Project Report

High Resistance Firefighting Robot
(Prototype)

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High Resistance Firefighting Robot

Gujarat Technological University, Ahmedabad.

Submitted in partial fulfillment of the requirement for the degree of

Diploma in Computer Engineering

Year 2020-2021

Team Members:

Shreyans Mehta, Kalp Shah, Divy Solanki, Lucky Pathan

Guided By:

Internal Guide	HOD
Ms. Chandni Shah	Prof. Poonam Faldu

Submitted To:

Parul Polytechnic Institute

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C E R T I F I C A T E

This is to certify that Shreyans Mehta, Kalp Shah, Divy Solanki, Lucky Pathan of Diploma (5th Semester) in Computer Engineering, Enrollment No: 186390307528, 186390307129, 186390307145,186390307114 Respectively, have satisfactorily presented their project entitled “High Resistance Firefighting Robot” for the term ending in 2021

Signature Of Guide	Department In Charge
Ms. Chandni Shah	Prof. Poonam Faldu
(Professor):	(HOD Comp. Dept.):

Seal of Institute:

ACKNOWLEDGEMENT

We take this opportunity to express our profound sense of gratitude and respect to all those who helped us throughout the duration of this project**.** Firstly, we are extremely grateful to Parul Polytechnic Institute, for providing us the excellent working environment to our project.
We devote our success in this effort to our **project guide Mrs. Chandni shah** for giving us the opportunity to undertake the project and providing crucial feedbacks that influenced us and provided opportunity to undertake the project work in the esteemed concern.
We are also deeply thankful to **Mrs. Poonam Faldu Head Of Computer Engineering Department**, whose useful suggestions, gentle soothing attitude and right directions helped us a lot to learn in this project.

Abstract:

Firefighting is a very important job but it is also a very dangerous occupation. Firefighting Robots are designed to find a fire and extinguish it. They can assist firefighters in building path for / and rescuing victims. Our Robot built for compact spaces where humans can’t go, and for clearing fire covered paths for rescue operations. Our robot development consists of 4 phases which are based on Waterfall model. The robot has several DC motors, for driving systems and other ones for fire blowing subsystems. Various sensors would also be interfaced with Raspberry PI Model 4B as a feedback to the robot such as camera sensor, flame sensor, Ultrasonic. For the programming part, we’ll be using Python language and C language to control the robot’s direction. The Robot would be able to work semi-autonomously

Contents of The Project

Image Index

Introduction:

- Our Firefighting Robot is a cheaper Alternative for Firefighting.
- In our project, we are developing a robot that is able to locate and extinguish fire in a compact environment. Which can Stream Video Output

Purpose:

- The Robot’s purpose is to reduce the risk of lives of Firefighters and the Victims of the Fire Accidents in a smaller Facility
- To develop a less expensive robot

Scope:

- To make a commercial robot which is least expensive.
- To lessen the risk of firefighters' lives.

Chapter 1

1. Existing Systems Available in India:

- Even though the market for Fire-Fighting is very small, there are some robots that exist. There are Commercial Bots available from Rs. 1Lacs.
- But Only 2 Existing Robots can be found in the Ahmedabad Municipal Corporation (AMC) Fire Department bought for around Rs 3 Cr and the other one at Mumbai Brihanmumbai Municipal Corporation (BMC) Fire Department at Rs 92L as a pilot project.
- The Existing systems are built for extreme conditions. So, can’t be bought and used locally.
- The Existing Systems are far too big, and costly.

Chapter 2

2. System Requirements:

2.1. Software Requirements:

2.1.1. Raspberry Pi OS:

What is the raspberry pi?
The Raspberry Pi is a cost friendly, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is going to be used here for Programming the Robot inside Python.

Raspberry Pi OS comes preloaded with Python (Thonny), the official programming language of the Raspberry Pi and IDLE 3, a Python Integrated Development Environment.
Raspberry is a reference to a fruit naming tradition in the old days of microcomputers.

2.1.2. C Language:

The C/C++ language is one of the most widely used programming languages in robotics. The Arduino microcontroller uses a programming language based on C and is a great way to learn the basics of this important language whilst doing hands-on robotics. It'll be used here in Arduino part of the Bot, which will read sensor Data and send it to the Pi via a serial connection.

2.1.3. Python Language:

Python is an interpreted, interactive, object-oriented programming language. It is also usable as an extension language for applications that need a programmable interface.
Instead of an operating system an interpreter can be used for a programming language like Python as well. The Python interpreter can be used from an interactive shell. Python offers a comfortable command line interface with the Python shell, which is also known as the "Python interactive shell".
Here we'll be mainly using RPi.GPIO, Flask and Pygame Modules for Programming the Robot and its Sensors.

2.1.4. RPi.GPIO

This package provides a class to control the GPIO on a Raspberry Pi.

Note: This module is unsuitable for real-time or timing critical applications. This is because you cannot predict when Python will be busy garbage collecting. It also runs under the Linux kernel which is not suitable for real time applications - it is multitasking O/S and another process may be given priority over the CPU, causing jitter in your program.

2.1.5. PyGame

Pygame is a cross-platform set of Python modules designed for writing 2d video games. It includes computer graphics and sound libraries designed to be used with the Python programming language.
It'll be used for creating a program which adds controller's events to GPIO pins (like servo motor control, motor control, etc.).

2.1.6. Flask Server

Flask is a micro web framework written in Python. It is classified as a microframework because it does not require particular tools or libraries.
It has no database abstraction layer, form validation, or any other components where pre-existing third-party libraries provide common functions. However, Flask supports extensions that can add application features as if they were implemented in Flask itself. We'll be using Flask Server for developing a web page to show the live-feed of the Pi's Camera.

2.1.7. HTML

The HyperText Markup Language, or HTML is the standard markup language for documents designed to be displayed in a web browser. It can be assisted by technologies such as Cascading Style Sheets (CSS) and scripting languages such as JavaScript.

2.1.8. CSS

Cascading Style Sheets (CSS) is a style sheet language used for describing the presentation of a document written in a markup language such as HTML. CSS is a cornerstone technology of the World Wide Web, alongside HTML and JavaScript.

2.2. Hardware Requirements:

2.2.1. Raspberry Pi Model 4 B (2 GB Variant):

This Raspberry Pi 4 is integrated with a 64-bit quad core cortex- A72 ARM v8, Broadcom BCM2711 and runs at a speed of 1.5GHz, and it's equipped with Bluetooth 5.0, BLE, gigabit ethernet and has 802.11ac

wireless at 2.4GHz and 5GHz, and 8GB RAM. The Raspberry Pi 4 has 2 micro-HDMI ports (supports 4k@60p), 2 lane MIPI DSI display port, 2 lane MIPI CSI camera port and 4-pole stereo audio and composite video port

Fig. 2.1: Raspberry Pi Model 4 B

2.2.2. Arduino UNO

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or

power it with an AC-to-DC adapter or battery to get started.

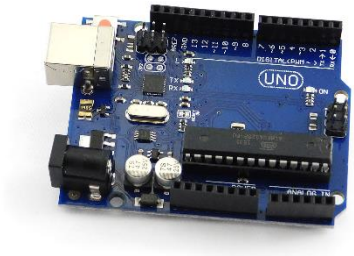


Fig. 2.2 : Arduino UNO

2.2.3. 2 x l298 Motor Driver Modules:

Motor Driver Modules would be used to control the 9v Motors of the Robot as well as the water pump would be controlled by l298 Motor Driver.

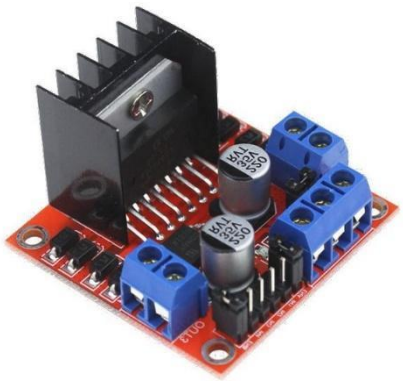


Fig. 2.3 : l298 Motor Driver

2.2.4. X-Box 360 Remote Controller:

Would be Used for controlling the Robot's Direction and Providing input to the 12v Pump, Servos and DC Motors.

Fig. 2.4 : Remote Controller

2.2.5. 5mp Pi-Camera Sensor:

Would be used as the Camera of the Pi. Used with flask for creating a Web-Stream.

Fig. 2.5: PI-Camera Sensor

2.2.6. Flame Sensor Module

One channel flame sensor would be used for detecting fire during auto-mode.

Fig. 2.6: Flame Sensor

2.2.7. 16 GB Memory Card

16 GB Memory Card is used for uploading programming and OS for the whole system. It stores Raspberry Pi OS, previously called Raspbian and whole python codes for the robot to work at its full potential.

Fig. 2.7: Memory Card

2.2.8. 12 V Water Pump

Used for spraying the Water.

Fig. 2.8: Water Pump

2.2.9. Power Bank

Would be used to Power 5v 3Amps. Supply to the Pi via a C-Type Cable.

Fig. 2.9: Power Bank

2.2.10. 12 V Battery

Would be main source of Power for Pump and DC Motors.

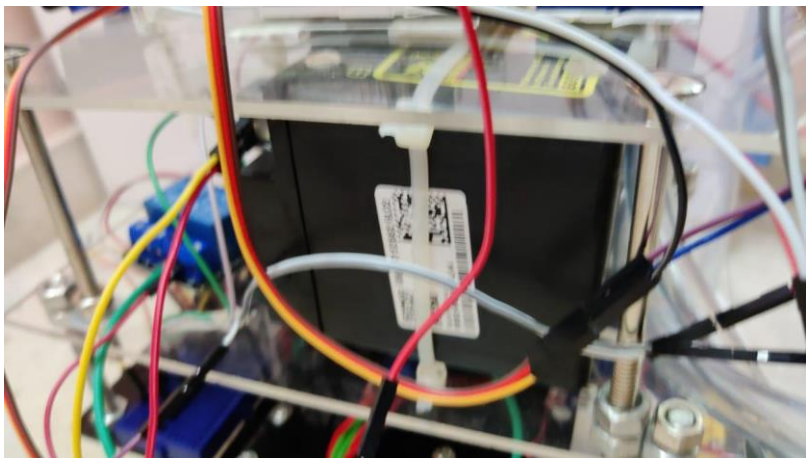


Fig. 2.10: Battery

2.2.11. 6x 9V DC Motors and Wheels

Used as the Wheels for the Robot

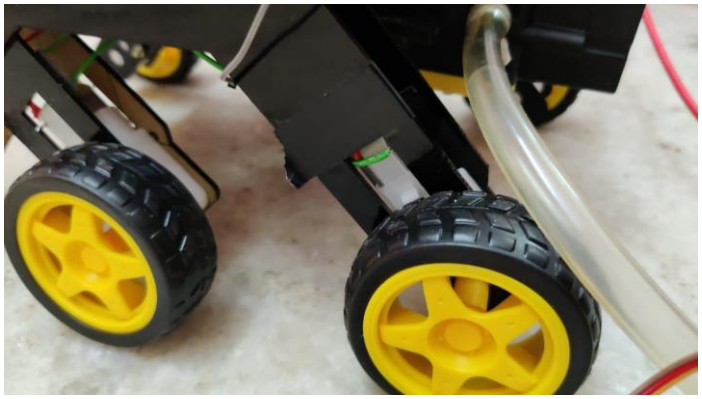


Fig. 2.11 : DC Motors

2.2.12. 12 V to 9V Step Down Converter Circuit

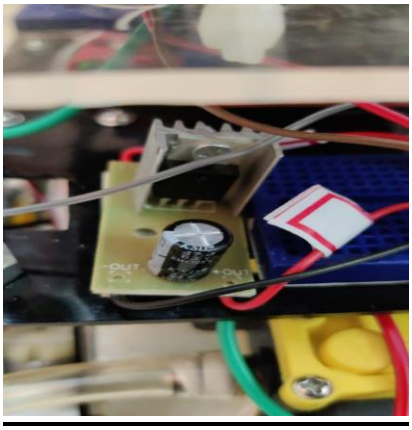


Fig. 2.12 : Step Down Converter Circuit

Chapter 3

3. Structure:

We are going to make a robot so we are using raspberry pi.
There are 3 main sensors which we are going to use like, flame sensor, pi camera and Ultrasonic Distance Measuring Sensor, mounted on a 6 wheels chassis.

It'll look like miniature Water Canon which sprays water with a nozzle and we are going to operate it by a remote control.

Users are going to see live feeds of the robot's camera via a browser.

Chapter 4

4. Design Specification Diagram:

4.1. Flowchart:

- **Start/End Symbol:**

  The terminator symbol marks the starting or ending point of the system. It usually contains the word "Start" or "End".

Fig. 4.1 : Start/End Symbol

- **Action or Process Symbol:**

  A box can represent a single step ("add two cups of flour"), or an entire sub-process ("make bread") within a larger process.

Fig. 4.2 : Action Symbole

- Decision Symbol:

  A decision or branching point. Lines representing different decisions emerge from different points of the diamond.

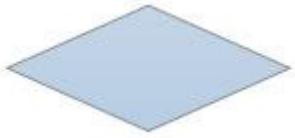


Fig. 4.3 : Decision Symbol

- Input/Output Symbol:

  Represents material or information entering or leaving the system, such as customer order (input) or a product (output).

Fig. 4.4 : Input/Output Symbol

System Flowchart

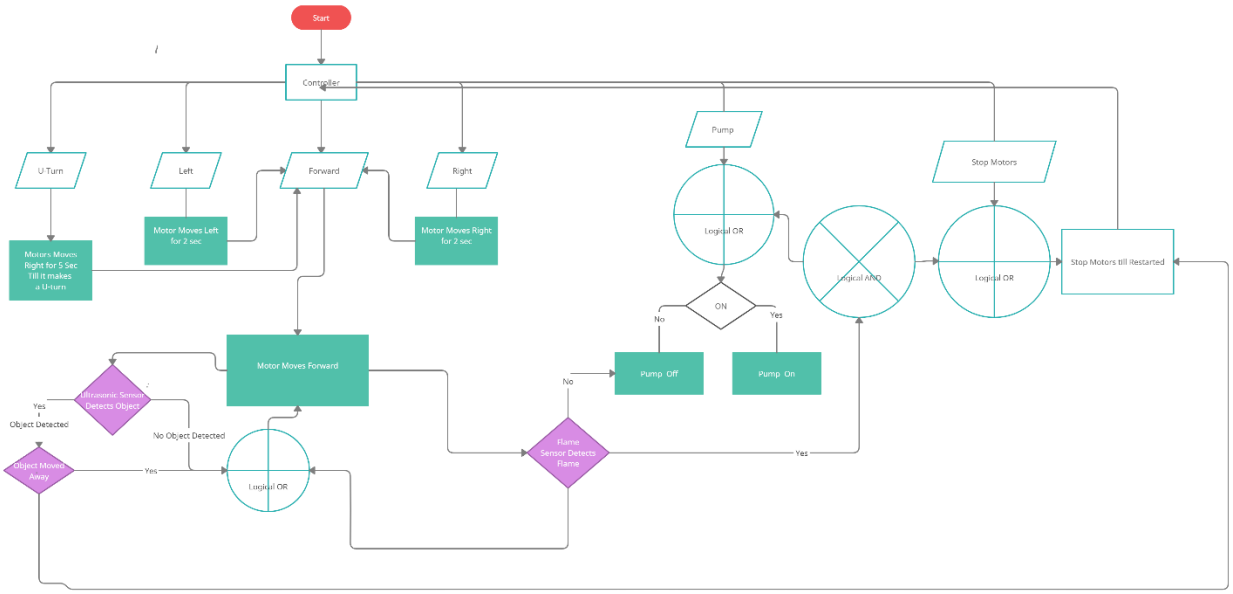


Fig. 4.5 : System Flowchart

4.2. Block Diagram:

- A block diagram is a diagram of a system in which the principal parts or functions are represented by blocks connected by lines that show the relationships of the blocks.

- They are heavily used in engineering in hardware design, electronic design, software design, and process flow diagrams.

- Block diagrams are typically used for higher level, less detailed descriptions that are intended to clarify overall concepts without concern for the details of implementation. Contrast this with the schematic diagrams and layout diagrams used in electrical engineering, which show the implementation details of electrical components and physical construction.

- As an example, a block diagram of a radio is not expected to show each and every connection and dial and switch, but the schematic diagram is. The schematic diagram of a radio does not show the width of each connection in the printed circuit board, but the layout diagram does.

- To make an analogy to the map making world, a block diagram is similar to a highway map of an entire nation. The major cities (functions) are listed but the minor county roads and city streets are not. When troubleshooting, this high-level map is useful in narrowing down and isolating where a problem or fault is.

- Block diagrams rely on the principle of the black box where the contents are hidden from view either to avoid being distracted by the details or because the details are not known. We know what goes in, we know what goes out, but we can't see how the box does its work.

- Symbol used in block diagram:

- Block diagrams use very basic geometric shapes: boxes and circles. The principal parts and functions are represented by blocks connected by straight and segmented lines illustrating relationships.
- We’re Using Waterfall Technique for our Workflow.

System Workflow

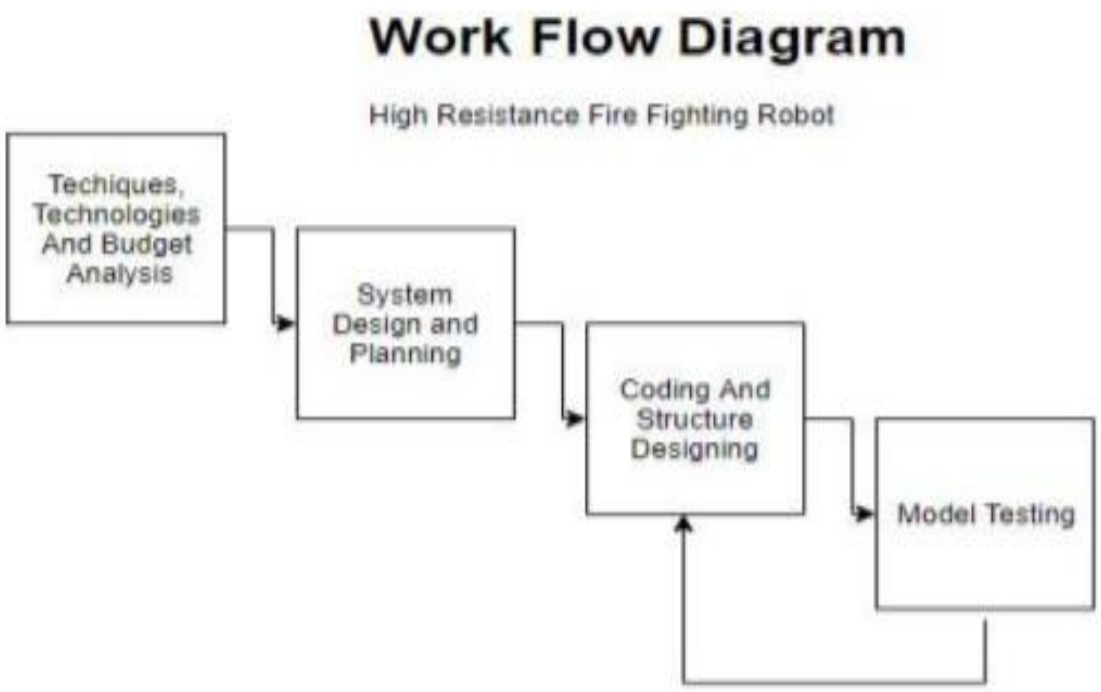


Fig. 4.6 : System Workflow

System's Circuit Diagram:

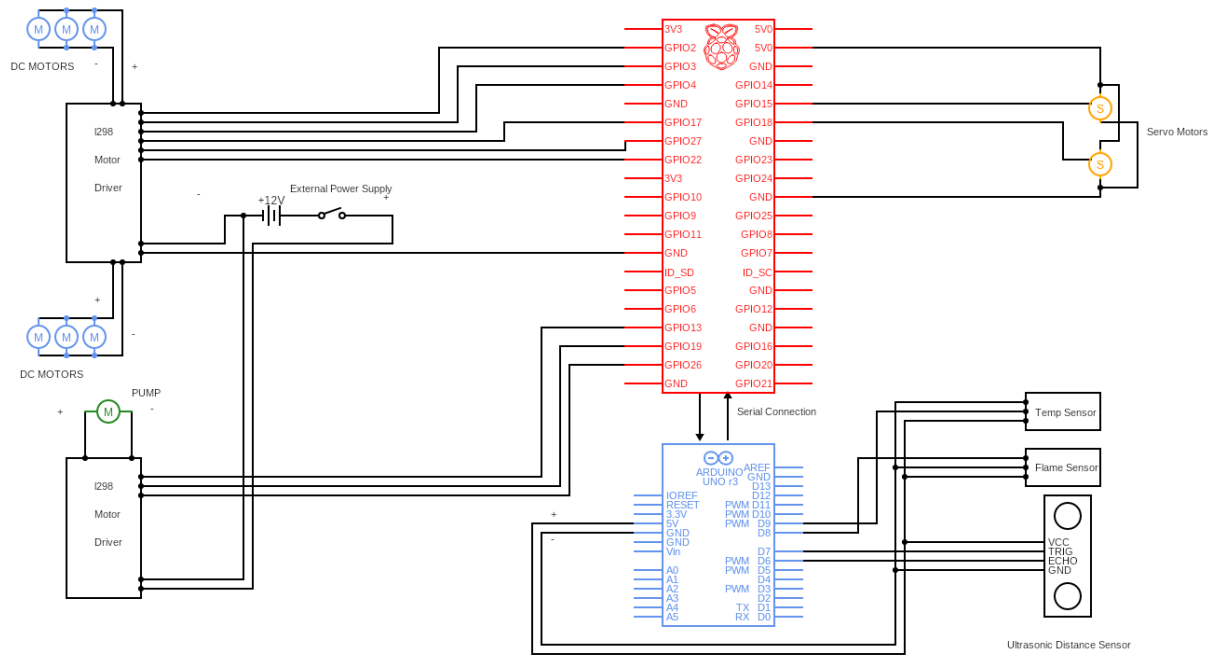


Fig. 4.7: Circuit Diagram

Chapter 5

5. User Manual:

Step1: User has to Connect a Pipe towards the back of the Robot.

Step 2: User has to power both the robot (Pi and the 12v Supply) and its Controller.

Step 3: The Robot will start moving after User Start command (X on the Controller). If the User wants to change the direction of the Robot, they can do so by pressing Left and Right on the Controller. To Spray the Nozzle Manually, the User has to press Y on the Controller (it'll stop the DC motor until pressed X back is pressed in order to target on the fire in a stable way.)

Step 4: User has to connect the camera link to see the live feed of the robot on his/her phone/tablet connected to the Same Network.

Step 5: User has to operate the D-pad on the controller to move the Nozzle in the direction of fire.

Step 6: The Robot will detect fire on its way and would stop when either there's a fire or when there's an object 15cms away from it. If there's a Fire detected by the Flame Sensor of the Robot, it would automatically activate the pump in order to spray through the Nozzle.

Chapter 6

6. Observation and Conclusion:

6.1. Observation:

6.1.1. While Testing we observed that, whenever we give start command to the robot, it moves forward until we give it another direction or an object is detected Ultrasonic Sensor in front of it.

6.1.2. If the Object's is more than 15 cm away from the Robot it moves forward else if it's at 15cm away from the Robot, the Motors of the Robot stops until User passes the command to change direction to left or right.

6.1.3. Or it waits until the object gets out of its way. While Moving, the Robot can also stream at a delay of 2-3 Seconds, depending on the Internet speed of the Facility.

6.2. Conclusion:

6.2.1. We were able to develop the Robot to be Semiautonomous. We were able to Make a Semi-Autonomous Firefighting Robot whose direction can be controlled by the Controller.

6.2.2. The Robot can stream via the Camera onto a webserver for locating fires and people.

6.2.3. Whenever the Robot Detects Fire, it Sprays Water until it extinguishes.

6.2.4. The User can extinguish Fire outside the range of Flame Sensor by changing the Position of Nozzle sitting on top of the Pan, Tilt Servo Module. We were able to add Video Streaming Functionality and Email Functionality to the Robot.

Chapter 7

7. Applications and Limitations of This Project:

7.1. Applications:

7.1.1. Our Robot is designed to be in places where a normal sized human can't go.

7.1.2. The main purpose is to build path for the rescuing of people by extinguishing fire in a small building, lab, or ground.

7.1.3. It can be used for surveillance purposes.

7.1.4. It can be used in record maintaining rooms where fire can cause loss of valuable data.

7.1.5. This robot could be used in Server rooms for immediate action in case of fire.

7.1.6. This Project was developed for smaller facilities which includes the Houses, small scale businesses, chemical labs, storage facilities, grounds.

7.2. Limitations:

7.2.1. It is not used to put off large fires.

7.2.2. It cannot work beyond the limits.

7.2.3. Can’t be used to put out fire in a Large Area

7.2.4. The Processor used in the prototype is weak and simply can’t be used in real-time.

7.2.5. The prototype is heavy and can’t carry more load.

Chapter 8

8. Future Enhancements:

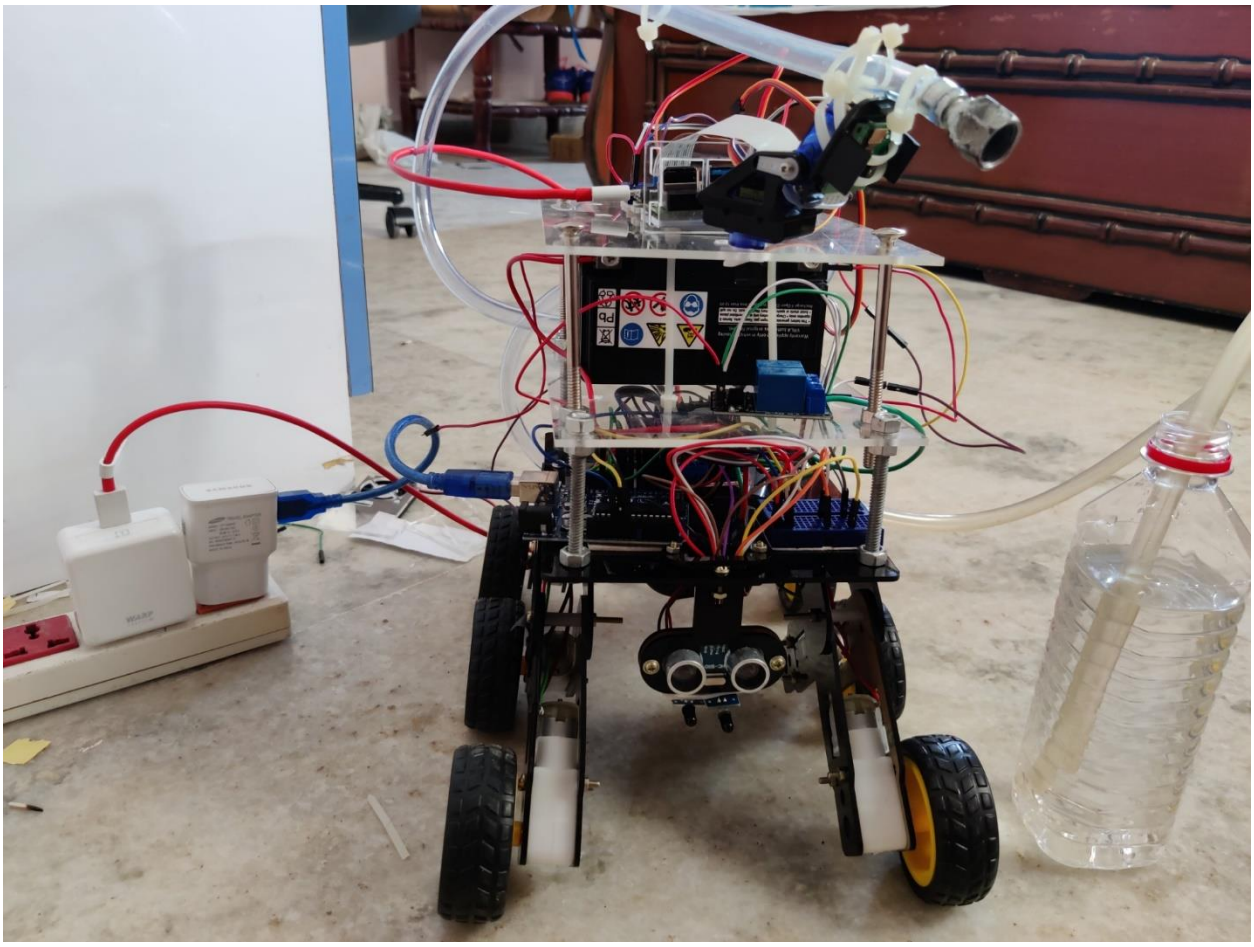
- This project has been made to design a system that can detect small scale fires and extinguish it. In the present condition it can extinguish fire only from its Front and not in all the directions and the robot can't be made to operate Fully automatically as it would be too risky.

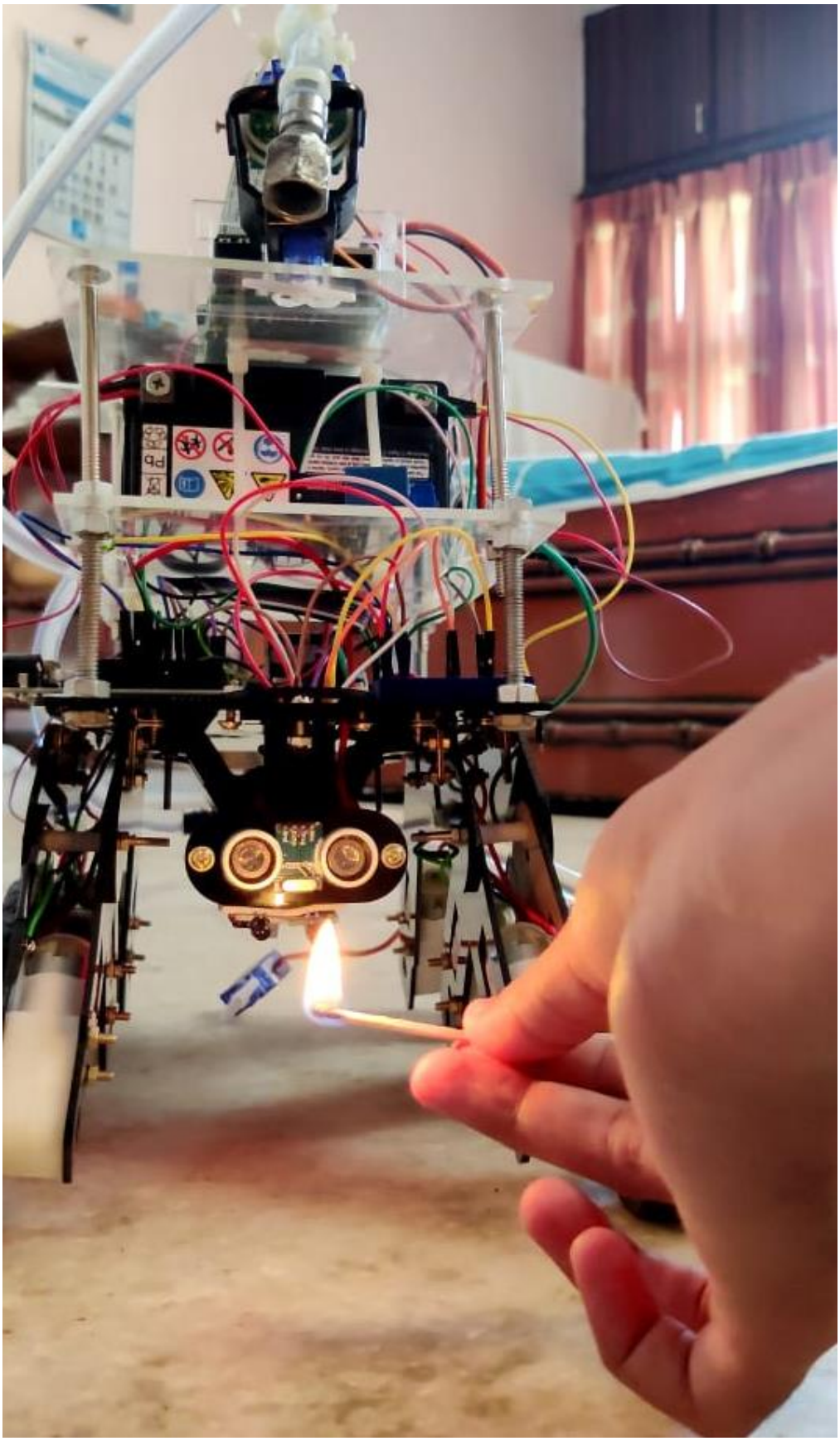
- This Project provides us the opportunity to make a robot that can assist in Firefighting and Rescue work.

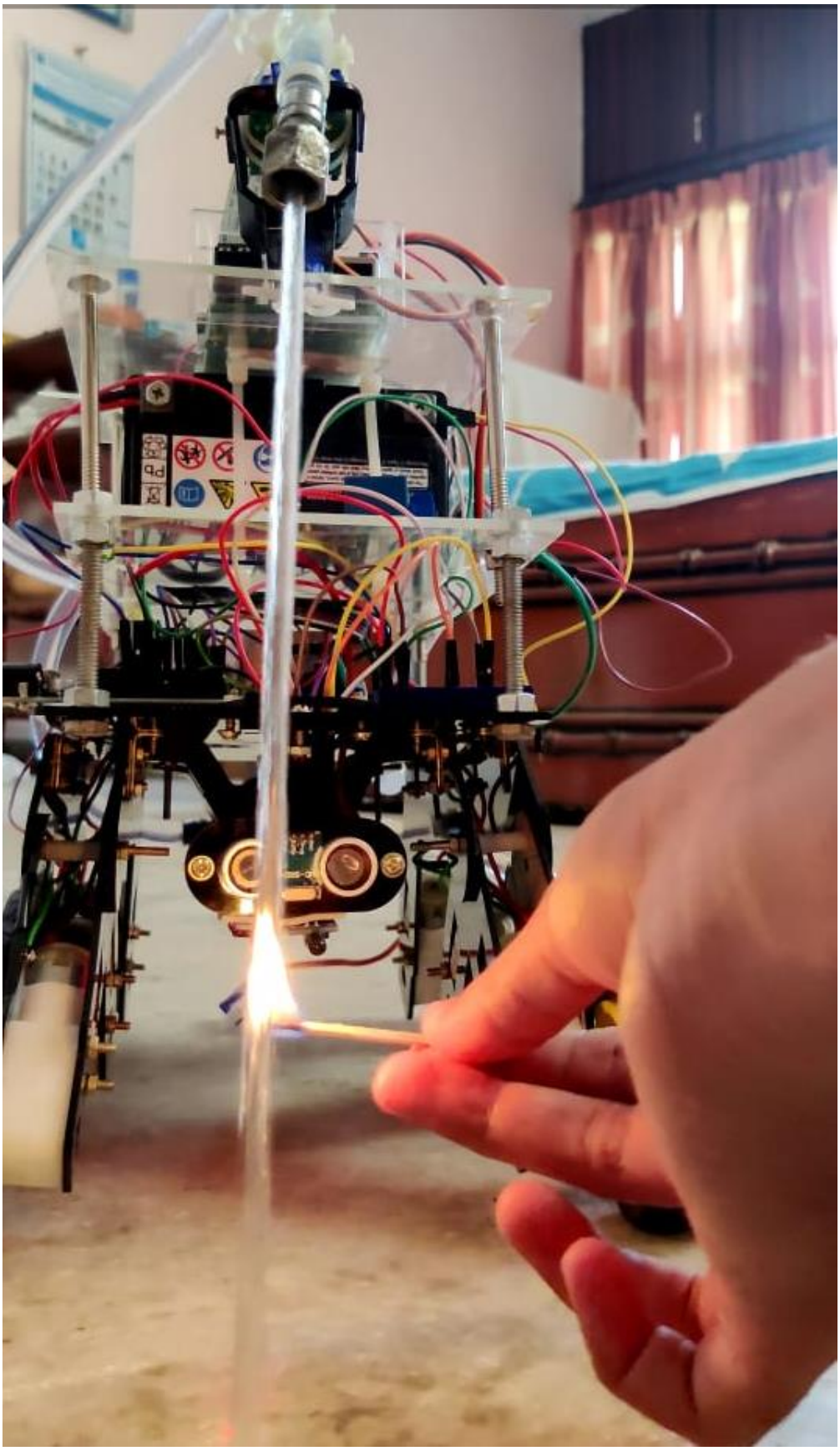
- For Future developments we're planning to port forward the live feed of the Robot's Camera and also to make a mobile application for controlling the robot virtually via joysticks simultaneously showing the live feed of the Cameras installed and we're also going to add Full Mode (Both Manual and Automatic mods).

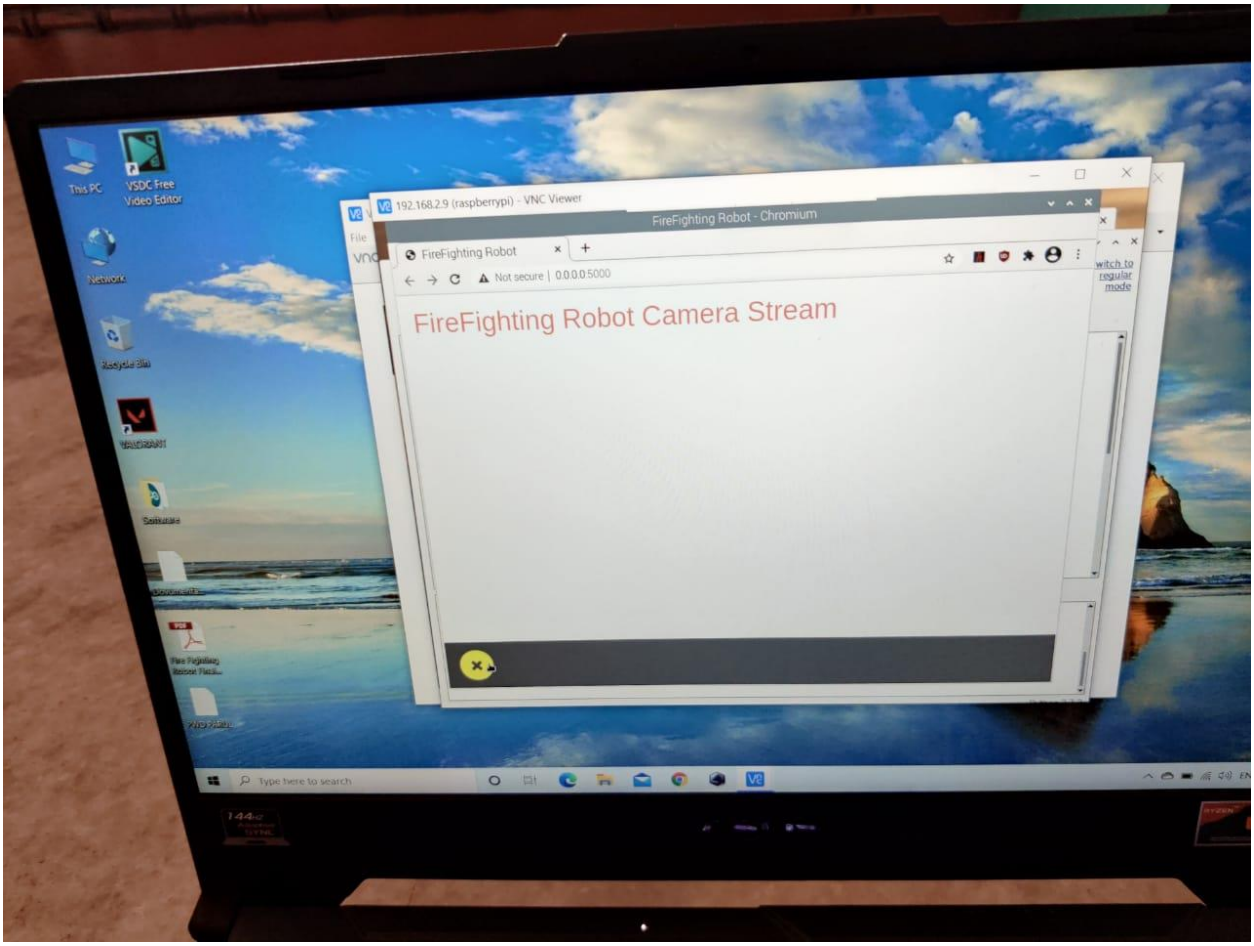
- All such concerns for now, are outside the scope and the budget of this project

Model Final Picture:








192.168.2.9 (raspberrypi) - VNC Viewer
FireFighting Robot - Chromium
FireFighting Robot
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FireFighting Robot Camera Stream
This PC
VSDC Free Video Editor
Network
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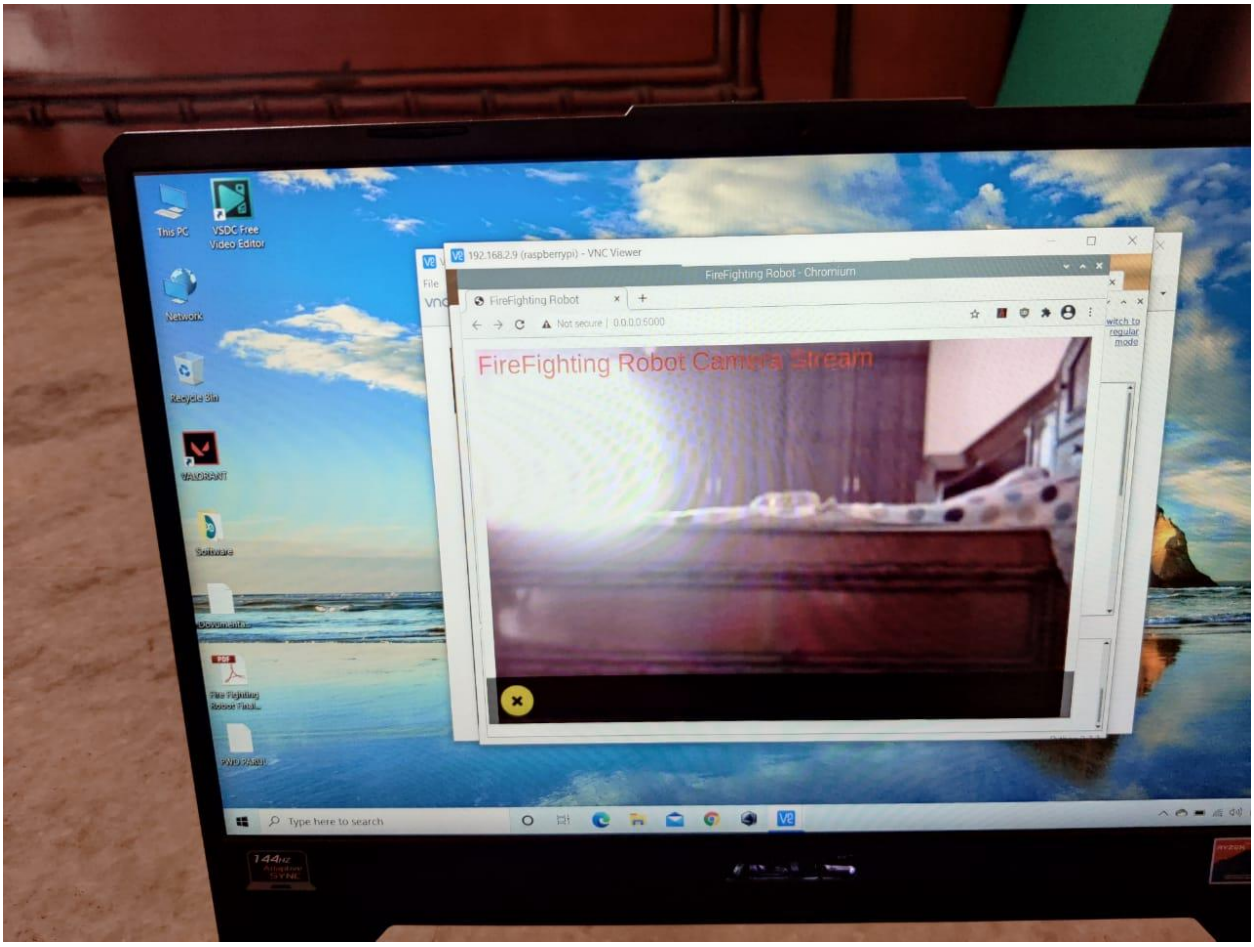
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Not secure | 0.0.0.0:5000
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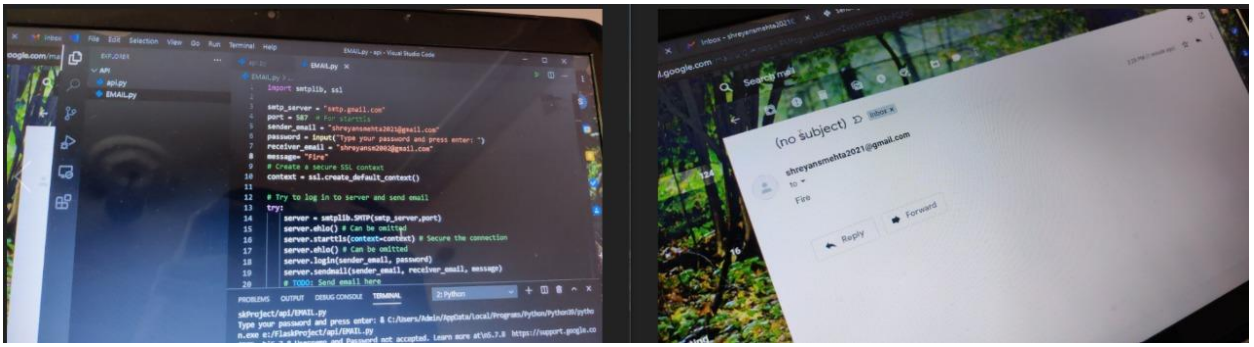
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shreyansmehta2021@gmail.com
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