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Smart Home Automation System

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Abstract

This project introduces the overall framework of an economical wireless home automation system (HAS). Its primary emphasis lies in establishing an Internet of Things (IoT)-centered home automation setup, capable of automatic configuration based on environmental conditions and capable of overseeing multiple devices remotely via the internet. The objective is to design firmware for intelligent control, ensuring automated functionality with minimal human intervention to uphold the well-being of all electrical appliances in the household. Node MCU, a widely recognized open-source IoT platform, has been employed for the automation process. Various transmission modes are implemented across distinct system components to relay user commands from Node MCU to the actual device. The central control system utilizes wireless technology, enabling remote accessibility via a smartphone. The incorporation of a cloud server-based communication system enhances project practicality, providing users unrestricted access to appliances, regardless of their spatial proximity. To fortify automation, a data transmission network has been established. The user-friendly interface, cost-effective construction, and straightforward installation make it an ideal solution for managing household electrical appliances and devices. Both control and appliance status can be monitored through an Android platform. The system's objective is to enhance the living conditions of elderly and disabled individuals by offering necessary support and assistance, ultimately elevating the overall home living experience with the concept of a smart home.

Keywords: *Low cost HAS, Internet control.*

1. Introduction

1.1 Background Research

The acceleration and enhancement of the household's living standards have been propelled by the utilization of advanced technologies today. Home Automation Systems, although present for decades, have historically remained exclusive to high-end consumers due to project costs and budget constraints. While the concept of smart home automation has existed for an extended period, it is only recently that a tangible smart home has emerged. In 1893, the invention and patenting of home appliances, such as a television with a remote control, marked the inception of simple home automation systems. Since then, numerous home appliances have been created. The early 2000s witnessed a surge in the popularity of smart home automation as new technologies made it more cost-effective and accessible to a broader consumer base. This shift in affordability led to the proliferation of smart home products on store shelves, including home networking and domestic technology gadgets. Today's smart home automation prioritizes intelligent living, sustainability, and security. Our environmentally friendly smart home contributes to energy conservation. Moreover, it can deter intruders by triggering alarms or sending alerts via smartphone applications. The current trajectory of smart home

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automation encompasses features such as automated lighting, remote mobile control, video monitoring, and the reception of mobile, email, and text notifications.

1.2 Objectives

- Develop a standalone Home Automation System (HAS) to automate and integrate household appliances into a network, ensuring centralized control.
- Create a wireless control application with speech and switch mode capabilities for convenient and seamless control of home appliances.
- Implement a feature within the application to monitor the condition and status of household appliances, contributing to ongoing improvement of the Home Automation System.
- Establish secure communication lines using Node MCU and secure Wi-Fi protocols (SSL over TCP and SSH) to prevent unauthorized access and ensure the security of the HAS.
- Ensure the HAS is compatible with any Wi-Fi-capable device, allowing for flexible and secure control of home appliances from various platforms such as PCs, iOS, Android, etc.

1.3 Scope of the Project

The objective is to develop a functional prototype enabling wireless remote control for a network of household appliances. The software is designed for Android devices, incorporating features such as voice command control, switch mode control, and the ability to directly view device status within the application. The versatility of this software extends its application to various contexts. The prototype's scope encompasses the management of electrical equipment, making it suitable for installation in malls, small companies, and residences. It facilitates remote access to appliances over both intranet and internet connections, offering control in diverse environments. This system employs technology to create a Home Automation System (HAS), allowing us to utilize our everyday electronics from a distinct perspective.

2. Literature Survey

[1] The project seeks to accomplish automation through the popular mobile operating system Node MCU, specifically the Android Operating system. This allows for the control of electrical and home appliances using Android mobile phones, providing the convenience of remotely managing appliances even when outside the house, eliminating concerns about accidentally leaving them on. Implementing a Home Automation System (HAS) tailored for the elderly and disabled can significantly enhance the quality of life for individuals who might otherwise depend on caregivers or institutional care. [2] The consumption of energy in electronic devices, particularly in Air Conditioners (ACs), is considerable. The primary goal of the intelligent AC control system is to reduce electricity wastage. Our system achieves this by implementing control over the AC temperature, which is influenced by people's traffic patterns, utilizing a GSM module. [3] The suggested design employs the EmonCMS platform for the aggregation and visualization of monitored data, as well as for remotely controlling home appliances and devices. The process involves collecting, processing, and uploading or downloading data to and from the cloud server. [4] The application of wireless technologies in the smart home is addressed by highlighting the advantages and limitations of existing approaches to tackle diverse and concurrent issues associated with the distributed control of household systems. Special attention is devoted to addressing the user localization problem, aiming to minimize the intrusiveness of monitoring systems. The review and discussion encompass wireless architectures, presenting them as flexible and seamless tools that contribute to achieving a change in thinking towards a fully automatic and autonomous environment. [5] Introducing the uID-CoAP architecture, our innovative framework is specifically crafted to accommodate IoT services on everyday embedded systems, such as conventional consumer appliances. The software framework, tailored for embedded appliance nodes, aims to simplify the process for producers by delivering a user-friendly, standardized, and intuitive Application Programming Language (APL). With this concept in mind, our framework not only includes a low-level communication API but also offers functionalities to construct RESTful services, enhancing the overall accessibility and usability of embedded systems in the IoT domain. [6] This study introduces an

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approach to establish a cost-effective Wireless Fidelity (Wi-Fi) based Home Automation System (HAS), embodying the concept of smart device internetworking. The primary aim of the Wi-Fi-based Wireless Sensor Network (WSN) is to oversee and regulate various aspects of a smart home, encompassing electrical, safety, and environmental parameters. The study delves into a machine intelligence system based on vision, specifically focusing on a temperature and humidity sensor, capable of discerning the operational status of common home devices. Through the proposed technique for detecting appliance conditions, a distinctive home automation system is developed. Leveraging IP addressing techniques within the Internet of Things framework facilitates remote network accessibility for the suite of home devices. The project utilizes two boards: an Intel Galileo Gen 2 and a Raspberry Pi, with wireless networking enabling communication between these boards and user devices. The Home Automation System comprises sections such as gas leak detection, fire alarm, burglar alarm, rain sensor, load and voltage control switching, and current sensing. To meet the core requirement of monitoring and controlling equipment, a smartphone application is employed. [7] The research outlines a machine intelligence system leveraging vision to discern the operational status (on or off) of common household devices. This innovative approach results in the development of a distinctive home automation system. The utilization of IP addressing techniques within the Internet of Things framework facilitates remote accessibility of the suite of home devices over a network. For this project's implementation, two boards are employed: An Intel Galileo Gen 2 and a Raspberry Pi. Communication between these boards and user devices is facilitated through wireless networking, enhancing the efficiency and connectivity of the system.

3. Methods and Materials

3.1 Block Diagram

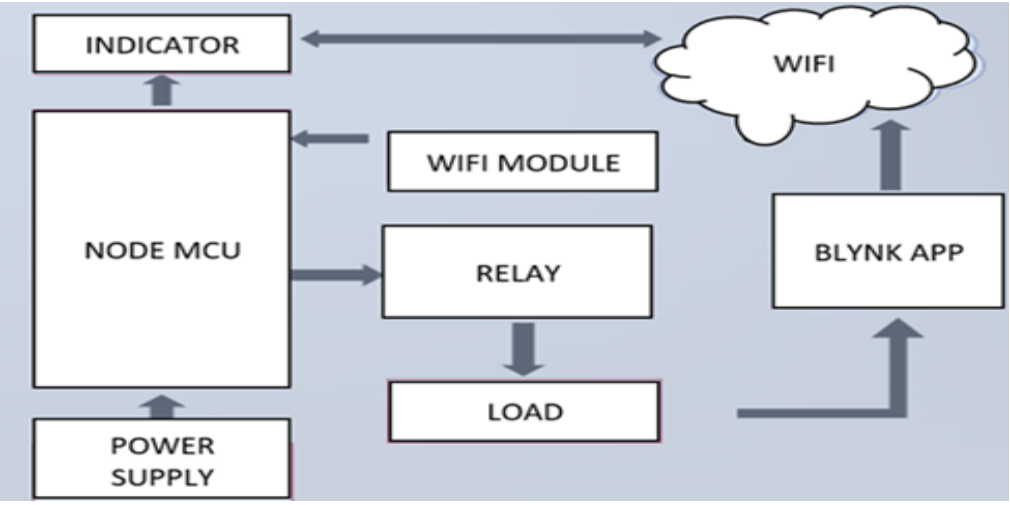

Figure 1 Block Diagram

3.2 Working

The central controlling unit in the system is the Node MCU microcontroller. Users issue commands for appliance operation through a mobile application. The BLYNK application, utilizing a Wi-Fi connection, establishes a wireless network and interprets user commands through voice or switch mode. These commands are then transmitted as signals to the Node MCU unit. Figure 1 To enable Wi-Fi communication and command reception over a wireless network, the Node MCU incorporates a Wi-Fi module within its architecture. Upon receiving the signal, the Node MCU utilizes a relay to toggle the appliance on or off. The appliances, relay, and Node MCU are physically interconnected, forming a

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prototype for a wireless remote switching system for home appliances. This model employs Wi-Fi for wireless control, providing an indoor range of up to 45m. Commands to switch appliances on and off can be issued via radio buttons on the smartphone application. Additionally, a feature has been developed to enable voice commands for remote appliance control using a smartphone. Any device with Wi-Fi capabilities can be employed to control the prototype. Security is ensured through secure connections, utilizing SSL over TCP and SSH. The design is straightforward, facilitating integration into various appliances and scalability. The application on the smartphone displays the status of each appliance, providing a convenient overview of the system.

3.3 Project Flow

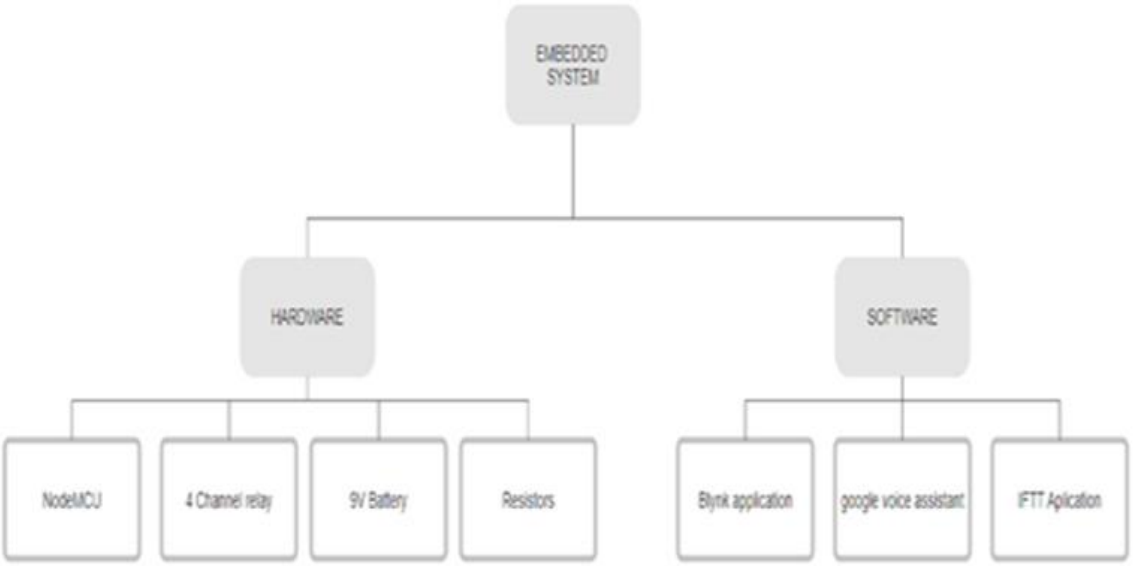

Figure 2 Project Flow

Four Channel Relay Module: The module includes four individual relays physically connected between the Node MCU and household appliances. These relays receive signals Figure 2 from GPIO pins of the Node MCU, allowing the connection or disconnection of home appliances from the power supply. They function as the switching devices within the system.

Node MCU: Serving as the microcontroller unit in the prototype, the Node MCU is equipped with an integrated Wi-Fi module (ESP8266 0.9). This module enables the wireless remote switching of home appliances.

Blynk Application: Tailored for the Internet of Things (IoT), the Blynk application assumes a pivotal role in the prototype. It possesses the capability to remotely control hardware, showcase sensor data, store and visualize data, etc. Its primary role in this context is to interpret user commands and transmit them to the hardware over a wireless network.

Google Assistant: Functioning as a system software on Android phones, Google Assistant interprets voice commands issued by users to turn appliances on or off. It serves as the voice-controlled interface within the system.

IFTTT Application: IFTTT as an intermediary application in the system. It becomes relevant when the voice commands interpreted by Google Assistant are not directly understandable by the Blynk application. IFTTT interprets commands from Google Assistant and sends on/off signals to the Blynk application via the Blynk server, facilitating smooth communication among various components in the system.

3.4 Components Required

1. Node MCU
2. Channel relay
3. Battery 9V
4. Resistor 2.2kohm
5. LED

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6. USB Cable
7. Blank PCB KS100
8. Male pin, Female pin, and Jumper Wires

4. Embedded System Setup

4.1 Hardware Assembly

The hardware assembly primarily involves linking the supply, ground pins, and digital pins of the NodeMCU to the four relays on the relay module. The essential setup of this prototype is straightforward. Connect any desired device for control to the remaining four relays. While assembling the hardware, it's crucial to keep track of which digital pin corresponds to each relay. This alignment follows the settings in the Blynk application. Configure the radio buttons on the Blynk application to toggle a specific Node MCU digital pin and ensure that the physical relay connections match this configuration. Figure 3 For instance, if D3 is assigned to operate with the radio button on the Blynk application corresponding to relay 1, physically connect relay 1 to Node MCU D.

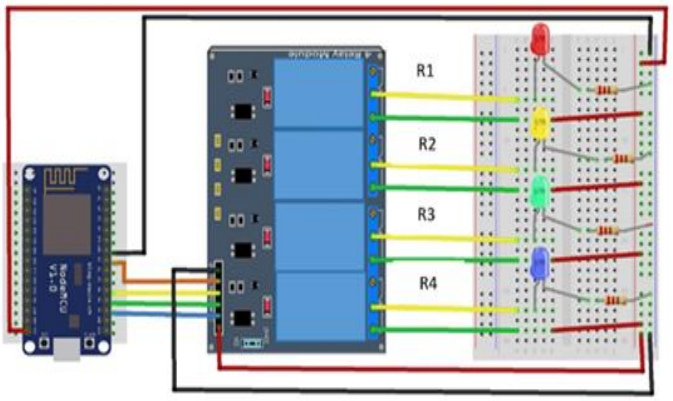

Figure 3 Hardware Design

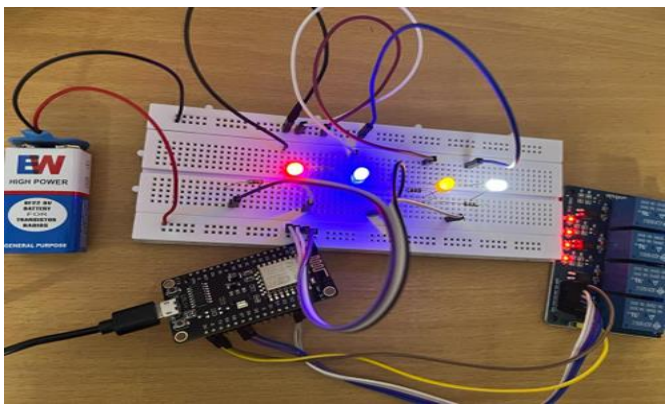

Figure 4 Prototype

4.2 Software Setup – Blynk Interfacing

- Install the Blynk application.
- The project is established, given a name, and has Node MCU hardware and Wi-Fi connection type selected.
- Blynk will now send an authentication token to the email address provided. Figure 4 The Blynk server's hardware will be recognized by this authentication token.
- Since the prototype makes use of a 4-channel relay module, the side bar's four buttons are added to the screen.
- After that, each of the four buttons can be personalized by giving them names and choosing the corresponding digital pin.
- The Blynk application has now finished setting up.

Figure 5 Blynk Interface

4.3 Uploading Code to NodeMCU

- A USB cable facilitates the connection between NodeMCU and the computer.
- Subsequently, we will modify certain parameters to set up the Arduino IDE configuration.
- The code can now be uploaded to the hardware. Upon clicking the upload button, the code is transferred to the Node MCU, establishing an instant connection to the designated Figure 5 Wi-Fi network the next time it powers on.

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Figure 6 Uploading Code

4.4 IFTTT Setup for Voice Control

- Link your Google account to IFTTT on both the website and Google Home app.
- Pick a voice phrase for Google Assistant to hear and activate Applet.
- Choose the Figure 6 service or device you want to control in response to the trigger.
- Fine-tune the action and any relevant details.
- Select web hooks and add the necessary extension to the URL that will allow to send commands to Blynk server.
- Speak the trigger phrase, check IFTTT for success.

5. Results and Discussion

5.1 Advantages

- Effortless installation without legal complications
- Theft deterrence through wireless operation, eliminating physical wire vulnerabilities.
- Extended control range of 150 feet indoors for comprehensive home automation
- Robust security ensured through a connection established over a secure network.
- Versatile integration into diverse setups, enabling easy addition or removal of appliances as needed.

5.2 Disadvantages

- Android devices with API versions lower than 16 necessitate internet access to convert voice to sentence or string.
- External voices may impact our results when utilizing voice mode.
- There's a likelihood that the speech command in voice mode might not yield the anticipated outcome, leading to an unclear result.
- Presently, the application is exclusively compatible with Android smartphones and is not supportive of other operating systems.

5.3 Result

This project demonstrates the feasibility of creating an individual home automation system using cost-effective, easily available components. This system proves capable of efficiently managing various home appliances such as the AC, security lamps, televisions, and the complete home lighting system. Moreover, the required components are minimal and compact enough to be easily integrated into a small space. The designed home automation system underwent rigorous testing and acquired certification for operating a diverse range of household appliances, including those used in entertainment, lighting, and air conditioning systems, highlighting its adaptability and scalability. The results align with expectations, given that the experimental model adhered to the circuit diagram. The incorporation of Wi-Fi networks enables remote control of household appliances, and both the voice mode and switch mode control approaches were successfully implemented. Additionally, the Blynk application effectively displays the status of each application within the system.

6. Future Scope

Given the current circumstances, there is an opportunity to create a solution that works across different platforms, including Windows and iOS. Expanding the automation to cover all household devices removes the limitation of operating only a set number of gadgets. The prototype can incorporate various sensors, such as a PIR for motion detection and security alerts, a DHT11 sensor for monitoring ambient temperature and humidity, adjusting the fan or air conditioner accordingly, and an LDR for sensing daylight and controlling the lamp. By extending the project's reach beyond homes and small offices, it can cater to a wide array of locations.

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