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IoT-Based Home Automation System Using ESP8266 and Google Assistant

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Abstract

This research paper discusses a smart home automation system. Through the implementation of the Internet of Things (IoT), a conventional home can be transformed into a smart home with enhanced automation and security. The proposed system aims to develop a voice- or text-controlled home application that enables users to control household appliances remotely. Users can switch appliances on or off according to their requirements by sending text messages or voice commands. Even when users are not physically near the equipment, they can monitor its status and manage scheduled operations. The system also allows access to previous schedules and enables devices to operate for predefined durations. The technology employed in this application is relatively low-cost while delivering high performance, resulting in a cost-effective implementation. In addition to providing real-time device control, the system offers the capability to schedule devices to operate at predetermined times. Furthermore, users can configure devices to remain active for specified periods, thereby promoting more efficient energy utilization. The history of scheduled activities and operational states is recorded within the application, allowing users to review historical usage patterns and make informed decisions based on past device performance.

Keywords: Alexa, Blynk IoT, Google Assistant, IoT, NodeMCU, smart control

INTRODUCTION

Smart home automation is a technology that enables devices or processes to be controlled with little to no human intervention. Home automation involves the monitoring and control of household appliances and systems. It has become increasingly easy to access and manage electrically operated equipment through automated technologies. With home automation, users can enjoy a more convenient and efficient lifestyle by controlling various household functions with only a few clicks. These functions may include opening or closing doors, turning on fans, and operating other electrical devices. Various technologies, such as Bluetooth, Zigbee, infrared remote (IR) controllers, and GSM-based systems, can be used to implement home automation solutions [1]. However, some of these technologies suffer from limitations related to communication range, reliability, and spectrum availability. Such limitations may affect system performance and, in certain cases, increase the risk of electrical hazards, including fire-related incidents. Therefore, a reliable method for remotely controlling household appliances is essential. The objective of this study is to demonstrate the implementation of a home automation system that utilizes Wi-Fi-based technology to address common challenges associated with home automation. The proposed system provides voice- and text-controlled operation of household appliances at an affordable cost. In addition, users can monitor device status, schedule appliance operations, and manage

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connected devices remotely, thereby transforming a conventional house into a smart home. This approach mitigates concerns associated with remote appliance management, improves accessibility to household devices, and enhances overall home security [2].

OBJECTIVES

- *Automation of daily routines:* Home automation eliminates the need for manual control of routine tasks, such as switching lights on or off, adjusting temperature settings, and controlling household appliances.
- *Energy efficiency:* Energy consumption can be reduced through the use of sensors that regulate lighting, HVAC systems, and appliances based on occupancy and predefined schedules [3].
- *Enhanced security and theft prevention:* Smart locks allow users to remotely verify whether doors are locked and can provide alerts in the event of unauthorized access. Additionally, smart outdoor lighting and security systems can help deter intruders and notify homeowners of suspicious activity.
- *Remote access and control:* Users can remotely monitor and control home devices through mobile applications, providing greater convenience and flexibility.
- *Enhancing safety:* Automated smoke, fire, and gas leak detection systems can send instant alerts, enabling rapid responses to potential hazards and improving household safety.
- *Comfort customization:* Custom operating modes, such as "Morning," "Night," and "Away," can be configured to automatically adjust lighting, temperature, and other environmental settings according to user preferences.

METHODOLOGY

This study offers a more cost-effective, simpler, and energy-efficient alternative. Moreover, the findings indicate that such systems can enhance daily productivity. Previous studies have also proposed numerous low-cost and low-power home automation solutions using technologies such as Blynk IoT, NodeMCU, Google Home, and Amazon Alexa. These solutions are designed to save time while improving convenience and efficiency [4].

Channel Relay Module

A relay is an electromechanical device used to switch electrical circuits, as shown in Figure 1. It functions as a switch that is operated by an electromagnet and can be used to turn electrical devices in a house on or off. The four-channel relay module can communicate directly with a microcontroller or sensor while requiring only a minimal number of components and connections, thereby simplifying system implementation [5].

Blynk IoT

First, an account must be created on the Blynk IoT platform. Next, three switch-type devices must be added, and notifications must be enabled.

Figure 1. Channel relay module.

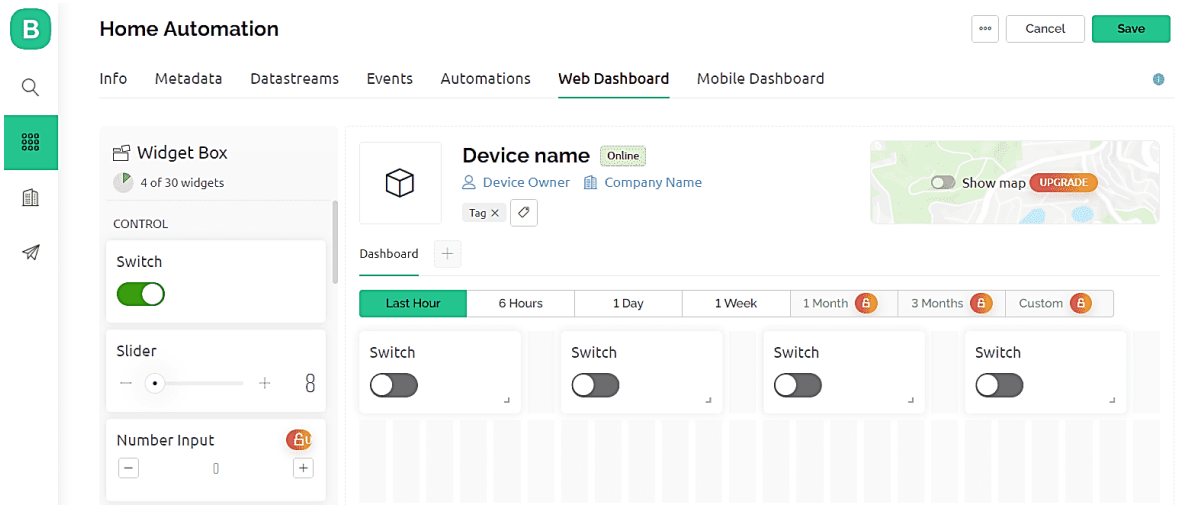

Figure 2. Blynk IoT web dashboard.

Figure 3. NodeMCU.

Second, the Blynk IoT libraries must be added to the Arduino IDE, along with their dependencies, including ArduinoJson and ArduinoWebsockets. The required Multi Switch Advanced program files should also be installed and configured. Next, the Wi-Fi SSID and password must be updated to match the local home network. The APP_KEY, APP_SECRET, and device credentials must then be entered. These credentials are available through the Blynk IoT platform. The system can subsequently be integrated with the Google Home application. After launching the application, users can sign in using their platform account and search for Blynk IoT under the Home Control option. Finally, automation patterns and schedules can be configured according to user requirements and operated through the application [6]. Figure 2 shows the Blynk IoT platform web dashboard.

NodeMCU

NodeMCU is also called Lolin. It is a board where ESP8266 is a chip-based, and it supports Wi-Fi (802.11 b/g/n). Therefore, there are 17 digital pins and one analog pin [7, 8], as shown in Figure 3.

Typical Wi-Fi range indoors: 30–50 m (depending on walls and interference).

Google Home Mini

Google Home Mini is a smart speaker that can be paired with Google's personal voice assistant. The device is integrated with the Google Home mobile application, which enables users to configure, manage, and control Google Home devices as well as other compatible smart devices through voice commands [9].

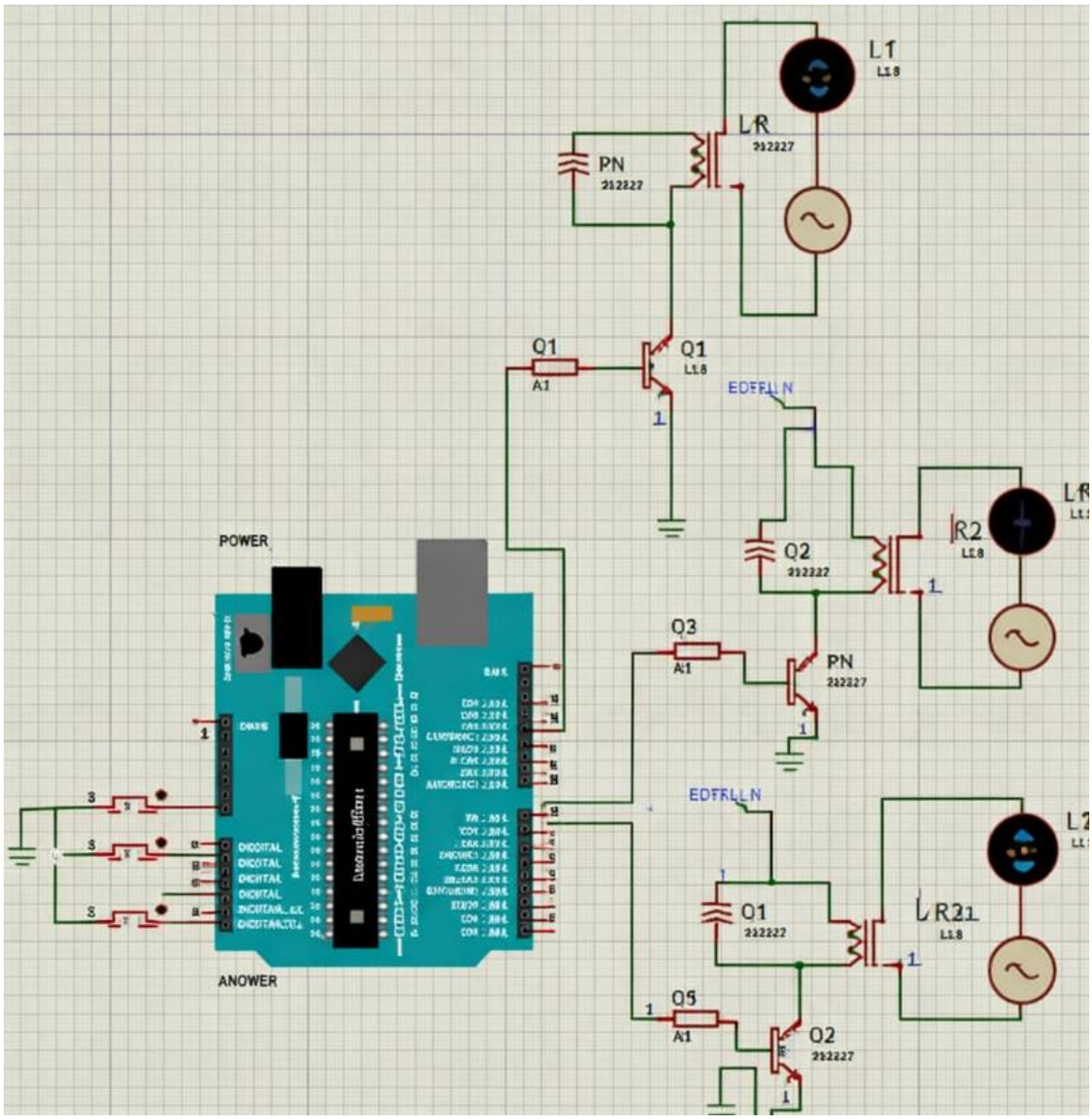

Figure 4. Simulation of the module.

Electrical Apparatus

The system enables voice-controlled operation of electrical devices rated up to 220 V and various current capacities through Google Home, Amazon Alexa, and the Blynk IoT platform. A wide range of devices can be controlled using this platform, including fans, light bulbs, switches, solenoid valves, and landscape irrigation systems. The implementation integrates smartphone applications, Google Home, Amazon Alexa, a NodeMCU board, relay modules, and the Blynk IoT platform to provide centralized device management and automation [10].

The following section outlines the sequence in which the new components must be installed, configured, and programmed. Minor differences exist among these options.

SYSTEM DESIGN AND SIMULATION

The circuit is designed to interface with a four-channel relay module using Arduino digital pins 10, 6, 7, and 8, as shown in Figure 4. The manual switches are connected to pins A0, A1, and A3, enabling manual control of the relay module. Instead of using external pull-up resistors for each switch, the

system utilizes the INPUT_PULLUP feature available in the Arduino IDE. According to the source code, the corresponding relay is activated when a LOW signal is applied to the relay-control pin and deactivated when a HIGH signal is received. However, the Arduino pins can operate only within a limited voltage range; therefore, an external DC power source is used to provide the required operating voltage for the relay module.

The circuit simulation was performed using the Wokwi platform.

DESCRIPTION

The smart home automation system is a set of devices connected to gadgets and appliances inside a house that can be controlled, automated, and monitored remotely by the user, and can be reached with the help of a smartphone, tablet, or voice-activated assistive technology. Such systems use Internet of Things (IoT) features to enable communication between devices and users, such as lights, thermostats, security cameras, door locks, and other home appliances.

An action can be scheduled based on time or sensor data (for example, when a person leaves the room, the light turns off), all of which are programmable in devices.

WORKING PRINCIPLE

A program that may be called me, Google Home/Alexa, is the identification of the voice. This command is used to change the state of the Blynk IoT-linked device from 0 to 1. The Wi-Fi module based on NodeMCU ESP8266 microcontroller decides what we need to keep ON for each set. Manual switches connected to light/fan, load changes from 0 to 1, relay switch from the OFF state to the ON state. Since 5 V is the supply voltage for the NodeMCU, it is DC 5 V. Hence, the author must be using an AC load, as the author is first checking the relay output with the use of supplies.

This is a simple circuit for controlling a four-channel relay module using Arduino pins 10, 6, 7, and 8, as shown in Figure 5. The manual switches are connected to pins A0, A1, and A3 to enable manual control of the relay module. Instead of using external pull-up resistors for each switch, the INPUT_PULLUP feature provided by the Arduino IDE was utilized. According to the source code, when a LOW signal is applied to the control pin of the relay module, the corresponding relay turns ON; when a HIGH signal is applied, the relay turns OFF. For simulation purposes, an AC load was connected to the relay output. Therefore, an AC voltage source was used in the simulation. Since the Arduino operates within a voltage range of approximately 5–9 V, an appropriate power source was employed for the circuit.

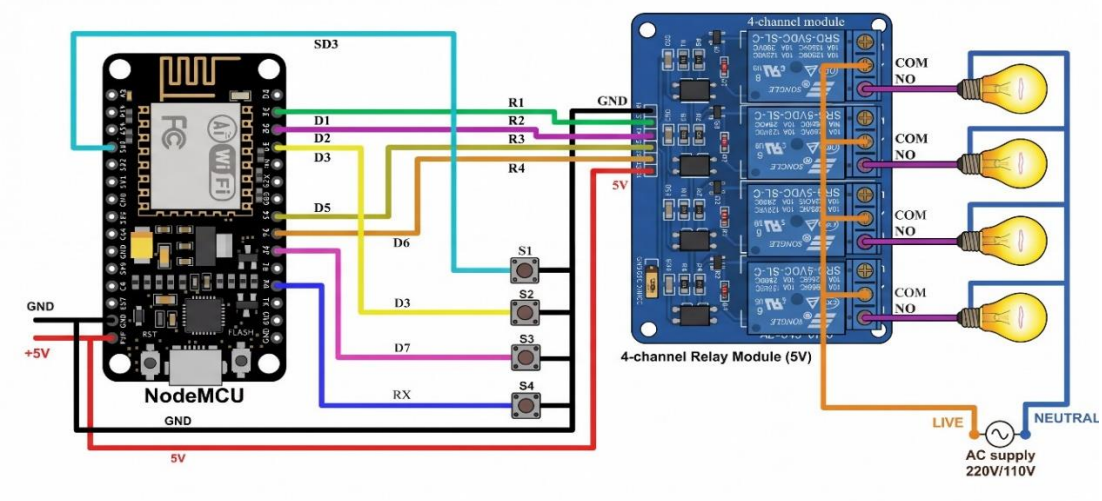

Figure 5. NodeMCU control relay module.

HARDWARE DEVELOPMENT AND TESTING

The NodeMCU can be powered using a regulated 5 V DC supply, and one convenient method is to use a mobile phone charger. Most mobile phone chargers provide a regulated 5 V DC output, which is compatible with the power requirements of the NodeMCU. Therefore, an old mobile phone charger can be reused instead of purchasing a separate power adapter. Typically, these chargers accept a 220 V AC input and deliver a regulated 5 V DC output. In this project, a standard mobile phone charger was repurposed as a power supply for the NodeMCU. This approach ensures compatibility with the device's power requirements while eliminating the need for a dedicated power adapter, thereby reducing costs and simplifying integration into the overall system.

ADVANTAGES

- *Convenience:* Automation saves time and effort compared to manual processes by enabling efficient control of lighting, heating/cooling, and security systems.
- *Enhanced comfort:* Automation can adjust room temperature, lighting, and sound levels according to an individual's preferences, thereby improving comfort.
- *Scalability and integration:* One of the major advantages of smart home systems is their ability to integrate with various devices, and new devices can be added as technologies evolve.
- *Higher resale value:* Smart home technology is attractive to buyers and can therefore increase the resale value of a property.
- *Home health and wellness:* Features such as air quality sensors help monitor indoor environmental conditions, while smart thermostats maintain optimal comfort levels, contributing to a healthier living environment.
- *Cost efficiency:* Automated energy management and maintenance alerts help reduce long-term costs, making smart home systems attractive from both financial and economic perspectives.

CONCLUSION

This system permits the remote control of household electrical devices, such as stoves, refrigerators, and water heaters, requiring a 220/240 V 50 Hz power supply from anywhere in the world. It is an ESP8266 microcontroller that is smartphone-controlled or activated using a remote physical switch. This study showed how a novel portable user-centered automation system can be designed, built, and installed. A home system can be set up in an ordinary dwelling using the IoT to enable real-time home status and equipment interaction monitoring.

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