Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

SMART HOME CONTROL USING AI

P. S. SANTHI, M. E. Lecturer Selection Grade, *, YOKESH.K**, KIRTIMAN.P ***, NAREN BALAJI.B ****, TAMIL SELVAN.G*****, ANUPPRIYA.S ******.

*Dept. of Electrical & Electronics Engineering, Murugappa Polytechnic College, Chennai, India, Email: eeesanthi@ gmail.com

**Dept. of Electrical & Electronics Engineering, Murugappa Polytechnic College, Chennai, India, Email: yokesh1sky@gmail.com

***Dept. of Electrical & Electronics Engineering, Murugappa Polytechnic College, Chennai, India, Email: kirtimanb1mpc@gmail.com

****Dept. of Electrical & Electronics Engineering, Murugappa Polytechnic College, Chennai, India, Email: balajih193@gmail.com

*****Dept. of Electrical & Electronics Engineering, Murugappa Polytechnic College, Chennai, India, Email:tamilselvan29112006@gmail.com

******Dept. of Electrical & Electronics Engineering, Murugappa Polytechnic College, Chennai, India, Email: anuppriyab1mpc@gmail.com

----------**********----------

Abstract:

The proposed intelligent smart home control system leverages Artificial Intelligence (AI), Internet of Things (IoT), and machine learning algorithms to provide a seamless, energy-efficient, and secure living experience. Integrating various sensors, actuators, and IoT devices, the system monitors and controls lighting, temperature, security, entertainment, and energy management systems. Utilizing AI frameworks and Natural Language Processing (NLP) libraries (Dialog flow), the system features voice command recognition, predictive energy management, automated scene setting, real-time security monitoring, and personalized automation. With enhanced energy efficiency (up to 30% reduction), improved home security (real-time monitoring and alerts), increased user convenience (voice command and automated scene setting), and scalability, this system is ideal for residential and commercial buildings, elderly care, energy-efficient buildings, and smart cities.

Keywords — Smart Home-Artificial Intelligence (AI)-Internet of Things (IoT)-Energy Efficiency-Security-Automation-Machine Learning-Natural Language Processing (NLP)-Voice Command Recognition Predictive -Energy Management-Real-time Monitoring-Personalized Automation-Scalability

----------**********----------

I. INTRODUCTION

Smart home automation has become an integral part of modern living, allowing homeowners to control their appliances, security, and energy usage remotely. This project focuses on developing a smart home system using the AI Thinker VC-02 voice module, ARDUINO UNO. The system allows users to operate home appliances using voice commands and a mobile application, ensuring enhanced convenience, security, and energy efficiency.

Home automation is gaining popularity due to its ability to enhance living standards, reduce energy consumption, and improve security. The introduction of voice-controlled automation has made interactions with home devices seamless and efficient. By integrating VC-02, ARDUINO UNO this project provides an innovative, cost-effective, and scalable solution for smart home management. The primary focus is on ease of use, accessibility, and automation, ensuring that users can operate their homes effortlessly with voice and remote commands.

This document provides a detailed breakdown of the system design, implementation, functionality,

challenges, and future prospects, ensuring a comprehensive understanding of the project

II. DESIGN AND CONSTRUCTION

The smart home system is designed with a combination of hardware and software components, ensuring seamless communication between devices and user interfaces. The architecture integrates voice control, IoT-based remote access, and automation using a well-defined communication framework.

OVERALL SYSTEM ARCIHTECTURE

The architecture consists of three primary layers:

1.Input Layer: Captures user commands via the VC-02 voice module.

2.Processing Layer: The processes commands and sends control signals to the relays.

***3.Output Layer*:** Actuates home appliances through the 4-channel relay module, providing real-time automation.

The integration of these layers allows users to operate home appliances both through voice commands and, ensuring accessibility and flexibility

III. WORKING PRINCIPLE

The smart home system operates seamlessly by integrating voice recognition and mobile control to manage home appliances. Here is a detailed breakdown of its working functionality:

1.VOICE COMMAND PROCESSING

The AI Thinker VC-02 voice module is responsible for capturing and processing voice commands. Upon receiving a voice command, the VC-02 module uses offline voice recognition to decode the audio into a corresponding hexadecimal command. The VC-02 converts the recognized speech into a hexadecimal string, such as 0x01 0x00 for turning the light on, and sends this data through the UART (Universal Asynchronous Receiver-Transmitter) protocol to the Arduino UNO This ensures the system does not rely on the internet for processing commands, which is one of the major advantages of this setup.

The Arduino UNO receives the hexadecimal data, compares it with the predefined set of commands, and triggers the appropriate action by controlling the 4-channel relay module. This module is responsible for physically switching the connected appliances on or off (such as lights, fans, air conditioners, warm Light).

2.HYBRID CONTROL SYSTEM

The most important aspect of this system is its hybrid control functionality, where users can choose between voice commands to operate appliances. This flexibility allows users to control their home devices even when they are not physically near them, offering both convenience and accessibility.

For example, users can turn on the fan using voice commands when they are in the room

3.RELAY ACTIVATION

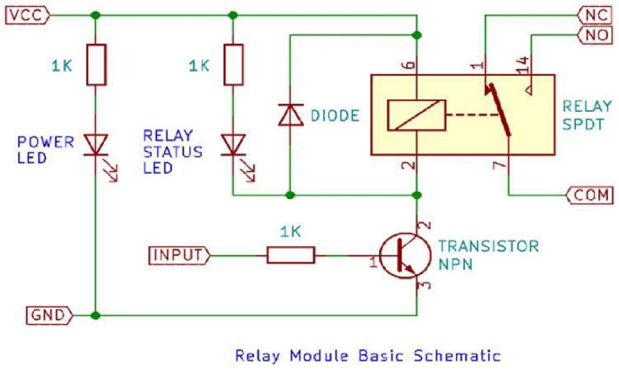


Fig.3.3.1

Each appliance is connected to one of the five relay channels, and the Arduino UNO processes the command (whether from voice or mobile control) to activate or deactivate the corresponding relay. The relay module controls the current flow to the appliances, thus turning them on or off based on the user's input.

- The relays are triggered by digital GPIO pins of the Arduino UNO, For instance: The light is controlled by GPIO5 (pin D1).
- The fan is controlled by GPIO4 (pin D2).
- The air conditioner is controlled by GPIO0 (pin D3).
- The warm Light is controlled by GPIO2 (pin D4).
- This method of controlling home appliances through relays is both efficient and reliable, ensuring that the devices only receive power when intended.

The circuit design plays a crucial role in ensuring the seamless operation of the smart home system. The integration of Arduino UNO, VC-02 voice module, relay module, and power supply requires a structured wiring approach to maintain efficiency and reliability.

1.Arduino UNO: The main controller that processes voice commands and controls relays.

2.VC-02 Voice Module: Captures voice commands and transmits hexadecimal instructions to Arduino uno

3.4-Channel Relay Module: Acts as an interface between Arduino UNO and home appliances, enabling switching operations.

4.Power Supply System: Provides appropriate voltage levels for each component to function efficiently.

4.POWER SUPPLY CONSIDERATIONS

Powering the Arduino UNO and relay module correctly is essential for stable operation. The Arduino UNO operates at **3.3V**, whereas the relay module requires **5V**. To ensure proper voltage levels:

- The Arduino UNO is powered via a 3.3V source.
- The relay module is powered using an external 5V supply.
- The GND connections of Arduino Uno, relay module, and VC-02 are all tied together to maintain a common ground reference.

5.CIRCUIT PROTECTION MECHANISMS

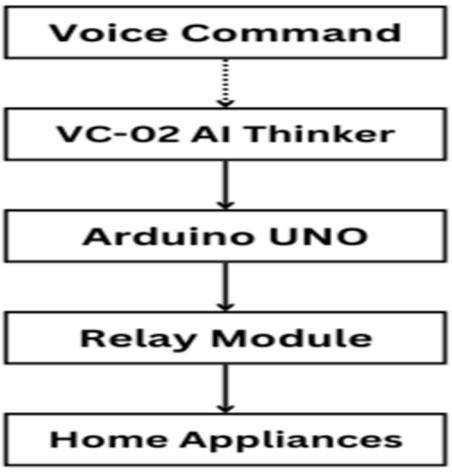
- To prevent damage due to electrical surges or miswiring, the following protective measures are implemented:
- Diodes across relay coils to prevent back EMF.
- Pull-up resistors on communication lines to ensure stable logic levels.
- Voltage regulators to maintain steady power supply.
- Fuse protection for relay-operated high-power appliances.

6.SYSTEM WORKFLOW

1.Voice Input: The user provides a voice command, which is processed by the VC-02 module.

***2.Command Transmission*:** The Arduino UNO receives the corresponding hexadecimal command and processes it.

3.Appliance Control: The appropriate relay is activated or deactivated based on the command received.



The modular design of the system ensures easy scalability, allowing the integration of additional

sensors and devices in the future. This makes the system adaptable to evolving home automation needs. The system consists of:

- Arduino UNO for Wi-Fi communication and processing
- VC-02 AI Voice Module for voice command recognition.
- 4-Channel Relay Module for appliance control
- Power Supply & Sensors for automation enhancements

7.COMMUNICATION PROTOCOLS

UART Communication between Arduino UNO and VC-02, Relay Control Signals for switching appliances. The architecture ensures a seamless integration of hardware and software components, allowing efficient control of home devices. The Arduino UNO acts as the central processing unit, handling both voice commands from VC-02. The relay module serves as the actuator, switching appliances based on received signals.

8.COMMAND CUSTOMIZATION & FLEXIBILITY

The system allows for easy customization of commands. By altering the firmware of the Arduino UNO, additional commands can be added to control other devices or appliances

adding extra relay channels and modifying the command logic in the firmware. Similarly, the VC-02 module can be trained to recognize different phrases for existing commands, offering more personalized voice control. This level of customization ensures that the system remains adaptable to future user needs.

9.ENERGY EFFICIENCY & AUTOMATION

The system can be extended to implement automation features for energy efficiency. For instance, the user can set schedules to turn off appliances like fans or lights when not in use, or create scenarios where certain devices operate only when a specific condition is met (such as turning on the air conditioner when the temperature exceeds a set limit).

In the future, additional sensors (e.g., motion sensors, temperature sensors) can be integrated into the system to further optimize energy usage and enhance home automation. The system could automatically turn off devices when no motion is Additionally, the use of command filtering ensures that invalid or malicious commands are ignored, adding an extra layer of security to the system.

10.SECURITY & AUTHENTICATION

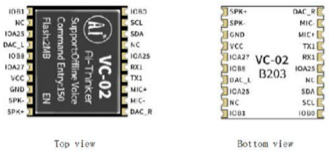
The system is built with security in mind. ensuring that only authorized users can access and control the system remotely.

Additionally, the use of command filtering ensures that invalid or malicious commands are ignored, adding an extra layer of security to the system.

IV. COMPONENTS

1.HARDWARE COMPONENTS

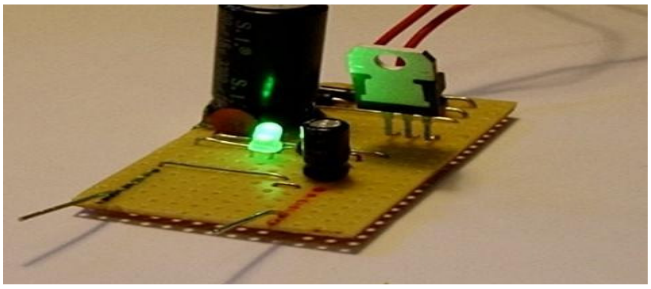
- ***AI Thinker VC-02:*** A dedicated voice recognition module that enables offline voice control, reducing dependency on cloud services.



- ***ARDUINO UNO*:** Acts as the core controller, managing communication between the voice module, relay module

- ***Relay Module (4-Channel):*** Controls home appliances such as lights, fans, air conditioners, motors, and heaters.

- ***Power Supply:*** Provides necessary voltage levels to operate the Arduino UNO, VC-02, and relay module.



2.SOFTWARE COMPONENTS

- ***Arduino IDE:*** Used for programming Arduino UNO and uploading firmware.

- ***Firmware for Voice AI Thinker:*** Manages data communication, command execution, and relay actuation.

V. CONCLUSIONS

This project successfully integrates voice control and IOT automation into a single, efficient system. Using the Arduino UNO, VC-02 the system ensures seamless appliance control via voice commands. The project paves the way for enhanced smart home solutions with AI-driven automation, increased security, and energy-efficient operations.

The combination of low-cost hardware, efficient software, and AI-driven control mechanisms makes this system scalable, reliable, and user-friendly. With further research and development, it has the potential to become a mainstream smart home automation solution.

ACKNOWLEDGMENT

The heading of the Acknowledgment section and the References section must not be numbered.

Causal Productions wishes to acknowledge Michael Shell and other contributors for developing and maintaining the IEEE LaTeX style files which have been used in the preparation of this template. To see the list of contributors, please refer to the top of file IEEETran.cls in the IEEE LaTeX distribution.

REFERENCES

1.Research Article:

- https://www.researchgate.net/publication/349869633_Designing_a_Smart_Home_Management_System_with_Artificial_Intelligence_Machine_Learning
- https://www.researchgate.net/publication/362399883_A_voice_controlled_smart_home_automation_system_using_artificial_intelligent_and_internet_of_things

2.Video Reference:

- https://youtu.be/9CBCDxCA5s8?si=JRPC8IWlQmYsLX3m
- https://youtu.be/UlT72MMbPu8?si=PylNOjKtWRwa4NnU

3.IEEE PAPER:

- https://ieeexplore.ieee.org/document/9781919
- https://ieeexplore.ieee.org/document/6295694
- https://www.researchgate.net/publication/351999190_An_IoT-Based_Smart_Home_Automation_System

