IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.021 ⪤ Peer-reviewed & Refereed journal ⪤ Vol. 13, Issue 4, April 2025

DOI: 10.17148/IJIREEICE.2025.13402

SMART VOICE-CONTROLLED APPLIANCE MANAGEMENT SYSTEM USING LABVIEW

Dr. Shanmugavalli M[1], Mohammed Abdullah N[2], Prasanna V[3], Koushik T[4]

Professor Department of Instrumentation and Control Engineering, Saranathan College of Engineering- Trichy, Tamil Nadu, India.[1]

UG Student, Department of Instrumentation and Control Engineering, Saranathan College of Engineering- Trichy, Tamil Nadu, India.[2,3,4]

Abstract: Home automation has transformed the way electrical appliances are managed, improving convenience, energy efficiency, and accessibility. This research presents a smart voice-controlled appliance management system that allows users to operate household appliances using voice commands transmitted via Bluetooth to myRIO. The system is particularly designed to assist individuals by providing a hands-free and intuitive method for controlling electrical devices. Using LabVIEW, the system processes and interprets voice commands, subsequently triggering the activation or deactivation of appliances through relay control circuits. The methodology includes voice recognition, wireless data transmission via Bluetooth, real-time processing in myRIO, and execution of commands through relay switching. Experimental validation demonstrates high command accuracy, minimal latency, and reliable Bluetooth communication. This paper discusses the system's design, working principles, testing outcomes, and future improvements. The proposed system is cost-effective, scalable, and practical for integration into smart homes and assistive technology applications.

Keywords: Home Automation, IoT, MyRIO, Bluetooth communication, LabVIEW.

I. INTRODUCTION

In recent years, automation and artificial intelligence (AI) have significantly impacted daily life, leading to advancements in smart home systems. Traditional methods of controlling electrical appliances, such as physical switches or remote controls, require manual operation, which may not be feasible for individuals with mobility impairments, the elderly, or those with physical disabilities. Additionally, manual controls can be inefficient when managing multiple appliances simultaneously. Voice-controlled automation provides a more intuitive, efficient, and accessible approach to home appliance control.

This technology leverages speech recognition and wireless communication to eliminate physical interaction, thereby offering an improved user experience. Bluetooth-based wireless control is particularly beneficial due to its low power consumption, affordability, and stable connectivity. This paper presents a Smart Voice-Controlled Appliance Management System that enables users to operate electrical appliances using voice commands transmitted to myRIO via Bluetooth.

The system is designed to:

- Enhance accessibility for differently-abled users.
- Provide hands-free and efficient control over multiple appliances.
- Improve energy efficiency by enabling smart control mechanisms.

Eliminate the need for physical remote controls, which can be misplaced or require maintenance. This research contributes to the field of smart automation and assistive technologies, demonstrating an effective and scalable voice-controlled appliance management system.

II. LITERATURE REVIEW

Bhuvaneswari, T., Chitra, V., & Goh, C. C. (2023). Voice Controlled Home Automation System Design. International Journal on Robotics, Automation and Sciences, 5(2), 94–100. This paper presents a voice-controlled home automation system utilizing an Android smartphone and a microcontroller, designed to assist individuals with disabilities or seniors. The system incorporates Bluetooth connectivity, voice recognition via Google Cloud Speech API, and manual control switching.

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering
Impact Factor 8.021 ⪅ Peer-reviewed & Refereed journal ⪅ Vol. 13, Issue 4, April 2025
DOI: 10.17148/IJIREEICE.2025.13402

Akour, M., Al Radaideh, K., Shadaideh, A., & Okour, O. (2020). Mobile Voice Recognition Based for Smart Home Automation Control. International Journal of Advanced Trends in Computer Science and Engineering, 9(3), 3788–3792. This study explores a mobile voice recognition system for smart home automation, focusing on the integration of voice commands to control various household appliances, enhancing user convenience and system accessibility.

Garg, P., Agrawal, S., Yiyang, W., & Saraswat, A. (2018). Design and Implementation of Interactive Home Automation System Using LabVIEW. In Proceedings of First International Conference on Smart System, Innovations and Computing (pp. 371–381). Springer, Singapore. This paper discusses an interactive home automation system employing LabVIEW software and a DAQ-6009 interface for controlling home appliances. The system features manual and automated modes, a scheduler system, and an authenticated log-in scheme to ensure optimal utilization and a secure environment.

Hamzah, N. A. B. A., Saad, M. R. B. A., Ismail, W. Z. B. W., Bhuvaneswari, T., & Rahman, N. Z. B. A. (2019). Development of A Prototype of An IoT-Based Smart Home with Security System Flutter Mobile. Journal of Engineering Technology and Applied Physics, 1(2), 34–41. This paper discusses the development of an IoT-based smart home prototype featuring a security system and a Flutter mobile application, aiming to provide a user-friendly interface and enhanced security features for home automation.

Osamor, V., Emebo, O., Fori, B., & Adewale, M. (2019). Engineering and Deploying a Cheap Recognition Security System on a Raspberry Pi Platform for a Rural Settlement. International Journal of Advanced Trends in Computer Science and Engineering, 8(6), 3686–3691. This research focuses on developing an affordable recognition security system using a Raspberry Pi platform, targeting rural settlements to enhance security and automation in home environments.

Wati, D. A. R., & Abadianto, D. (2017). Design of Smart Home Systems Prototype Using MyRIO. IOP Conference Series: Materials Science and Engineering, 215(1), 012034. This paper presents a smart home system prototype using the MyRIO 1900 embedded device as the main controller. The system includes wireless monitoring, email-based notifications, and data logging, with simulated sensors and actuators to demonstrate real-time responses and system stability.

Hossain, M. S., Islam, M. N., & Alam, M. S. (2016). Voice-Activated Home Automation System Using Natural Language Processing and IoT. International Journal of Computer Applications, 144(12), 7-13. This paper presents a home automation system that utilizes voice commands processed through natural language processing (NLP) techniques and IoT devices.

Arul, S. B. (2014). Wireless Home Automation System Using Zigbee. International Journal of Scientific & Engineering Research, 5(12), 133–138. This research introduces a wireless home automation system utilizing Zigbee technology, focusing on the design and implementation of a cost-effective and efficient solution for controlling household appliances remotely.

Pandya, S., Kale, O., Shaikh, N., & Vishwanath, S. (2014). Interactive Home Automation System Using Speech Recognition. International Journal of Engineering Research & Technology (IJERT), 3(4). This paper presents a home automation system that enables users to control household appliances through speech commands.

Hamed, K. A. A. (2012). Design and Implementation of Wi-Fi Based Home Automation System. World Academy of Computer, Electrical, Automation, Control and Information Engineering, 6(8), 2177–2183. This paper presents the design and implementation of a Wi-Fi-based home automation system, highlighting the use of wireless technology to monitor and control home appliances, enhancing convenience and energy efficiency.

III. METHODOLOGY

The methodology section (Figure 1) outlines the design, implementation, and functioning of the Smart Voice-Controlled Appliance Management System using LabVIEW. The system is structured to receive voice commands, transmit them via Bluetooth, process them using myRIO, and control connected appliances accordingly. The following subsections provide an in-depth view of each stage in the system's operation.

DOI: 10.17148/IJIREEICE.2025.13402

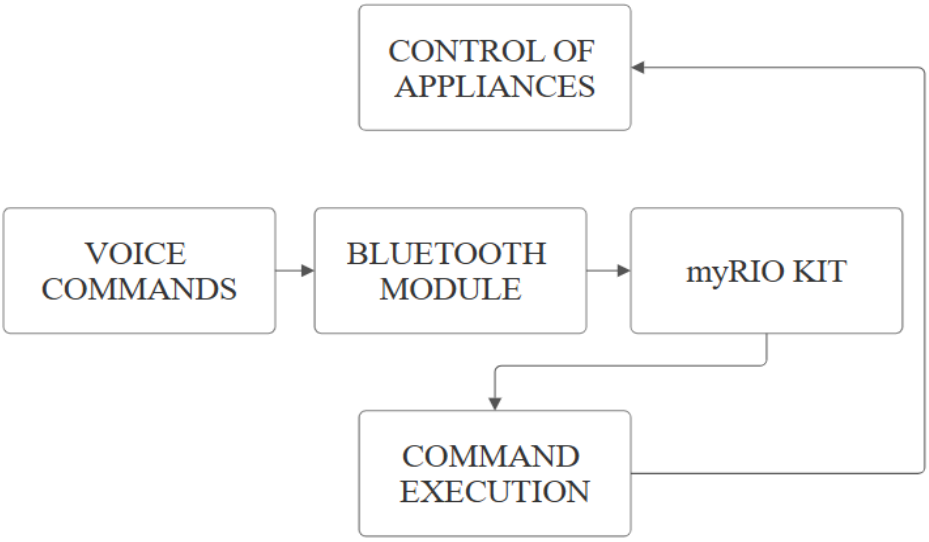

Figure 1: Functional block diagram of the system

a. System Overview

The proposed system (Figure 1) is designed to control home appliances using voice commands transmitted via Bluetooth. The system consists of three primary components:

- Mobile Device with Voice Recognition: Captures and processes voice commands.
- Bluetooth Communication Module: Acts as an interface between the mobile device and myRIO.
- myRIO and Appliance Control Circuit: Processes received commands and controls appliances like lights, fans, and motors.

When a voice command such as "Light ON" is given, it is processed and converted into a text command. This command is sent via Bluetooth to myRIO, which interprets it and activates the corresponding appliance. The system ensures real-time execution with minimal response delay.

b. Voice Recognition Using Mobile Device

Voice recognition is the foundation of this system, allowing users to issue commands naturally. The mobile device records the user's speech and processes it using a speech-to-text engine. The spoken command is then converted into a standardized text-based instruction such as "LIGHT_ON" or "FAN_OFF." To improve accuracy, the system operates within a predefined command set, reducing errors caused by background noise or variations in speech. Once the text command is generated, it is formatted into a structured data packet and transmitted to myRIO via Bluetooth. This method ensures that the system can accurately interpret and respond to the user's instructions in real-time.

c. Bluetooth UART Communication

Wireless communication between the mobile device and myRIO (Figure 2) is established using a Bluetooth module that operates through UART (Universal Asynchronous Receiver-Transmitter) communication. Once paired with the mobile device, the Bluetooth module continuously listens for incoming data. When a command is received, it is transmitted in the form of a serial data packet. myRIO is programmed to continuously monitor the Bluetooth UART interface, ensuring that no command is lost. This wireless communication method provides a reliable and energy-efficient means of data transmission while eliminating the constraints of wired connections. The low-latency nature of Bluetooth enables quick responses, ensuring that appliance control is near-instantaneous.

d. Data Acquisition in myRIO

The myRIO processes incoming data using LabVIEW Real-Time (RT). A UART serial read function is implemented to fetch the transmitted command. The received data is stored as a string variable and passed to the decision-making unit. To handle erroneous or incomplete transmissions, the system validates each received string before executing any action. Additionally, a timeout mechanism is implemented to discard outdated or incomplete commands, preventing unintended system behavior. The acquired data is buffered temporarily before being passed to the decision-making unit for further processing.

DOI: 10.17148/IJIREEICE.2025.13402

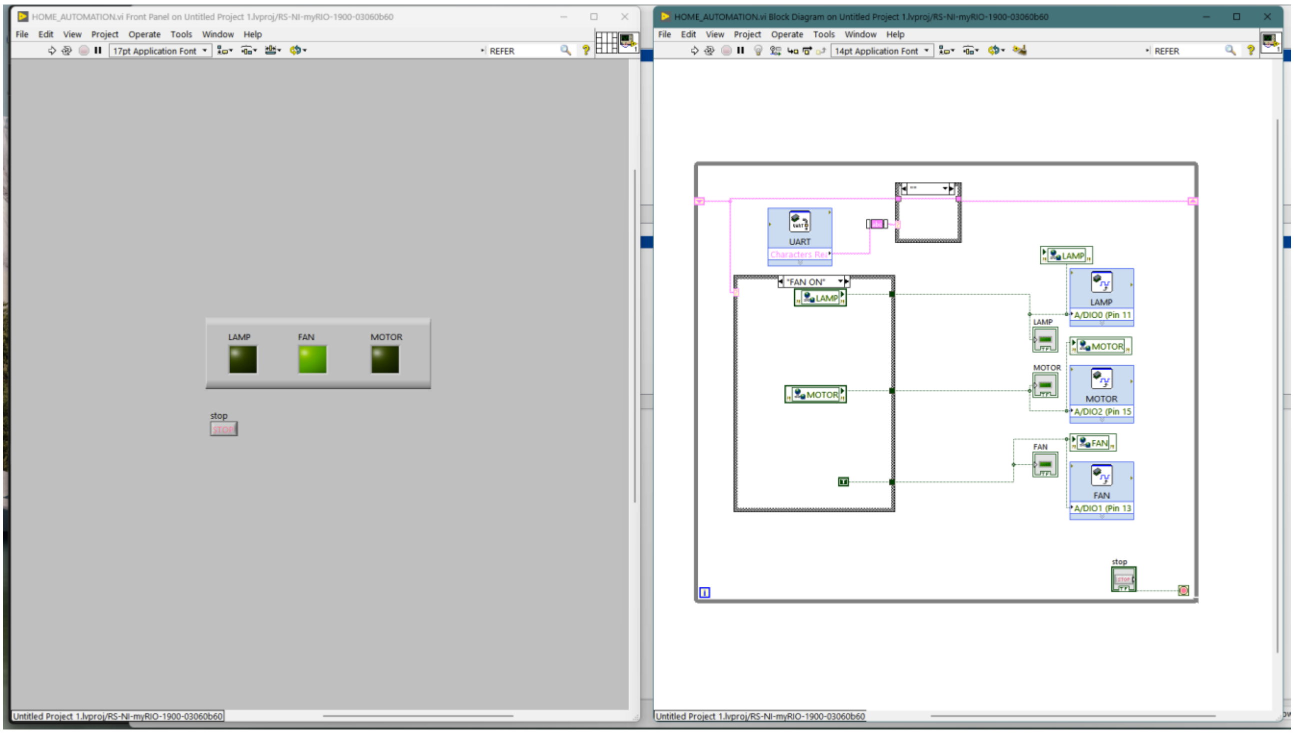

Figure 2. Labview Front panel and Block diagram for controlling appliances.

e. Command Processing Using Case Structure

A Case Structure is used in LabVIEW to compare the received string with predefined commands. If a match is detected, the system triggers the corresponding action (Figure 3).

To execute the received commands, a case structure is implemented in LabVIEW. The process includes:

- Checking the Command: myRIO compares the received command with predefined cases (e.g., *"LIGHT_ON"*, *"FAN_OFF"*).
- Selecting the Appropriate Action: The corresponding case is executed, triggering the appropriate control signal.
- Sending the Control Signal: The signal is sent to the appropriate appliance relay to perform the action.

This structured approach ensures an organized and efficient command execution process.

f. Execution of Commands

Upon receiving and processing the command (Figure 2), myRIO controls the connected appliances using relays, ensuring accurate and efficient execution.

- Activating the Correct Relay: myRIO identifies the target appliance and sends a digital output signal to the corresponding relay, ensuring precise control.
- Switching the Appliance ON/OFF: The relay toggles the appliance state based on the command, turning it ON or OFF as instructed.
- Indication on LabVIEW Front Panel: A visual indication system updates the appliance status in real time, showing ON/OFF states through LED indicators or status labels.
- Confirming the Action: A confirmation message is sent back to the mobile device, ensuring the user is aware of the command execution.

This approach ensures real-time control with minimal delay, enhancing system reliability and user experience.

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526
International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering
Impact Factor 8.021 ⪤ Peer-reviewed & Refereed journal ⪤ Vol. 13, Issue 4, April 2025
DOI: 10.17148/IJIREEICE.2025.13402

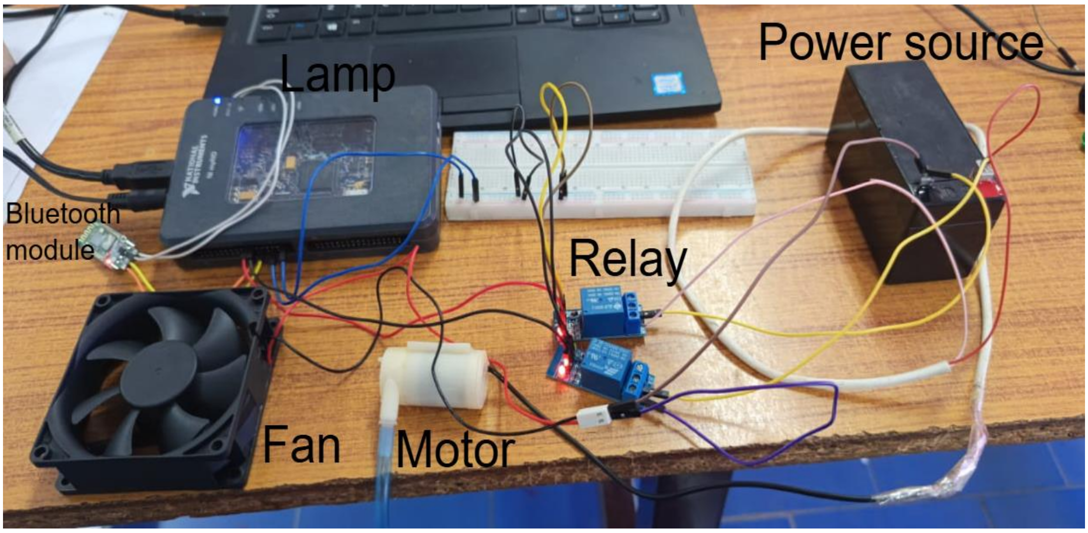

Figure 3: Hardware connection diagram for the system.

g. Real Time System Response

The response time of the system is measured to ensure minimal latency. The time taken from speech recognition to keypress execution is analyzed to evaluate the system's efficiency. Optimizations such as buffering serial data and reducing processing delays are implemented. A typical response time of 100-300 milliseconds is observed, making the system highly responsive for real-time applications. Further optimizations include:

- Adjusting Bluetooth baud rate (9600, 115200, etc.) for optimal speed
- Reducing unnecessary processing steps within LabVIEW RT
- Implementing a priority queue for sequential command execution

h. Validation and Testing

The system undergoes rigorous validation and testing to ensure its accuracy, efficiency, and robustness. Voice recognition accuracy is tested by issuing various commands under different environmental conditions, such as varying background noise levels and different speaker accents. Bluetooth communication stability is evaluated by testing data transmission at different distances and obstructions to determine its reliability. The system's ability to control appliances is assessed through multiple test cases, verifying whether the correct appliance responds to each command. Additionally, response time is measured to ensure real-time operation. By conducting extensive testing, the system is refined to provide a high level of performance and reliability.

i. Further Improvement

Although the current system provides efficient voice-controlled automation, further enhancements can be made to improve its capabilities. Future improvements include integrating Internet of Things (IoT) technology to enable remote control and monitoring of appliances through a cloud-based system. Expanding voice recognition to support multiple languages and accents can improve accessibility for a diverse range of users. Implementing AI-based speech recognition can enhance command accuracy, reducing errors caused by misinterpretation. Additionally, the system can be enhanced by incorporating motion or temperature sensors, allowing for automated control based on environmental conditions. These improvements will further enhance the system’s versatility, making it more intelligent and adaptive to user needs.

IV. RESULT AND DISCUSSION

The system was successfully tested to verify its functionality and reliability. The system effectively recognized and processed voice commands transmitted via Bluetooth, allowing seamless control of appliances such as lights, fans, and motors.

To validate the system’s performance, various test scenarios were conducted, including turning appliances ON and OFF individually and simultaneously. The response time was observed to be minimal, ensuring real-time control with high accuracy. Additionally, the LabVIEW front panel displayed the current status of each appliance, providing a clear visual indication of the executed commands.

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.021 ⁒ Peer-reviewed & Refereed journal ⁒ Vol. 13, Issue 4, April 2025

DOI: 10.17148/IJIREEICE.2025.13402

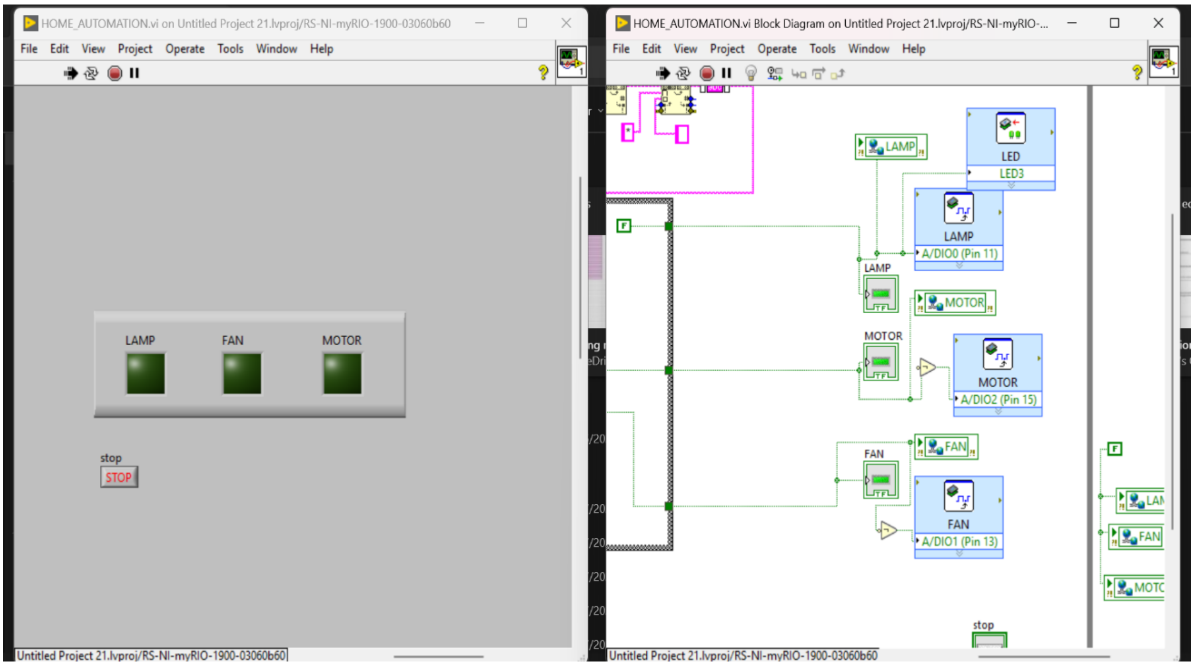

Figure 4a. Outcome of the system when all appliances are turned OFF.

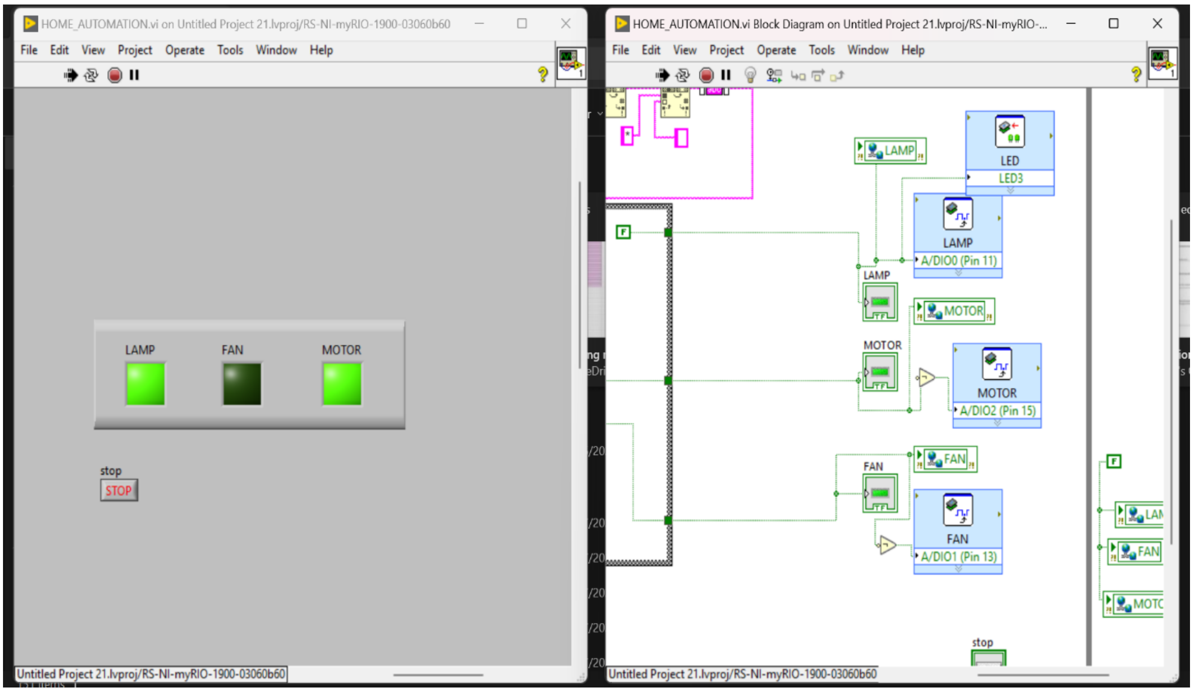

Figure 4b. When lamp and motor are turned ON.

For documentation purposes, images were captured during testing. One image (Figure 4a) shows the initial state where all appliances are OFF, while another (Figure 4b) demonstrates the successful activation of the lamp and motor in response to voice commands. These images serve as evidence of the system's effectiveness and real-time response capability.

The results confirm that the system is both functional and efficient, offering a hands-free solution for appliance control. Future enhancements could include IoT integration for remote access and AI-driven voice recognition for improved command accuracy.

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.021 ⪤ Peer-reviewed & Refereed journal ⪤ Vol. 13, Issue 4, April 2025

DOI: 10.17148/IJIREEICE.2025.13402

V. CONCLUSION

It enables hands-free control of electrical appliances through voice commands transmitted via Bluetooth. By integrating voice recognition, Bluetooth UART communication, and myRIO-based processing, the system provides an efficient, user-friendly, and reliable solution for home automation. The implementation of relays ensures seamless execution of commands, while the LabVIEW front panel offers real-time status indication, enhancing usability and system transparency.

The system demonstrates high accuracy in recognizing and executing voice commands with minimal delay, making it particularly beneficial for individuals with mobility impairments. The validation and testing phase confirmed its effectiveness in various conditions, proving its robustness and reliability.

One of the key strengths of the system is its ability to function without requiring complex wiring or extensive hardware modifications, making it an easily adaptable solution for existing home environments. Additionally, the integration of Bluetooth technology ensures secure and short-range wireless communication, reducing potential interference and improving command accuracy.

While the system has proven to be effective, future improvements could include IoT integration for remote access, AI-driven speech recognition for enhanced accuracy, and additional automation features such as sensor-based activation. Expanding the range of controllable devices and incorporating energy monitoring capabilities could further enhance the system's efficiency.

REFERENCES

[1]. **Bhuvaneswari, T., Chitra, V., & Goh, C. C. (2023).** Voice Controlled Home Automation System Design. International Journal on Robotics, Automation and Sciences, 5(2), 94–100

[2]. **Akour, M., Al Radaideh, K., Shadaideh, A., & Okour, O. (2020).** Mobile Voice Recognition Based for Smart Home Automation Control. International Journal of Advanced Trends in Computer Science and Engineering, 9(3), 3788–3792.

[3]. **Hamzah, N. A. B. A., Saad, M. R. B. A., Ismail, W. Z. B. W., Bhuvaneswari, T., & Rahman, N. Z. B. A. (2019).** Development of A Prototype of An IoT-Based Smart Home with Security System Flutter Mobile. Journal of Engineering Technology and Applied Physics, 1(2), 34–41.

[4]. **Osamor, V., Emebo, O., Fori, B., & Adewale, M. (2019).** Engineering and Deploying a Cheap Recognition Security System on a Raspberry Pi Platform for a Rural Settlement. International Journal of Advanced Trends in Computer Science and Engineering, 8(6), 3686–3691.

[5]. **Garg, P., Agrawal, S., Yiyang, W., & Saraswat, A. (2018).** Design and Implementation of Interactive Home Automation System Using LabVIEW. In Proceedings of First International Conference on Smart System, Innovations and Computing (pp. 371–381). Springer, Singapore.

[6]. **Wati, D. A. R., & Abadianto, D. (2017).** Design of Smart Home Systems Prototype Using MyRIO. IOP Conference Series: Materials Science and Engineering, 215(1), 012034.

[7]. **Hossain, M. S., Islam, M. N., & Alam, M. S. (2016).** Voice-Activated Home Automation System Using Natural Language Processing and IoT. International Journal of Computer Applications, 144(12), 7-13.

[8]. **Arul, S. B. (2014).** Wireless Home Automation System Using Zigbee. International Journal of Scientific & Engineering Research, 5(12), 133–138..

[9]. **Pandya, S., Kale, O., Shaikh, N., & Vishwanath, S. (2014).** Interactive Home Automation System Using Speech Recognition. International Journal of Engineering Research & Technology (IJERT), 3(4).

[10]. **Hamed, K. A. A. (2012).** Design and Implementation of Wi-Fi Based Home Automation System. World Academy of Computer, Electrical, Automation, Control and Information Engineering, 6(8), 2177–2183.