Swanirman Sunirmit Publications of Research Volume 5, Issue 1-March 2025 | [2025-26]
ISSN [Online]: 2583-2654

Smart Home Automation System with Speech Recognition Module VC-02

G. Hema Naga Vaishnavi
Department of ECE
BE(ECE)-V Sem
Maturi Venkata Subba Rao (MVSR) Engineering College

Aditi Hotkar
Department of ECE
BE(ECE)-V Sem
Maturi Venkata Subba Rao (MVSR) Engineering College

B. Bhavani, Asst.Prof.
Department of ECE
Maturi Venkata Subba Rao (MVSR) Engineering College

Abstract: The rapid growth of IoT and home automation has made modern life much easier**.** With a few taps or voice commands various home appliances ranging from basic lights and fans to complex security systems can be controlled making modern homes smarter and more functional. The available Home Automation systems mostly rely on cloud-based infrastructure. They transmit the personal data of users to the cloud for effective functionality which makes them vulnerable to cyber-attacks. Additionally, they rely heavily on stable internet connections which makes the system awry if the connection is weak or disrupted. This report presents an overview of a project on an offline home automation system that can be reliable during poor network connection and is secure from cyber-attacks. This voice-activated system is more beneficial for the elderly and people with disabilities. The proposed system can effectively optimize the appliances connected to it and is more cost-efficient than existing systems.

Keywords: offline, speech recognition, smart home automation systems, AI Thinker, voice-controlled devices, natural language processing, efficient energy use.

I. INTRODUCTION

The integration of technology and advancements in the Internet of Things (IoT) has significantly transformed people's interaction with their living environment. Home automation improves the convenience of using security and energy efficiency in modern living. It drastically improves the lives of elderly and differently abled people due to its hands-free control [1]. The voice-activated commands play a key role in improving the accessibility to an easier lifestyle. Though many cloud-based systems are available on the market launched by companies like Google and Amazon (Alexa), their dependency on internet connectivity leads to vulnerability during power outages or internet connectivity issues. Storage of users' data on the cloud consistently raises privacy and security concerns. Many modem families are reluctant to use these voice assistants due to the repeated need for subscriptions.

The security issues can be solved by using an offline home automation system. These systems operate independently of internet connectivity, ensuring reliability and uninterrupted functionality.

The basic home appliance can be easily controlled with voice commands hence there is scope for cyber attacks like DoS and Man in the Middle[2]thus making these offline systems more secure and private. Many existing offline home automation systems utilize technologies like RF modules, and IR controllers which can work without the internet but struggle with a limited range of logic controllers that are more reliable and flexible but can be complex to program and costly for small applications.

Various researchers have proposed many techniques for using offline-based voice-assisted home automation systems. An example of an offline demotic system based on voice commands is Errobidart et al. 2017. This uses the EasyVR speech recognition module in conjunction with Arduino Mega [3]. Since Natural Language Processing (NLP) is not incorporated into the device, commands need to be predefined for each task. Also, comparing the

ISSN [Online]: 2583-2654

cost of the EasyVR shield with that of the Arduino MEGA, the total cost of the device becomes more than what those commercially available home assistants cost [4].

This project on offline home automation proves to be much more cost-effective and free from multiple risks embedded in standard smart home systems. The system deletes any dependency for popular online system functionalities of the recurring internet subscription cost paid. Instead, there is an alternative cost-efficient hardware i.e. an offline speech recognition module VC-02. The system utilizes the VC series offline voice module developed by Ai-Thinker Company to achieve simple voice operation control, making it easy for users to make corresponding responses to the relevant content of voice broadcast prompts. The proposed system uses the vc-02 voice recognition module which receives commands and sends the respective signal associated with the command to the relay module. The relay module controls various appliances based on the module's signal.

II LITERATURE SURVEY

As convenient and functional as home automation is, it can pose some threats to user's personal information and privacy. According to Jouni Himanen's thesis on 'Cybersecurity risks of Home Automation',2023, several attacks like Dos and MitM are harder to resolve. Offline home automation can be an answer to enhance the security of smart homes.

Similar disadvantages of cloud-based home automation are mentioned in a study by A .S. Nassem where it has been provided that offline home automation can be a solution.

According to Yuhang Xie's jmynal, 'Design of Intelligent Voice Greenhouse System, ' a voice-assisted model can be an effective tool in modern agriculture. Taking this as the base, a simpler version of a voice-assisted home automation system that controls various home appliances was developed. This system is a cost-efficient and simple model for controlling a set of devices by voice commands.

III WORKING MODEL

The proposed system uses VC-02 as the main control. Where it controls the command-based operation of appliances, it has a mic to receive the command and a speaker for a return word—a relay module for the on-off of devices. The power supply is connected to the relay from the sockets. A smart socket can be used to connect the devices. The block diagram of this system is shown in Fig 4,

3.1 Design of Voice Recognition Module.

Designing a voice interaction recognition module. VC-02, an offline voice module, has been developed by Ai-Thinker Company. This module processes local voice recognition without cloud access.

Its recognition is about 90% for far-field distance-1~5 meters. It also has an RTOS lightweight system, GPIO control, UART, I2C, SPI, and more communication support.

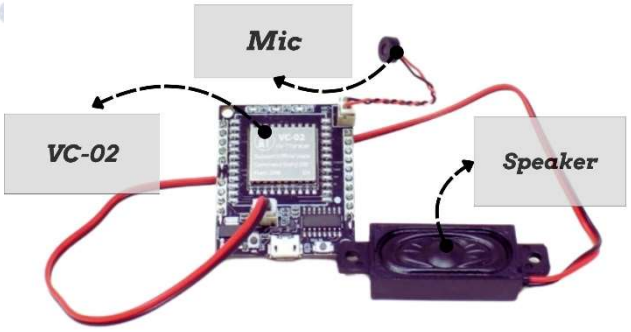
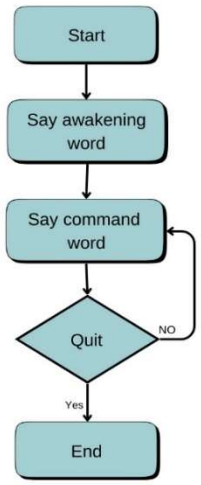


Fig.1 Voice Recognition Module-VC-02

The working principle of VC-02 involves sample picking within the speech sample library, followed by a feature extraction. Formation of an acoustic model involves pre-processing for model classification and matching, along with the output of recognition results. VC-02 sets a wake-up word through SDK. Users control VC-02 to execute the appropriate input-output based on the defined word and select whether to exit after a time interval. The voice identification

ISSN [Online]: 2583-2654

and control process is shown in Fig. 2.[5] The UART transmission protocol facilitates full-duplex communication, allowing two-way data transfer making VC-02 a versatile module. The user can voice command the system directly from the VC-02.



Fig,2 Voice identification process of vc-02

3.2 Microphone

The electret condenser microphone is used to receive the voice commands from the user and transmits it to VC-02 where it decodes the command and performs the required action.

3.3 Speaker

A speaker connected to the VC-02 outputs the relay word allocated for the specified action. The relay is fed to VC-02 by the SDK file generated and dumped onto the VC-02 module.

3.3 Relay Module

This system uses a 220v-5v DC relay to convert the 220v supply to a 5v DC supply. This relay helps in controlling devices or circuits that require more current voltage than the control circuit can handle directly. A relay uses a low-power signal to control a larger one making it safer and easier to switch high-power devices ON and OFF.

The basic relay component and its working is shown in Fig. 3. The relay in the system proposed isolates the VC-02 module from the high-power home appliances making the environment safe to work.

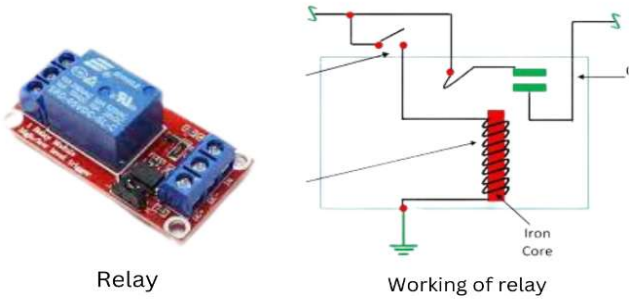


Fig.3 Relay and Its Working

3.4 Software Specification

The tool needed to build the voice SDK for VC-02 is provided by the AI-Thinker company, in which the user just needs to log in and enter the various commands that are needed for their project. Then user has to provide the functions of GPIO pins according to the voice commands. The SDK file is built for the required specifications. This file can be flashed onto the vc-02 module using the Hummingbird Burning Tool.

The implementation of the system is shown in Fig. 4. Various home appliances can be controlled using voice commands as shown. Section 3.5 shows the flow and working of the system.

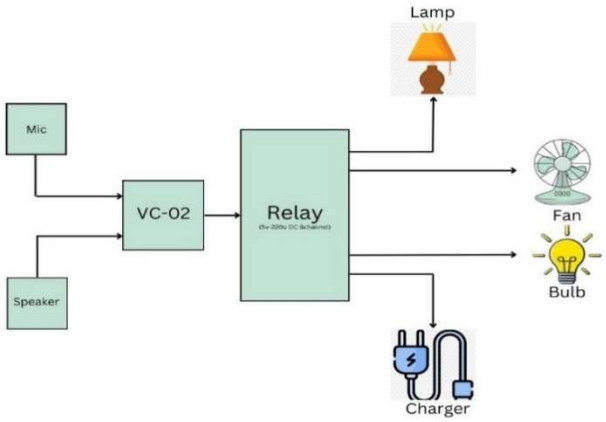
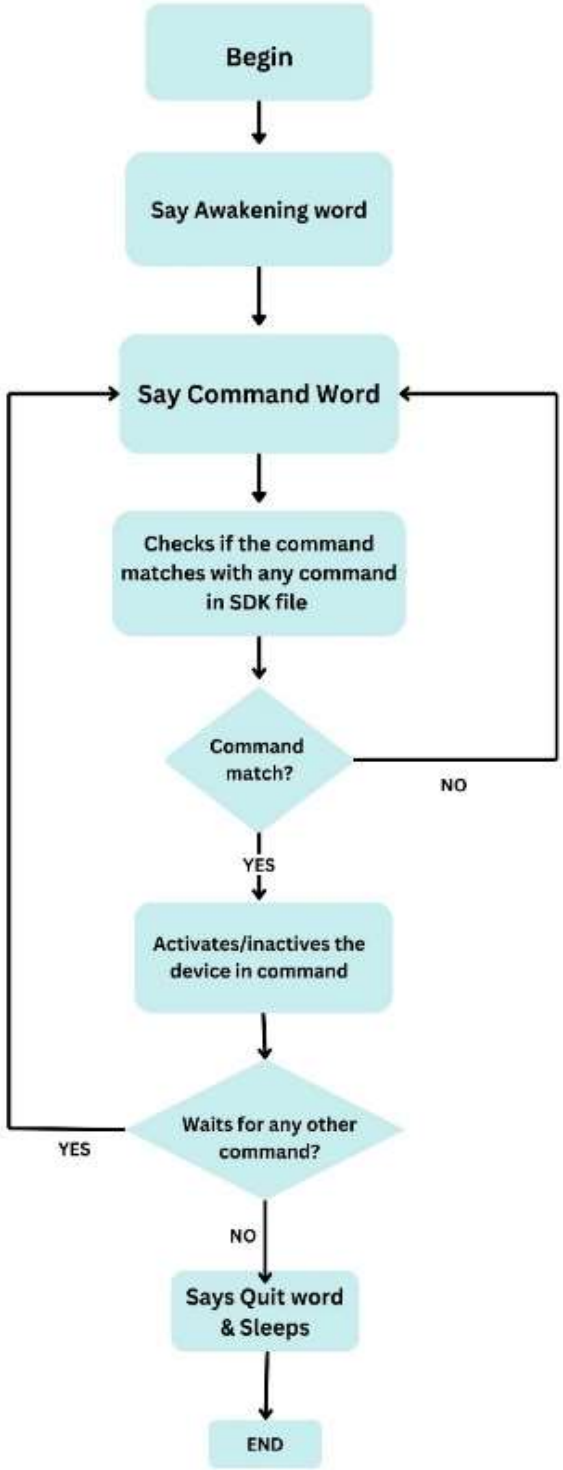


Fig.4 Block diagram

ISSN [Online]: 2583-2654

3.5 Flow Diagram



IV IMPLEMENTATION OF THE SYSTEM

V FUTURE SCOPE

Other potential areas for future research and development in the offline home automation application of VC-02 could involve further sensors - such as ambient temperature and humidity, enhance the capabilities of the system through the achievement of more comprehensive automation experiences. The extension of multiple rooms and appliances into it would increase its utility and attractiveness to the customer. For example, because in this system, the number of appliances that the user may operate is equal to the number of relay connections, implementing power-saving algorithm features would be an ideal input to control the future growth of power consumption. Considering a comparative study of different elements of innovation in offline mode could guide a researcher towards various pros and cons of the tested VC-02 module in terms of offline voice recognition and control concerning the number of appliances connected.

VI CONCLUSION

The main discovery of this study was that the offline home automation system with the VC-02 module has made a significant step forward in home automation technology. It enables a very simple and safe method for control of home appliances without dependence on the internet.

ISSN [Online]: 2583-2654

The offline home automation system using the VC-02 module provides a promising solution to those seeking a reliable, user-friendly, and efficient Home Automation system. The scope of this research to further improve the capability of the system includes looking at more applications for improving performance.

REFERENCES

[1] N. Katuk, K. R. Ku-Mahamud, N. H. Zakaria, and M. A. Maarof, "Implementation and recent progress in cloud-based smart home automation systems," ISCAIE 2018 - 2018 IEEE Symposium on Computer Applications and Industrial Electronics, pp. 71–77, Jul. 2018, doi: 10.1109/ISCAIE.2018.8405447.

[2] Jouni Himanen," Assessment of the emerging cyber security risks of home automation*", the Lahti University of Technology LUT, Bachelor's thesis in Electrical Engineering,2023.*

[3] J. Errobidart, A. J. Uriz, E. Gonzalez, I. E. Gelosi, and J. A. Etcheverry, "Offline domotic system using voice comands," 2017 8th Argentine Symposium and Conference on Embedded Systems, CASE 2017, pp. 25– 30, Nov. 2017, doi: 10.23919/SASE-CASE.2017.8115370.

[4] "EasyVR 3 Plus Shield for Arduino - COM-15453–SparkFunElectronics."https://www.sparkfun.com/products/15453(accessed Apr.09, 2022).

[5] " Design of Intelligent Voice Greenhouse System Based on STM32 MCU", Yuhang Xie 2023 J. Phys.: Conf. Ser. 2562 012054.

AUTHOR'S PROFILE

G. Hema Naga Vaishnavi pursuing her BE in ECE from MVSR Engineering College, Hyderabad, has a strong interest in exploring IoT and embedded systems, along with their applications in fields like industrial automation.

Aditi Hotkar, is a passionate student pursuing her degree in Electronics and Communication Engineering from MVSR Engineering College. She is enthusiastic about learning various developments in Satellite communication.

Mrs. B. Bhavani has obtained her B.E degree from Andhra University and an MTech Degree from JNTU, Hyderabad with a specialization in Embedded Systems. She is currently working as an Assistant Professor in Maturi Venkata Subba Rao (MVSR) Engineering College, Hyderabad, Telangana. She has more than 16 years of teaching experience and has published 12 papers in International Journals. She is a Life member of ISTE and IETE.