, right, forward, backward, clockwise, counter-clockwise and waving. It also has built-in proximity detection. It can sense approaching and departing objects. It uses an array of Infrared sensors, which can detect nearby movement, within a 5-15 cm, 60° wide angle.



Overall Mechanism of The Device

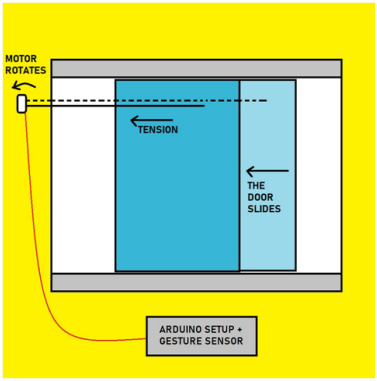
The Overall Mechanism of the device can be explained under the headings of the three types of door that it will open:

- **Hinged Door** :



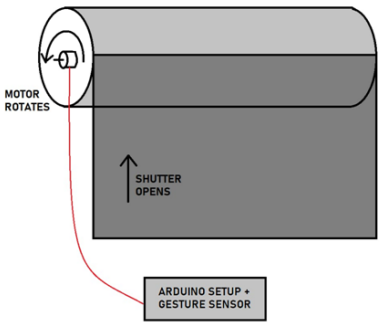
In the above illustration, the DC Motor will rotate, with the wire attaching the door to the axle of the DC Motor, winding it around the axle. That way it pulls the wire and in turn the door towards itself, opening it.

- **Sliding Doors :**



In the above diagram, once again, the DC Motor rotates its axle, thereby coiling the wire around the axle and the tension in the wire pulls the door open.

- **Shutter Door:**



In the above illustration, the shutter door is opened or closed with the help of the DC Motor in a little different way. There will be a rod connecting two ends of the cylinder(diametrically) on which the shutter door coils. This rod passes through the hole in the axle of the motor, so that when the motor rolls, the cylinder also rolls, and the shutter opens up.

Roles of the Team Members

- Dheeraj Chandak: Code Writing.
- G. Harshitha: Code Writing, Preparing the PPT, Video Editing.
- Mrinmay Pal: Illustration and Animation Design.
- Nirvik Paul: Assembly of the Components, Mechanical Set Up and Demonstration.
- Shaikh Amaanur Rahman: Design, Management, Report Writing.

Calculations

- Time Required by motor to open the door

To calculate time required, we needed to consider angular acceleration produced by motor in door.

On conducting few experiments, we concluded that the motor can lift 2 kgs of weight vertically up.

$\therefore$ Max Force $= 2 \times 9.81$
$= 19.62$ N

Also, we estimated the frictional moment at the door hinge, which was equivalent to applying 1 to 1.5 N force at the extreme end of the door.

Also, this meant our motor was easily powerful enough to open the door.

To calculate angular acceleration, we needed mass of the door.

After considering average density of the wood of the door, we got:

$$m = 3162.5\ g$$
$$= 3.1625\ kg. \quad (\rho = 0.55\ g/cm^3, V = 5750\ cm^3)$$

$\therefore \quad \tau = I\alpha$

$$\Rightarrow (19.62 - 1.25) \times 0.05 = \frac{ml^2}{3}\alpha.$$

$$\Rightarrow 18.37 \times 0.05 = \frac{3.1625 \times (0.05)^2}{3} \times \alpha.$$

$$\Rightarrow \alpha = 203.953\ rad/s^2.$$

$\theta = \frac{1}{2}\alpha t^2$ (∵ Initial angular speed is 0)

For 90° opening, we can say $\theta = \frac{\pi}{2}$ rad.

$t = 0.1241$ s.

Similarly, we estimated for a bigger household door, we got : $t \approx 0.5$s.

- <u>Longevity of battery</u>

At max power, $P = \tau \omega$

$\tau = 19.62 \times 6 \times 10^{-3}$ (6mm is radius of ~~wound~~ winding arc of motor)

$= 0.11772$.

$\omega = 200 \times 2\pi$ (200 rpm motor).

$= 1256.637$

$P = 147.93$ W.

Total Energy Available by batteries

$= 79920$ J.

$\therefore t = 540$s

$= 9$ <u>mins</u>

Cost

Item/Service	Cost
Arduino Uno R3	650
Mini Breadboard	30
Medium Breadboard	60
Gesture Sensor	700
Li - Ion Batteries	65x3=165
Motor	185x2=370
L293D IC	60
Battery Holder	80
9V Battery	25

Total = 2140

Challenges Faced

While doing the project, we encountered many challenges, which we were able to overcome as a team:

- While doing the hardware work, one of the Arduino Uno Boards got permanently damaged accidentally. We had to replace the board.
- We lost a set of Li-Ion Batteries, and their holder as they accidentally short circuited.
- Making the animation for the working of a shutter door was a totally new experience. The Team Member concerned, Mrinmay Pal, had to not only dig for such a type of animation software but also had to learn it. So there was a learning challenge there. Also, to make the animation realistic, he had to configure the ‘physics settings’ and ‘material settings’ for the shutter door.
- While trying to come up with a code, we tried three different ways to implement the passcode feature. But only one of them worked. There was a bit of a challenge there as we were previously not very fluent with programming languages.
- While setting up the apparatus, it became a challenge to us as to where we could place the DC Motor, for opening the door. Soon we had to come up with a slight adjustment to overcome that challenge.(The door would not open to a 90 degree angle).

Conclusion

While doing this project we learnt a whole bunch of things. We learnt about the Arduino Uno microcontroller. We learnt a bit of how the code we write in the microcontroller affects the functioning of the microcontroller. We also learnt how to use the Gesture Sensor, and how it fundamentally works.We learnt how to connect the DC Motors separately with the help of the L293D Motor Driver IC.

As a whole, it was an enriching experience. Apart from the technical things we learnt, we were also able to learn a lot of things about teamwork and ethics. Being able to develop something creative with the help of basic components, making a plan of execution, and then overcoming the challenges which were faced, makes us proud of ourselves.

We would like to sincerely thank our professors once more for their help and support, and for pushing us towards thinking new ideas.

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