SMART HOME AUTOMATION USING VOICE-ASSISTANCE WITH ARDUINO AND AI

by

MOHAMMAD KAZIM

A Vocational Training project report has been submitted in partial fulfillment of the requirements for the degree of

Bachelor of Technology

in

ELECTRONICS & COMMUNICATION ENGINEERING

Under the supervision of

Sandeep Yadav

Assistant General Manager

Department of Telecommunication
SAIL Bhilai Steel Plant

July,2024

CERTIFICATE

This is to certify that the project titled "**Smart Home Automation Using Voice-Assistance with Arduino and AI**" was carried out by **Mohammad Kazim, [ECE]** at BSP under 4 weeks project based training with registration number [P-24/9491].

A comprehensive project report has been submitted in partial fulfillment of the requirements for the degree of Bachelor of technology in Electronics & Communications & is absolutely based on his own work under the supervision of Sandeep Yadav, Assistant General Manager Telecom department at BSP. The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

.....

Sandeep Yadav
Assistant General Manager, Telecommunication Department
SAIL BSP

DECLARATION

"We Do hereby declare that this submission is our own work conformed to the norms and guidelines given in the Ethical Code of Conduct of the Institute and that, to the best of our knowledge and belief, it contains no material previously written by another neither person nor material (data, theoretical analysis, figures, and text) which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgement has been made in the text."

….....

Mohammad Kazim

ABSTRACT

This project demonstrates a voice-controlled home automation system using Arduino.
The system allows users to control multiple devices, including LEDs and a fan, through voice commands.
The project integrates a Python script for speech recognition and serial communication with the Arduino, providing real-time control and feedback.
The implementation showcases the potential of combining hardware and software to create intuitive and efficient home automation solutions.

The main aim of this project is to provide an intuitive and accessible way to control household devices, enhancing user convenience, reducing physical interaction with devices, and accommodating individuals with mobility or accessibility challenges.

OVERVIEW

The home automation system aims to simplify the control of household devices using voice commands. By leveraging an Arduino Uno, LEDs, a fan, and a Python-based voice recognition interface, the system allows users to issue commands such as "turn on red LED" or "turn off all components." The feedback mechanism confirms the execution of commands via both visual and auditory signals, enhancing user interaction.

Components Used:

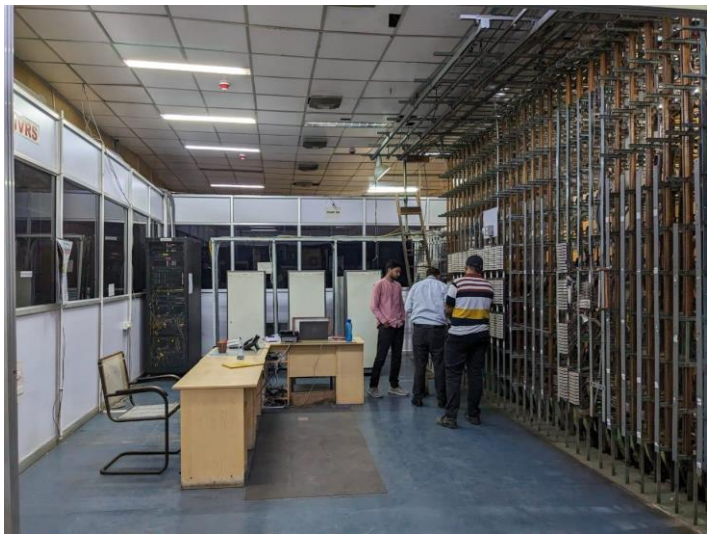
- Arduino Uno
- 2 Red LEDs
- 2 Blue LEDs
- Fan
- Jumper Wires
- Breadboard
- Laptop (for microphone and speaker)

Software:

- Arduino IDE
- VS Code Editor
- Python with pyserial, speech_recognition, and pyttsx3 libraries

CONTENTS

TELECOMMUNICATION DEPARTMENT



Telecommunication is crucial in modern society, enabling global connectivity and instant communication, thus bridging geographical divides. It drives economic growth by enhancing business operations and supporting the digital economy. Additionally, it revolutionizes education through remote learning and broadens access to information, making resources more inclusive. Telecommunication is vital for governance, healthcare, and emergency response, ensuring efficient coordination. Overall, it fosters technological advancement, improves quality of life, and creates a more connected and informed global community.

The telecommunication department at Bhilai Steel Plant plays a critical role in ensuring seamless communication and operational efficiency within the plant. It manages the internal and external communication networks, supporting essential functions such as coordination between various departments, real-time data transfer, and automated process control. The department ensures the reliability and security of communication systems, which is vital for the safety and productivity of the plant.

Additionally, the telecommunication department manages CCTV systems, enhancing security and safety through continuous surveillance, real-time monitoring, and integration with the telecommunication network for prompt incident response.The telecommunication department supports administrative functions, including coordination of meetings through teleconferencing and video conferencing, thus facilitating better decision-making and management efficiency. It also aids in supply chain management by improving communication with suppliers and distributors. Overall, the telecommunication department enhances operational efficiency, safety, and productivity at Bhilai Steel Plant.

TELEPHONE EXCHANGE:-

A telephone exchange is a system that connects telephone calls by switching signals between lines. It enables efficient routing of incoming and outgoing calls within a network, supporting both local and long-distance communication. Telephone exchanges can be manual or automated, using various technologies to ensure seamless and reliable connectivity for users.

- **Call Server:-**

  A call server in the telecom department of Bhilai Steel Plant (BSP) manages internal and external communications, utilizing PBX systems and VoIP technology for efficient call routing. It ensures cost-effective, scalable, and reliable telephony services, supporting seamless connectivity within the plant and with external entities.

- **Line Interface Unit:-**

  A Line Interface Unit (LIU) is a critical component in telecommunications systems, connecting digital and analog signals between devices and transmission lines. It manages signal conversion, conditioning, and ensures proper signal transmission and reception, providing isolation, protection, and signal integrity in communication networks.

- **Cisco Switch:-**

  Cisco switches are network devices designed to connect and manage multiple devices within a network, facilitating efficient communication and data transfer. They offer features like VLAN support, high-speed data forwarding, security protocols, and network management tools. Cisco switches are known for their reliability, scalability, and advanced capabilities, making them suitable for various networking environments, from small businesses to large enterprises, ensuring seamless and secure network operations.

- **Media Gateway:-**

Amedia gateway is a device or software application that serves as an interface between different communication networks, protocols, or technologies, allowing for seamless interoperability and the efficient exchange of voice, video, and data traffic. It performs the conversion and routing functions necessary to bridge the gap between different types of networks.

Ez32-2: The 232 cardboard enables 32 analog terminals to be connected to the ACT system. There are two generations of 232 boards.

INTOF2: The INTOF2 Board (part number 3BA23260AA) from Alcatel is available from MF communications The INTOF2 board can be used in 2 ways, depending on the software running it. Each behavior enables the connection of a remote shelf. The unit consists of 4 MIC links which makes in total 120 time slots.

GPA2: The GPA2 has 60 channels, and the board is fitted with 2 physical DSPS (5 logical DSPS) that can support the function like calling.

NPRAE-2: New primary rate access board can be used to connect an Alcatel lucent omniPCX enterprise communication server to another server.

INT IP3: INT IP3, also known as In-Band Network Telemetry (INT) with IP version 3, is a network monitoring and diagnostic technology. It provides granular visibility and monitoring capabilities within an IP network infrastructure. INT IP3 allows for the collection of detailed telemetry data about the performance and behavior of network flows.

- **Float cum Boost Charger(FCBC):-**

A float cum boost charger is a type of battery charger that can operate in two modes: float mode and boost mode. In float mode, the charger maintains the battery at full charge by supplying a constant voltage slightly above the battery's nominal voltage. This mode is used to keep the battery topped up and ready for use.In boost mode, the charger provides a higher voltage to quickly charge a partially discharged battery.

The float cum boost charger automatically switches between these modes based on the state of the battery, ensuring optimal charging performance and extending the battery's lifespan. These chargers are commonly used in applications where batteries need to be kept charged and ready for use, such as in backup power systems or emergency lighting systems.

- **Router:-**

A router is a networking device that forwards data packets between computer networks. It connects multiple networks together, such as a home network and the internet, and uses routing algorithms to determine the best path for data to travel. Routers operate at the network layer of the OSI model and are essential for internet connectivity.

- **Network Monitoring Server:-**

A network monitoring server is a dedicated system or software application that monitors and analyzes network infrastructure and traffic to ensure its optimal performance, security, and availability.

Functions of a network monitoring server include real-time monitoring, alerting and notification, performance analysis, troubleshooting and diagnostics, security monitoring, reporting and visualization, integration and compatibility, and scalability and flexibility.

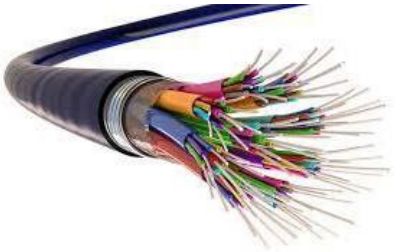
CABLES:-

In telecom, cables are used to transmit signals between devices. Fiber optic cables transmit data as light pulses, while copper cables transmit data as electrical signals. They are vital for communication networks.

There are different types of cables depending upon their purpose.They are classified in following types:-

- **Fiber Optics Cable:-**

Fiber optic cables use thin strands of glass or plastic to transmit data as pulses of light over long distances. They offer high bandwidth, low attenuation, and immunity to electromagnetic interference, making them ideal for high-speed telecommunications and internet connectivity.



- **JFC Cable:-**

JFC cable, or Jointing and Terminating Fiber Optic Cable, refers to the process of splicing and terminating fiber optic cables to create reliable connections in telecommunications and networking applications.

- **Coaxial Cable:-**

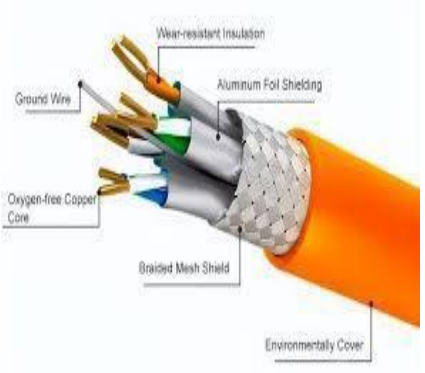
Coaxial cable is a type of electrical cable consisting of a central conductor, an insulating layer, a metallic shield, and an outer insulating layer. It is used for transmitting high-frequency signals, such as those for cable television, internet, and data networks, due to its excellent noise-rejection properties

- **Ribbon Electric Cable:-**

Ribbon electric cable is a flat, ribbon-like cable consisting of multiple insulated wires running parallel to each other. It is commonly used in applications where space is limited, such as inside computers and other electronic devices. The flat design of ribbon cables makes them easy to route and manage within tight spaces.

- **Shielded Cable:-**

Shielded cable is an electrical cable with an additional layer of conductive material surrounding the insulated conductors. This shield helps protect the signal from electromagnetic interference (EMI) and radio frequency interference (RFI), ensuring a cleaner and more reliable signal transmission in sensitive applications.



CCTV Camera & Devices:-

CCTV cameras enhance security by monitoring and recording activities in various settings. They deter crime, provide evidence for investigations, and help manage public and private spaces efficiently, ensuring safety and accountability.

CCTV cameras can be broadly classified into two types:-

1. Analog Camera:-

An analog camera is a type of CCTV camera that captures and transmits video signals in analog format. These cameras were widely used before the advent of digital technology and the popularity of IP (Internet Protocol) cameras. Some of the key characteristics of analog cameras are :

- **AnalogSignal:** Transmit video signals in analog format over coaxial or dedicated wiring.
- **LowerResolution**: Typically offer lower resolutions compared to digital cameras, ranging from 420TVL to 1000TVL.
- **Connectivity:** Connect to a surveillance system using coaxial or twisted pair cables (RG59 or CAT5).
- **DVR-BasedRecording:** Connected to a digital video recorder (DVR) that converts analog signals to digital for storage and playback.
- **Limited Functionality:** Lacks advanced features like remote access, intelligent video analytics, or integration with network-based systems.
- **Cost-Effective:** They are generally more affordable compared to IP cameras, making them suitable for budget-conscious installations.
- **Limited Upgradability:** Upgrading to higher resolutions or advanced functionalities requires replacing the entire camera system.

2. **IP Camera:-**

An IP camera, also known as a network camera or internet protocol camera, is a type of CCTV camera that captures and transmits video and audio data over an IP network. Unlike analog cameras, IP cameras digitize and encode video signals directly within the camera itself. Here are the key characteristics of IP cameras summarized:

- **Digital Signal:** Transmit video data in a digital format over an IP network.
- **HighResolution:** Offer a wide range of resolutions, from SDto HDandUHD.
- **Power over Ethernet (PoE):** Some IP cameras can receive power and network connectivity over a single Ethernet cable.
- **Advanced Features:** Include motion detection, facial recognition, object tracking, and video analytics.
- **RemoteAccess:** Access and manage cameras remotely over a network or the internet.
- **Scalability and Flexibility:** Easily integrate into existing IP-based network infrastructure and expand the system as needed.
- **VideoManagement Software (VMS):** Work with VMS for centralized control, recording, and management of multiple cameras.
- **Integration with Other Systems:** Can integrate with access control systems, alarms, and analytics platforms.

There are various types of CCTV cameras based on usage:-

1.Dome Camera:-

A dome camera is a surveillance device enclosed in a dome-shaped housing, offering 360-degree coverage, often used in security systems for its unobtrusive design and wide-angle monitoring capabilities.

2.Bullet Camera:-

A bullet CCTV camera is a long, cylindrical surveillance device designed for extended outdoor use, offering focused, high-definition monitoring, often featuring weather-resistant housing and infrared capabilities for night vision.

3.PTZ Camera:-

A PTZ camera (Pan-Tilt-Zoom) is a surveillance device that can remotely adjust its field of view, providing flexible, dynamic monitoring with capabilities to pan, tilt, and zoom for detailed observations.

Network Video Recorder(NVR):-

An NVR (Network Video Recorder) is a digital device that records video footage from IP cameras over a network, offering centralized storage, playback, and management of high-definition surveillance video.

Digital Video Recorder(DVR):-

A DVR (Digital Video Recorder) records TV programs digitally, allowing users to pause, rewind, and record live TV, and watch later with playback controls, enhancing viewing flexibility and convenience.

Hybrid Video Recorder(HVR):-

HVR (Hybrid Video Recorder) combines DVR and NVR capabilities, supporting both analog and IP cameras. It records and manages video from multiple sources, providing versatile surveillance solutions for security systems.

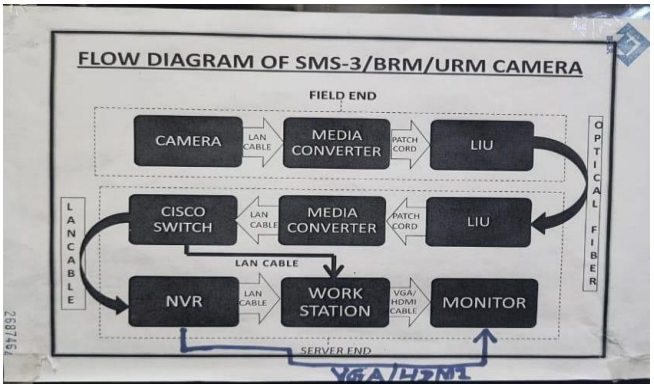
Media Converter:-

A media converter changes one type of network media to another, such as from copper to fiber optic, enabling seamless data transmission across different network infrastructures while extending network reach.

HUB:-

A hub is a basic networking device that connects multiple cameras in a local network. It broadcasts data to all connected devices, resulting in potential collisions. Hubs operate at the physical layer of the OSI model and lack data filtering.

HOW CCTV WORKS IN BSP:-


FLOW DIAGRAM OF SMS-3/BRM/URM CAMERA
FIELD END
CAMERA
LAN CABLE
MEDIA CONVERTER
PATCH CORD
LIU
OPTICAL FIBER
LAN CABLE
CISCO SWITCH
LAN CABLE
MEDIA CONVERTER
PATCH CORD
LIU
LAN CABLE
NVR
LAN CABLE
WORK STATION
VGA/ HDMI CABLE
MONITOR
SERVER END
VGA/HDMI

TELECOMM LAB:-

The task of the telecom lab is to handle repairs of frequently used electronic devices such as telephone,camera,VHF walkie-talkie,NVR,DVR,PA systems,monitors,etc.

Here is a brief description of devices that are repaired most frequently in telecomm lab :-

Telephone:-

A telephone is an instrument designed for simultaneous transmission and reception of the human voice, Telephones are inexpensive and simple to operate, and they offer immediate, personal type communication.

Working: Inside the microphone of the handset , there is a thin piece of metal called a diaphragm. It vibrates when the vibrations from your voice hit it.As the diaphragm vibrates, it wiggles a magnet to make current flow down the wire. At the other end is the speaker.

Walkie Talkie:-

A Walkie-Talkie, more formally known as a handheld transceiver (HT), is a hand-held,portable ,radio transceiver. Typical Walkie-Talkies represent a telephone handset, with a speaker built into one end and microphone in the other, and an antenna mounted on top of the unit.

A Walkie-Talkie is a half-duplex communication device. Multiple walkie-talkies use a single radio channel, and only one radio channel can be transmitted at a time, although any number can listen. The transceiver is normally in receiver mode; when the user wants to talk , they must press a “push-to-talk” button that turns off the receiver and turns on the transmitter.

Working: When you talk into a walkie-talkie, your voice is picked up by the microphone, encoded onto a radio frequency and transmitted with the antenna. Another walkie-talkie can receive the signal with its antenna, decode your voice from the radio signal and drive a speaker.

-:PROJECT:-

PROBLEM STATEMENT:-

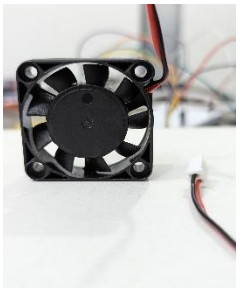
In traditional home environments, controlling multiple devices often requires manual interaction, which can be inconvenient and inefficient. This project addresses the need for an automated solution that allows users to control household devices using simple voice commands. The system aims to provide a seamless and user-friendly interface for managing home automation tasks, improving convenience and accessibility.

COMPONENTS REQUIRED: -

❖ Hardware:-

1.Arduino: Arduino is an open-source electronics platform based on easy-to-use hardware and software. It consists of a microcontroller and a development environment. Arduino boards read inputs (light on a sensor, a finger on a button) and turn them into outputs (activating a motor, turning on an LED). It's popular for prototyping and educational purposes due to its simplicity and versatility.

2.DC Motor: A DC motor converts electrical energy into mechanical motion through direct current. It's commonly used in various applications like fans, toys, and tools. The speed and direction of the motor can be controlled by adjusting the voltage or using a motor driver.



3.LEDs: LEDs (Light Emitting Diodes) are used as indicators in this project. The Arduino controls 2 red LEDs and 2 blue LEDs, which respond to voice commands to turn on or off, providing visual feedback to the user.

Software:

Arduino IDE: The Arduino Integrated Development Environment (IDE) is a cross-platform application that is used to write and upload programs to Arduino compatible boards. It supports C and C++ languages using special rules of code structuring. The Arduino IDE simplifies the process of writing code and programming the microcontroller, making it accessible for beginners and professionals alike.

Python: Python is a high-level, interpreted programming language known for its ease of use and readability. It has a vast collection of libraries and frameworks that make it an excellent choice for a variety of applications, including web development, data analysis, machine learning, and hardware interfacing. In this project, Python is used to handle speech recognition and serial communication with the Arduino board.

PySerial Library: PySerial is a Python library that encapsulates access to serial ports. It provides a consistent API to access the serial ports, enabling seamless communication between the Python script and the Arduino board. This library is crucial for sending commands from the Python script to the Arduino to control the connected components.

SpeechRecognition Library: The SpeechRecognition library is a Python package that provides an easy-to-use interface for converting spoken language into text. It supports various speech recognition engines and APIs, including Google Web Speech API. In this project, it is used to capture and interpret voice commands, which are then sent to the Arduino for execution.

pyttsx3 Library: pyttsx3 is a text-to-speech conversion library in Python. Unlike other libraries, it works offline and is compatible with both Python 2 and Python 3. In this project, pyttsx3 is used to provide audio feedback, allowing the system to repeat commands back to the user through the laptop's speaker.

Connections:

1. **Arduino to LEDs:**
    - Red LED 1: Pin 8
    - Red LED 2: Pin 9
    - Blue LED 1: Pin 10
    - Blue LED 2: Pin 11

2. **Arduino to Fan:**
    - One Terminal of Fan connected to Pin 4 and other Ground

3. **Laptop:**
    - Microphone for capturing voice commands
    - Speaker for providing audio feedback

CODE:

MAIN PROGRAM (main.py)

```
import serial
import time
import speech_recognition as sr
import pyttsx3

# Initialize the recognizer
recognizer = sr.Recognizer()

# Initialize TTS engine
tts_engine = pyttsx3.init()

# Function to recognize speech and return the text
def recognize_speech():
    with sr.Microphone() as source:
        print("Listening... Please speak into the laptop's mic.")
        audio = recognizer.listen(source)

        try:
            print("Recognizing...")
            text = recognizer.recognize_google(audio)
            print(f"Recognized: {text}")
            return text.lower()
        except sr.UnknownValueError:
            print("Could not understand the audio")
        except sr.RequestError:
            print("Could not request results; check your network connection")
        return ""

# Function to send command to Arduino
def send_command(command):
    try:
        arduino.write((command + '\n').encode())
        print(f"Sent command: {command}")
    except Exception as e:
        print(f"Error: {e}")

# Function to speak the command
def speak_command(command):
    tts_engine.say(command)
    tts_engine.runAndWait()

# Main script
if __name__ == "__main__":
```

```
try:
    # Replace 'COM4' with the appropriate port for your system
    arduino = serial.Serial('COM4', 9600, timeout=1)
    time.sleep(2)  # Give time for the connection to establish

    while True:
        command = recognize_speech()
        print(f"Command received: {command}")

        if "red on" in command:
            send_command("red on")
            speak_command("Turning red on")
        elif "red off" in command:
            send_command("red off")
            speak_command("Turning red off")
        elif "blue on" in command:
            send_command("blue on")
            speak_command("Turning blue on")
        elif "blue off" in command:
            send_command("blue off")
            speak_command("Turning blue off")
        elif "fan on" in command:
            send_command("fan on")
            speak_command("Turning fan on")
        elif "fan off" in command:
            send_command("fan off")
            speak_command("Turning fan off")
        elif "all on" in command:
            send_command("all on")
            speak_command("Turning all components on")
        elif "all off" in command:
            send_command("all off")
            speak_command("Turning all components off")
        else:
            print("Unknown command")
            speak_command("Unknown command")
except serial.SerialException as e:
    print(f"Error opening serial port: {e}")
except KeyboardInterrupt:
    print("Program terminated")
finally:
    try:
        arduino.close()
    except:
        pass
```

CONTROLLER PROGRAM (Arduino Code):

```
const int redLed1 = 8;
const int redLed2 = 9;
const int blueLed1 = 10;
const int blueLed2 = 11;
const int fanPin = 4; // Pin connected to the transistor controlling the fan

void setup() {
  Serial.begin(9600);
  pinMode(redLed1, OUTPUT);
  pinMode(redLed2, OUTPUT);
  pinMode(blueLed1, OUTPUT);
  pinMode(blueLed2, OUTPUT);
  pinMode(fanPin, OUTPUT);
}

void loop() {
  if (Serial.available() > 0) {
    String command = Serial.readStringUntil('\n');
    command.trim(); // Remove any trailing whitespace

    if (command == "red on") {
      digitalWrite(redLed1, HIGH);
      digitalWrite(redLed2, HIGH);
    } else if (command == "red off") {
      digitalWrite(redLed1, LOW);
      digitalWrite(redLed2, LOW);
    } else if (command == "blue on") {
      digitalWrite(blueLed1, HIGH);
      digitalWrite(blueLed2, HIGH);
    } else if (command == "blue off") {
      digitalWrite(blueLed1, LOW);
      digitalWrite(blueLed2, LOW);
    } else if (command == "fan on") {
      digitalWrite(fanPin, HIGH);
    } else if (command == "fan off") {
      digitalWrite(fanPin, LOW);
    } else if (command == "all on") {
      digitalWrite(redLed1, HIGH);
      digitalWrite(redLed2, HIGH);
      digitalWrite(blueLed1, HIGH);
      digitalWrite(blueLed2, HIGH);
      digitalWrite(fanPin, HIGH);
    } else if (command == "all off") {
      digitalWrite(redLed1, LOW);
      digitalWrite(redLed2, LOW);
```

```
    digitalWrite(blueLed1, LOW);
    digitalWrite(blueLed2, LOW);
    digitalWrite(fanPin, LOW);
  } else {
    Serial.println("Unknown command");

}
```

Project Working:

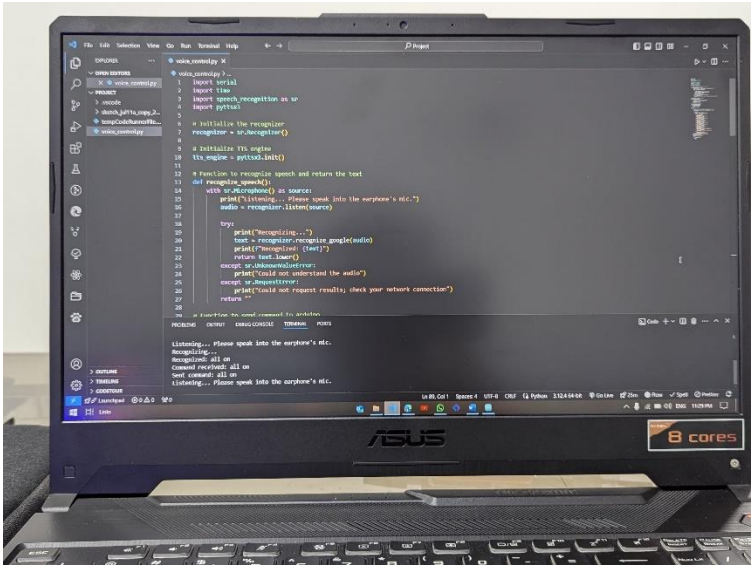
In our project, we focused on developing a voice-controlled home automation system by integrating both software and hardware components. The system allows users to control multiple devices using voice commands, creating a seamless and intuitive interface for managing home appliances.

Software Implementation:

1.Voice Recognition and Command Processing: We employed Python as our primary programming language for its robust libraries and ease of integration with external hardware. The SpeechRecognition library was used to capture and process voice commands. This library interfaces with various speech recognition engines, including Google Web Speech API, to convert spoken words into text.

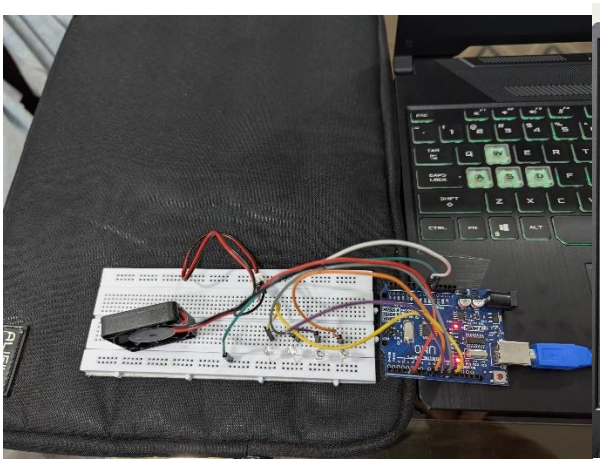
2.Serial Communication: We used the PySerial library to establish a communication link between the Python script running on the laptop and the Arduino Uno. This connection allows the laptop to send commands to the Arduino based on the recognized voice inputs.

3.Text-to-Speech Feedback: For audio feedback, we used the pyttsx3 library, which is a text-to-speech conversion library in Python. This allows the system to repeat the recognized commands through the laptop's built-in speaker, providing confirmation to the user.



Hardware Integration:

Arduino Setup: The Arduino Uno controls various connected devices, including LEDs and a fan. It receives commands from the Python script via the serial connection and activates the appropriate pins to control these devices.

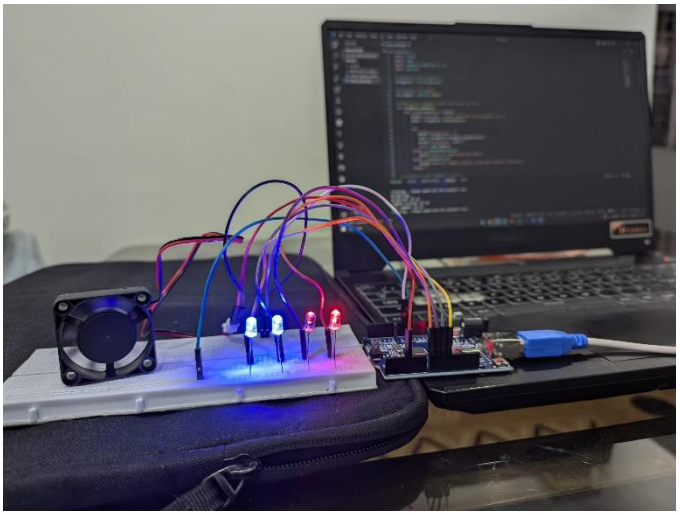


System Operation:

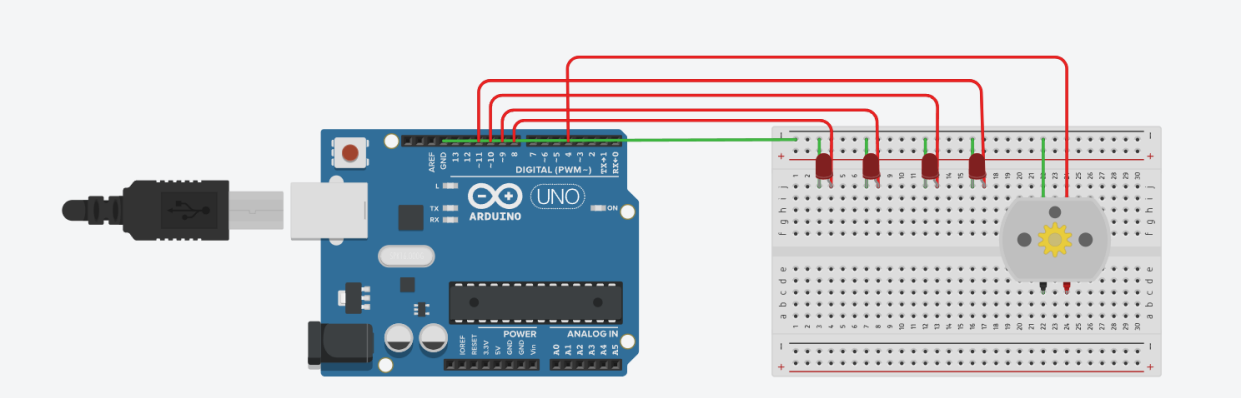
1.Voice Command Recognition: The user issues a voice command, which is captured by the laptop's microphone. The Python script processes this command using the SpeechRecognition library and converts it to text.

2.Command Interpretation and Execution: The recognized text command is then sent to the Arduino via the serial connection. The Arduino interprets the command and activates the corresponding pins to control the LEDs and the fan.

3.Audio Feedback: The Python script also uses the pyttsx3 library to provide audio feedback through the laptop's speaker, confirming the execution of the command. This feedback ensures the user is aware of the system's actions.



SOFTWARE SCHEMATIC:



CONCLUSION :

The home automation project successfully demonstrates how voice commands can be used to control multiple devices using an Arduino and a laptop. By integrating hardware components with Python scripts, the system provides an intuitive and efficient way to manage home appliances. The project highlights the potential of combining speech recognition, serial communication, and microcontroller programming to create smart home solutions.

REFERENCES:

- Arduino IDE Documentation: https://www.arduino.cc/en/Guide/Environment
- PySerial Library Documentation: https://pyserial.readthedocs.io/en/latest/
- SpeechRecognition Library Documentation: https://pypi.org/project/SpeechRecognition/
- pyttsx3 Library Documentation: https://pyttsx3.readthedocs.io/en/latest/
- Chatgpt : https://chatgpt.com/share/4c69cf14-9d16-4502-8187-1b7bada49842