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Bluetooth And Arduino Uno-Based Voice-Controlled Home Automation System

Sapna Rajput[1],Narottam dutt Upadhyay[2],Chandrabhan Singh Kushwah[3],Shobha Kumari[4]

Department of Electronics &Communication

Institute of Technology &Management Gwalior

Abstract: This research presents the design and implementation of a voice-controlled home automation system using Bluetooth communication and the Arduino Uno microcontroller. The primary goal of the system is to offer a cost-effective, user-friendly solution for controlling household electrical appliances using voice commands, with a particular focus on aiding elderly and physically challenged individuals.The system architecture integrates an HC-05 Bluetooth module for wireless communication, a 2-channel relay module to control AC devices, and an Arduino Uno as the central processing unit. Voice commands are issued via an Android smartphone application, which transmits instructions to the Arduino through the Bluetooth module. Upon receiving the commands, the Arduino processes the input and triggers the corresponding relay to turn appliances on or off.The prototype was tested successfully with standard home lighting, demonstrating high accuracy, low latency, and reliable performance within the typical Bluetooth communication range. The results confirm the feasibility of the proposed system in real-world home environments. This project highlights the potential of combining embedded systems and wireless technology to enhance home automation, improve accessibility, and contribute to the development of smart living spaces.

Keywords: Arduino, home automation, voice, HC-05 Bluetooth Module

2-channel Relay Module(5v),2 Bulb

I. Introduction:

Automation has become an increasingly vital part of daily life and the global economy. Engineers strive to design complex systems by integrating automated hardware with mathematical and organizational tools to serve a wide array of applications and human activities. As technology and intelligent services have advanced, expectations around how services should be delivered and accessed—particularly at home—have shifted significantly. This shift has led to the evolution of the traditional household into the modern *smart home*, giving rise to the concept of **home automation systems**.Home automation involves the integration of domestic amenities and electronic equipment into a centralized system. These systems allow users to monitor and control electrical appliances with ease [1]. For example, a microcontroller-based control panel can manage heating, cooling, lighting, security, and other electronic devices [2]. Home automation enables remote control of appliances via computers or mobile devices, automatic responses to specific conditions, and centralized management through a single interface [3].Many traditional home automation systems, such as those based on Arduino, rely on wired connections. While this approach is suitable when integrated during the construction phase of a building, retrofitting such systems in existing structures can be costly. In contrast, **wireless** solutions—such as those using Bluetooth, Wi-Fi, and IoT (Internet of Things)—offer a more flexible and cost-effective alternative. The widespread adoption of wireless technologies and cloud computing has made these systems more accessible and prevalent in everyday use [4].

Over the past few decades, home automation has gained popularity for enhancing comfort, convenience, and quality of life [5]. For some users, especially those with physical disabilities, the need for accessible and user-friendly automation solutions is even more pronounced. Integrating speech recognition into home automation systems, for instance, can greatly assist individuals with limited mobility, making control simpler and more intuitive.Historically, appliance control was manual—such as physically operating a switch. With time, remote controls introduced more convenience by allowing users to manage devices from a distance [6]. Building on this progress, researchers have explored various innovative control methods [5], [7]–[10]. One notable advancement is the use of **voice commands** as a control interface,

offering an intuitive and hands-free solution. Home automation systems not only provide convenience but also contribute to energy savings and improved efficiency [11].

II Methodology:

The design of the Bluetooth and Arduino Uno-based voice-controlled home automation system involves both hardware and software components working in coordination. The system architecture is divided into four main stages: voice input, Bluetooth communication, microcontroller processing, and relay-based output control.

1) **Arduino Uno:**

In this figure shows that In a Bluetooth and Arduino Uno-based voice-controlled home automation system, the Arduino Uno acts as the central controller. A Bluetooth module (such as HC-05) is connected to the Arduino, enabling wireless communication between the Arduino and a smartphone. Through a mobile application with voice recognition capabilities, the user can issue voice commands like "Turn on the light" or "Switch off the fan." These commands are converted into digital signals and transmitted via Bluetooth to the Arduino Uno. The Arduino then interprets the commands and activates or deactivates connected devices, such as lights, fans, or appliances, through relays or other electronic switches. This setup provides a convenient, cost-effective, and user-friendly solution for smart home automation, especially for individuals with mobility challenges.

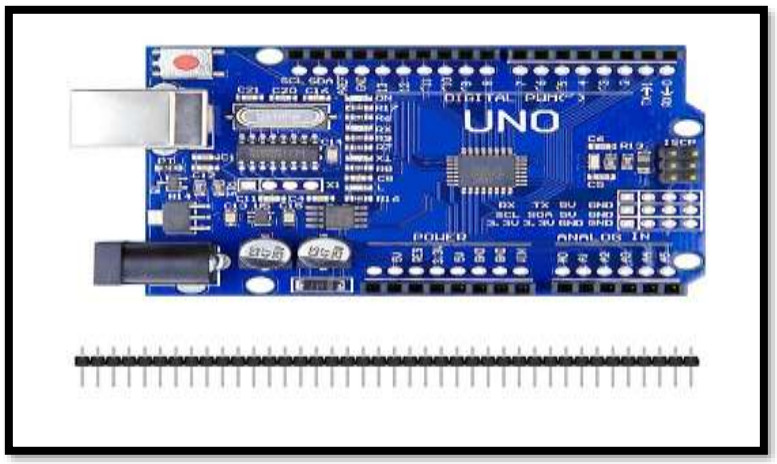

Figure 1 Show that Arduino Uno

2) Relay Module (2-Channel, 5V):

In this figure shows that the 2-channel relay module plays a key role in controlling household devices. When a user speaks a command into a smartphone app, the voice input is processed and sent via Bluetooth to the Arduino Uno. The Arduino receives this command and, based on the instructions, activates the appropriate relay channel. For example, if the command is "Turn on the light," the Arduino sends a 5V signal to the relay module, which in turn closes the circuit and powers the light. This integration of Bluetooth communication, voice recognition, the Arduino Uno, and a relay module creates an efficient, wireless home automation system.

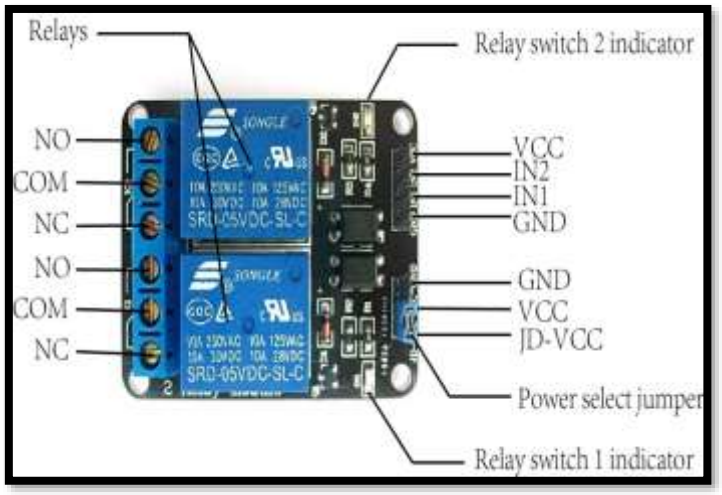

Figure 2 Show that Relay Module (2-Channel, 5V)

3) HC-05 Bluetooth Module:

In this figure shows that the HC-05 module serves as the communication bridge between the Arduino and a smartphone. When a user speaks a command into a voice-controlled mobile app, the app converts the voice into a text command and sends it via Bluetooth to the HC-05 module. The HC-05 receives this data and transmits it to the Arduino Uno through serial communication. The Arduino then processes the command and performs the corresponding action, such as turning on a light or switching off a fan, by controlling the connected devices through a relay module. The HC-05 is crucial in enabling the wireless and hands-free operation of home appliances in this smart automation system.

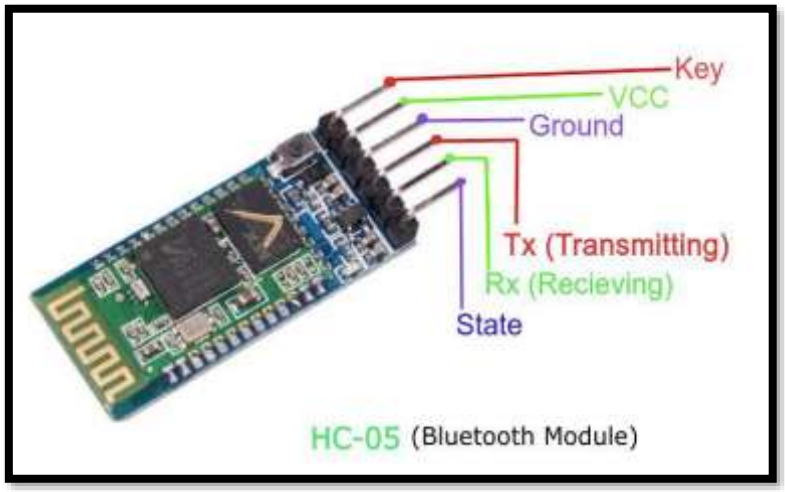

Figure 3 Show that HC-05 Bluetooth Module:

4) AC Bulb:

In this figure shows that the AC bulb represents one of the primary output devices being automated. The Arduino Uno, connected to a 2-channel relay module and an HC-05 Bluetooth module, serves as the central controller. When a user gives a voice command through a smartphone app, such as "Turn on the light," the command is transmitted via Bluetooth to the HC-05 module. The HC-05 forwards the command to the Arduino Uno, which then activates the appropriate relay channel. This relay closes the circuit that powers the AC bulb, effectively turning it on. This setup allows the user to wirelessly control the AC bulb through simple voice commands, enhancing convenience and enabling smart home functionality.

Figure 4 Show that AC Bulb

5) Component arrangement :

The key parts of this project's use are the Voice Command , HC-05 Bluetooth module,the 12v relays, the ARM software, and the Arduino Uno micro controller board. These components are arranged on Arduino Uno board using a circuit diagram stimulated on proteus, and the schematic diagram is presented in Figure 5.

Figure 5 Show that Components arrangement

III.CIRCUIT DESCRIPTION:

Figure 6 shows the schematic diagram of the voice recognition home automation system using Arduino. The figure explained in detail, the function of each component involved in the circuit.User gives a voice command (like “Turn on the light”) through a mobile app.The smartphone converts the voice into text and sends it to the HC-05 Bluetooth module.The Bluetooth module transmits this data to the Arduino UNO via serial communication.Arduino reads the command and processes it in the sketch (program).For example:"ON" → Arduino sets pin HIGH → Relay turns ON → AC bulb lights up."OFF" → Arduino sets pin LOW → Relay turns OFF → AC bulb turns off.The relay acts as a switch for the 220V AC supply to the bulb, enabling safe isolation between low-voltage control (Arduino) and high-voltage output (bulb).

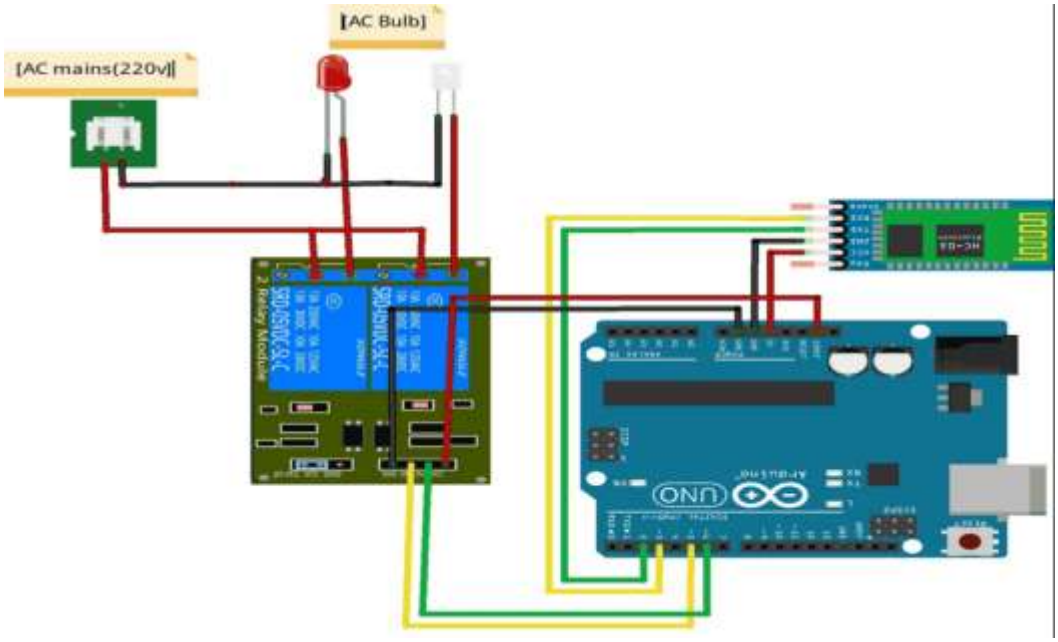

Figure 6: Schematic diagram of a Voice Recognition Home Automation System Using Arduino and Bluetooth.

IV.RESULT AND DISCUSSION

The implemented prototype demonstrates a functional and cost-effective voice-controlled home automation system. The hardware configuration consists of an Arduino Uno micro-controller, an HC-05 Bluetooth module, a 2-channel relay module, and two AC light bulbs. The system responds to user commands issued via a smartphone running a voice recognition application (e.g., AMR Voice).When a voice command is given, the HC-05 module receives the command and transmits it to the Arduino Uno via serial communication. The Arduino processes the command and activates or deactivates the corresponding relay channel. This, in turn, switches the connected AC loads (light bulbs) on or off. The image confirms that the setup is fully functional, as indicated by one bulb being lit, showing real-time control via voice input.

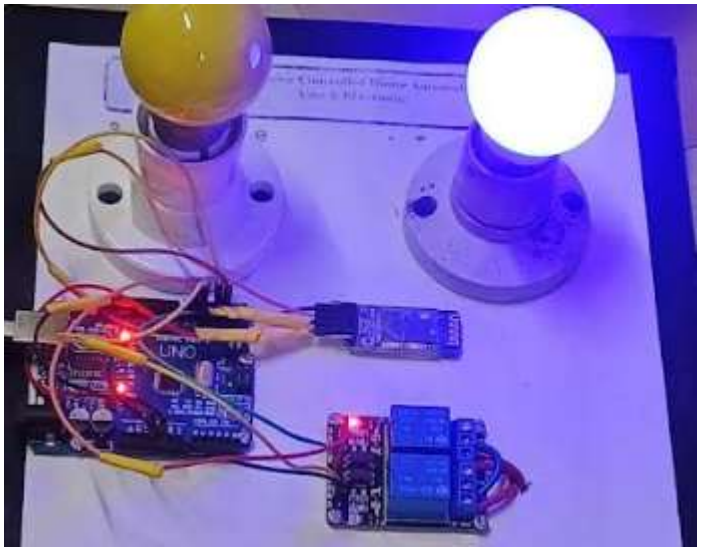

Figure7: Diagram of the loads responding to voice commands to turn on

V Conclusion:

The developed prototype successfully demonstrates a low-cost, voice-controlled home automation system utilizing Arduino and Bluetooth communication. The integration of the HC-05 Bluetooth module with the Arduino Uno allows for seamless wireless interaction between the user and the system via voice commands issued from a smartphone.

The relay module effectively handles the switching of AC appliances (as represented by the two light bulbs), providing reliable control without direct physical interaction. The system proves to be practical, especially for assistive applications, offering enhanced accessibility and convenience for the elderly and physically challenged individuals.

This project meets its primary objectives of simplicity, affordability, and user-friendliness. Furthermore, it lays a strong foundation for future enhancements such as Wi-Fi-based remote control, voice feedback, or integration with IoT platforms for broader smart home applications.

VI: REFERENCES

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