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Home Automation using Family Voice Control

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Abstract: *This paper presents a voice-controlled home automation system designed specifically for use within a family environment. The system utilizes an ESP32 microcontroller in conjunction with Python, Arduino IDE, and voice recognition apis to provide contactless control over home appliances. Uniquely, the system supports multiple authorized users by implementing speaker-dependent voice authentication using Python libraries and apis such as Picovoice Eagle and Hugging Face. Through the integration of hardware components and software logic, the system processes user speech, verifies speaker identity, transcribes commands, and activates devices via serial communication. The prototype demonstrates practical application of iot, embedded systems, and speech processing, aiming to provide a secure, user-friendly, and scalable solution for smart home automation.*

Keywords: Home Automation, Voice Recognition, ESP32, iot, Python, Speaker Authentication, Smart Homes

I. INTRODUCTION

The modern household is rapidly adopting automation to improve convenience, efficiency, and accessibility. This project, titled "Home Automation Using Family Voice Control", leverages voice recognition to automate the control of household devices. The key innovation lies in the system's ability to differentiate between authorized users using speaker-dependent authentication. This is especially beneficial for elderly and physically challenged users who may struggle with traditional switches. The project showcases the synergy between embedded hardware (ESP32) and Python-based software running on a local PC to facilitate secure and real-time device control.

II. LITRATURE REVIEW

Dehak, N., Kenny, P. J., Dehak, R., Dumouchel, P., & Ouellet [1] have provided extension of our previous work which proposes a new speaker representation for speaker verification. In this modeling, a new low dimensional speaker- and channel-dependent space is defined using a simple factor analysis. This space is named the total variability space because it models both speaker and channel variabilities.

Ms. Arundhati S. Mehendale and Mrs. M. R. Dixit [2] have proposed Speaker recognition is the computing task of validating a user's claimed identity using characteristics extracted from their voices. Voice -recognition is combination of the two where it uses learned aspects of a speaker's voice to determine what is being said - such a system cannot recognize speech from random speakers very accurately, but it can reach high accuracy for individual voices it has been trained with, which gives us various applications in day today life. This paper has evaluated the use of pitch for Robust Speaker Identification. This is how we can evaluate the pitch and Mel Frequency Cestrum Coefficients. There are various methods to evaluate pitch and MFCC. These parameters help us to identify the speaker. There are various applications of speaker authentication and all, which can be helpful in day today life.

Rejwan Bin Sulaiman identification, [3] have Proposed Voice Controlled Wireless Home Automation Based on internet/ Bluetooth/ wi-fi is a project that is integrated system with mobile phone (application) to give the facility to the elderly and the disable people, so that they can easily control home utilities fully Based on their phone through voice command.

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III. WORKING

Fig 4.1 : Block diagram of home automation using family voice control

Serial communication. The system begins with a voice input from a laptop, where the user gives commands that are processed and converted into a digital signal. These commands are then transmitted via Serial communication a which establishes a wire link between the laptop and the controller. The controller unit, typically a microcontroller like ESP32, receives and processes the command to determine which appliance needs to be controlled. Once the command is interpreted, the microcontroller sends a signal to the relay control circuit, which acts as an electronic switch to turn appliances ON or OFF accordingly. Finally, the output relays activate or deactivate the connected home appliances, such as lights or fans, providing a seamless voice-controlled automation experience. This system offers a wireless, efficient, and user-friendly approach to home automation using serial data cable**.**

Home Automation Using Family Voice Control is an innovative solution designed to control household appliances like fans and lights using voice commands from multiple family members. The system integrates both software and hardware components to enable a hands-free and intelligent home automation experience. At the core of the system lies the ESP32 microcontroller, which serves as the primary control unit. The ESP32 is connected to a laptop via a USB cable, which is used for both power supply and data communication. The laptop captures the user's voice using a microphone and processes the speech into text using Python-based speech recognition libraries .The interpreted command is then sent to the ESP32 through the serial port.

Once the ESP32 receives the command, it performs the required action by controlling specific GPIO (General Purpose Input Output) pins. These pins are connected to leds via 330-ohm resistors, which act as current limiters to protect the leds from damage. In this setup, the blue LED is used to indicate the status of a light, while the green LED represents a fan. When a voice command like "turn on the fan" or "switch off the light" is recognized, the appropriate GPIO pin is triggered to turn the corresponding LED ON or OFF. This simulation effectively mimics the operation of actual appliances.

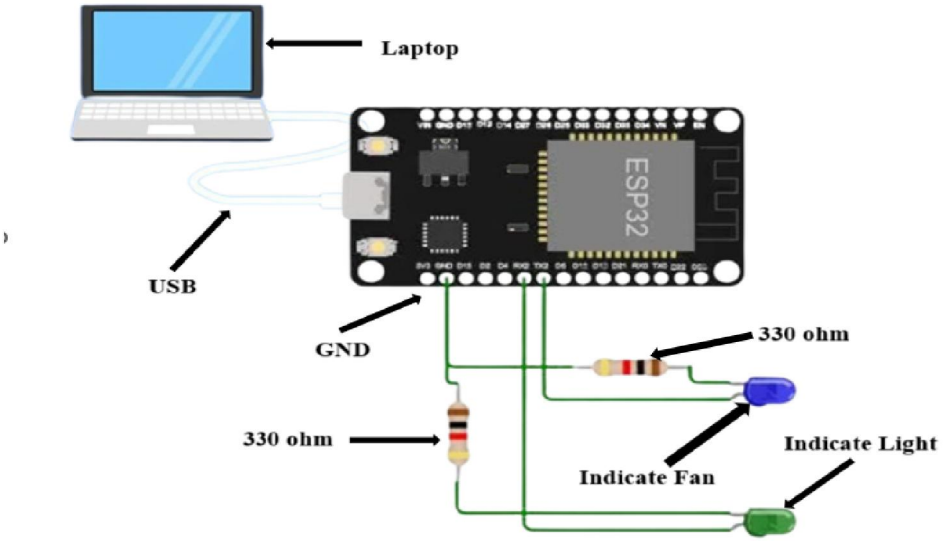

Fig : Circuit Diagram of home automation using family voice control

The ground (GND) pin of the ESP32 is shared among all the connected components to complete the circuit. The system is designed to be simple, cost-effective, and efficient, making it particularly useful for elderly individuals or people with disabilities who may find physical switches difficult to use. By allowing multiple authorized family members to give commands, the system enhances convenience and accessibility. However, one limitation is that the system depends on a

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continuously running laptop for voice processing. Additionally, its performance can be affected by background noise or unclear speech. Despite these challenges, this project represents a significant step towards smart home technology using voice control in a family-friendly environment.

IV. SYSTEM REQUIREMENT

The system requirements for the portable 3D printer include both hardware and software components essential for its operation. On the hardware side, the setup consists of an Arduino Mega 2560, RAMPS 1.4 shield, A4988 stepper motor drivers, NEMA 17 stepper motors, a heated bed, MK8 extruder, endstop switches, a 128×64 smart LCD, and a 24V 10A power supply. The software requirements include the Arduino IDE for uploading firmware, Marlin firmware for controlling printer functions, and Cura slicing software to convert 3D models into G-code instructions.

V. HARDWARE REQUIREMENT

The hardware system of the family voice-controlled home automation setup is built using a modular and cost-effective combination of open-source components to ensure reliability, user-specific control, and ease of integration. At the heart of the system lies the ESP32 microcontroller, which features dual-core processing, built-in Wi-Fi, and Bluetooth capabilities, making it ideal for handling both network communication and voice data processing. Voice input is captured using an external microphone module or USB microphone, interfaced via the PC or a USB sound card, and processed through a connected computer running a Python-based voice recognition script. The recognized commands are then wirelessly transmitted to the ESP32, which controls the connected appliances. Relay modules (typically 4-channel or 8-channel) are used to switch home appliances such as lights, fans, or plugs ON and OFF, with the ESP32 sending control signals to these relays based on recognized voice commands. For speaker-specific recognition, a machine learning model trained on voice samples of authorized family members is employed using Jupyter Notebook, ensuring that only pre-approved voices can trigger specific operations. The system also features status leds and optional feedback through an OLED display to indicate the current state of appliances. Power to the system is supplied via a 5V/2A adapter for the ESP32 and a separate 230V AC to 5V DC converter circuit for relay modules and other peripherals. All hardware components are housed in a lightweight, wall-mounted acrylic enclosure to ensure safety and portability, making it suitable for smart homes requiring secure and voice-personalized control of household devices.

VI. SOFTWARE REQUIREMENT

The software system of the family voice-controlled home automation project serves as the backbone for processing voice commands, managing user authentication, and controlling the connected appliances with precision and security. The core software component is developed using Python, running on a computer or laptop that captures voice input via a microphone and processes it using the speechrecognition library in conjunction with pyaudio for real-time audio streaming. The software leverages Google Speech API or offline models like Vosk to convert speech into text. To implement user-specific access control, a speaker recognition model is integrated using machine learning libraries such as scikit-learn and Librosa for feature extraction (MFCC – Mel-Frequency Cepstral Coefficients) from audio samples. This model is trained on voice data from individual family members, allowing the system to authenticate users before executing any control commands.

VII. CONCLUSION

This project successfully implemented a functioning voice-controlled home automation prototype using ESP32, breadboard wiring, and Python-Arduino software architecture. It demonstrates hands-free control of multiple devices with solid response times under typical home conditions. The integration of speech-to-text processing, serial communication, and microcontroller actuation establishes a clear pathway from user command to real-world action. It aligns with design objectives of affordability, local control, and expandability. While recognition accuracy declined slightly in noisy environments, adopting directional microphones and error-handling improved robustness. The modular design makes the system resilient and easy to maintain results show latency averaging about 1.2 seconds, which is acceptable for domestic use. Power measurements indicate low energy consumption, with deep-sleep options available

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for battery scenarios. Future enhancements could include natural language expansion, voice authentication, wireless connectivity via MQTT, and integration with home standard protocols like Zigbee, Z-Wave, or homekit. Educationally, the project bridges embedded systems, iot, voice technologies, and software development, making it a solid candidate for lab courses or maker community workshops. Limitations include reliance on serial wiring and lack of authentication; addressing these would be crucial before deployment in live environments. Overall, this system proves the feasibility and usefulness of voice-based family home automation and offers a strong foundation for more advanced, secure, and networked versions in future work.

VIII. ACKNOWLEDGMENT

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