Smart Home Automation

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***Abstract*- The way we interact with and control our living spaces has been drastically changed by smart home automation technologies. Users can now remotely control and automate many aspects of their houses using Wi-Fi connectivity thanks to the integration of components including a centralized device, relays, and other gadgets like lighting and fans. In this system, Wi-Fi is essential because it makes it possible for the linked devices and the central controller to communicate with each other without interruption. Users can control and monitor their gadgets through smartphones from anywhere in their home by connecting the smart home appliances to the Wi-Fi network. The system's brain, the central controller, uses Wi-Fi to communicate with linked gear using relays that function as switches to execute commands. This enables customers to operate appliances using their smartphones, which serve as a practical and user-friendly control hub, by turning them on or off, changing settings, and setting up scheduled routines.**

I. INTRODUCTION

In recent years, the idea of a "smart home" has gained popularity, bringing in an entirely novel phase of residential living. Smart houses connect numerous areas of daily life using cutting-edge technology, giving users more convenience, efficiency, and security. A "smart home" is a domicile that has a network of connected, automated, and remote-controllable systems and gadgets. These gadgets, often known as Internet of Things (IoT) devices, comprise actuators, sensors, appliances, and other home furnishings capable of exchanging information over the internet or a local network. These gadgets may be seamlessly controlled and automated to perform a variety of tasks around the house, including managing lighting, humidity, safety entertainment, and energy usage.

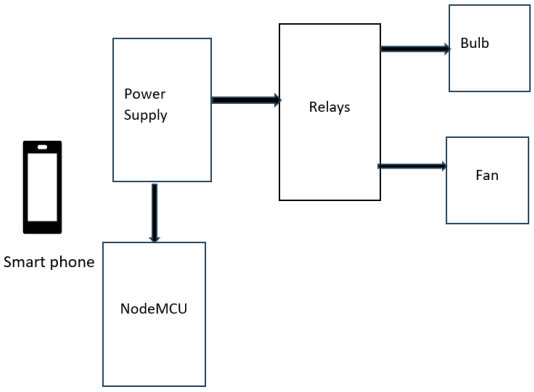
Several important factors have fueled the growth of smart home technologies. First, the development of wireless communication technologies like Wi-Fi and Bluetooth have made it possible for devices to connect and communicate with one another easily, opening the door for the interconnection of various home systems. Additionally, a wider spectrum of consumers now has access to smart home technology since smart devices are becoming more affordable and compatible items are becoming more widely available. Numerous advantages are available to homeowners with smart houses. Increased control and convenience are two of the main benefits. Using mobile devices, tablets, or voice assistants, homeowners may remotely monitor and manage a variety of features of their homes. They can, for instance, lock doors, change the temperature at home, turn on/off the lights, or even watch surveillance footage. Homeowners who have this amount of control may effectively maintain their properties and customize them to suit their interests. Users can use NodeMCU to automate tasks like scheduling the lighting or fan to turn on and off. Lower utility bills are the outcome of these intelligent automation features that stop excessive energy consumption. Additionally, Wi-Fi connectivity enables house owners to keep track of their energy consumption in real-time, giving them useful information and enabling them to make well-informed choices about energy conservation.

II.REVIEW OF LITERATURE

A home's automation is a cordless home automation system that is meant to be implemented in the surroundings of the home without making any structural alterations. With the development of automation technology, daily living is becoming simpler and easier in every way. Home automated processes allow the homeowner to control the house from their personal computer with settings and schedules that should be dependent on the time or other detection system readings like light, temperature, or noise via any gadget in the home automation network. In the modern world, automated systems are preferable than handcrafted ones. IoT is the oldest and most recent internet technology. This paper [1] gives an overview of the exponential growth in internet users over the past ten years that has made the internet a way of life. The Home Automation System (HAS) uses Cisco Packet Tracer and integrates wireless communication to enable users' remote control over multicolored illumination, pumps, fans, and appliances in their home while saving the data. Based on the data from the detectors, the system will inevitably change. This system's low cost and expandability make it possible to manage a range of biases. All modern-day daily activities depend heavily on technology. One of these requirements is to build a smart house with smartphone-controlled operation and device-off switch. Using package tracking software with IoT features, this implementation can be controlled and simulated as a smart home. IoT technology can be used to address a variety of practical problems, including those related to schoolwork, therapy, campus, and the workplace. The emphasis of this study [2] is on a safe home system that consists of appliances like air conditioning, alarms, lighting, and doors. The goal of this project is to create a smart device simulation using packet tracer that can be remotely controlled by the end user's smart device and then demonstrate the idea of a "smart home." The results of the simulation support the idea of practical implementation by demonstrating that smart objects may be successfully monitored and connected to the home portal. The simulation of a smart home is the goal of this study. Smart windows, smart fan, smart garbage, and sensor devices are all controlled by smartphones and home gateways. Automation is quickly becoming a reality. People have less time to handle any tasks, thus automation is a quick technique to handle any equipment or device that will perform as we want. The purpose of this paper [6] is to construct and design a home automation system utilizing an Arduino and a Bluetooth module. A simple and dependable technology is provided by a home automation system with an Android application. Home automation systems employing Arduino Uno and a Bluetooth module may operate appliances

like fans, bulbs, AC units, and automated door locks. The paper [6] primarily focuses on the monitoring and management of smart homes via Android phones as well as the provision of a secure smart home while the inhabitants are not there. This paper's main goal is the control of appliances at home in smart homes with user-friendly, affordable, and straightforward installation. Home automation is a unique kind of equipment that uses extra effort to regulate household appliances. Along with this discussion on novel technology that is now being studied that will reduce human effort will be used in the future. Our homes are increasingly being mechanized and thus more convenient thanks to technology. Designing and implementing a home automation system that is affordable, adaptable, adaptive, and secure is the goal of this study [7]. This paper discusses a home automation system that would let a designated user control all the appliances using a smartphone. The system consists of three parts: a microcontroller called an Arduino for tying up the gadgets, a Bluetooth module that's used for signal transmission, and an Android app running on a smartphone. The user's voice command is decoded by an Android application, which then determines its precise meaning. The architecture relies on the Arduino Uno board, and switches are used to connect the appliances to this board. Bluetooth is used by the Smartphone and Arduino to communicate. The House Automation System uses voice control to operate gadgets. In the twenty-first century, automation is a hot topic [8] that has become integral to our daily lives. Human effort, time, and some human errors are reduced through automation. This study gives an overview on how to create a voice-activated control system that will enable persons with physical disabilities to operate household equipment. The idea of a low-cost voice recognition-based home automation system allows physically disabled people with quadriplegia or paraplegia—who are unable to move their arms and legs but can speak and listen—to control a variety of home appliances simply by speaking commands that are tailored to their needs and comfort. The system described in reference [8] offers substantial support to individuals with physical disabilities, eliminating the need for assistance from a third party. This technology aims to empower people with physical limitations, enabling them to perform tasks and activities independently and with greater ease. This makes the technology more reliable as users gain advantage by using voice to control the home appliances.

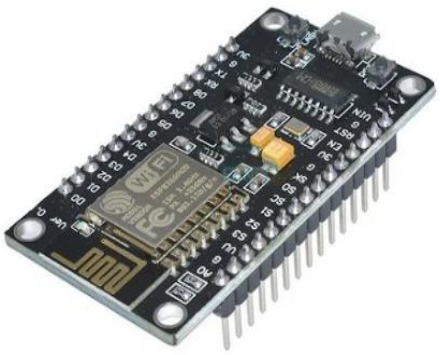
III. Methodology



Block Diagram

The central controller, or NodeMCU, oversees the automation process. There is no longer a requirement for a separate power source to operate the NodeMCU because a dedicated power supply has been included to power both the relays and the NodeMCU. The smart phone connects through WIFI to NodeMCU and controls the appliances through an application called TCP/IP. As the interface between the user and the connected appliances, the NodeMCU, relays play a crucial role. The NodeMCU's built-in Wi-Fi function-ality allow users to remotely control and automate the fan and lamp through the relay using wireless connection. The NodeMCU and the relays will each receive enough power from the power source to ensure smooth operation. The lamp uses an external source of alternating current (AC) and the fan runs on direct current (DC). To effectively convert and regulate the incoming power to satisfy the unique requirements of the NodeMCU, this power supply device is required.

NodeMCU



An open-source Arduino board called NodeMCU has become well-known for its capacity to link gadgets to the internet via integrated Wi-Fi. The NodeMCU board, which is run by the ESP8266 microprocessor, provides a cheap and practical way to prototype and construct Wi-Fi-enabled products. The microcontroller's clock frequency is 80 MHz, and it has enough memory and processing capacity for IoT applications. The NodeMCU board smoothly integrates with Wi-Fi networks thanks to compatibility for 802.11 b/g/n Wi-Fi standards, enabling devices to link to the internet and communicate with different gadgets. The open-source development board NodeMCU has become well-known for its capacity. Additionally, the board has GPIO pins that developers may program to link with other electronic parts and sensors. This allows them to read sensor data, operate devices, and interact using well-known standards like I2C, SPI, or UART. Both novice and expert developers can use the NodeMCU development environment because it is highly supported by a vibrant community and can be programmed using the Arduino IDE. Its adaptability and use are further increased by its USB connectivity and power supply options. Overall, the NodeMCU board provides an effective and straightforward foundation for creating Internet of Things (IoT) projects with Wi-Fi connectivity.

Relays

Electrical circuit regulation relies heavily on relays, which are electromechanical devices. Relays are essential for controlling lights or other electrical appliances in a smart home system. An electromagnet, an armature, and one or more sets of contacts make up a relay. The armature of the electromagnet moves and makes or breaks electrical contacts when an electrical current is delivered to its coil, creating a magnetic field that attracts the armature. When employing a relay to regulate a lightbulb, the relay serves as the link between the power supply and the lightbulb. The NodeMCU sends an electrical signal to the relay coil, energizing it and turning on the electromagnet. Due to the contacts closing as a result, electricity can now pass from the power supply to the bulb. The lamp thus illuminates. Conversely, the contacts open when the electrical signal to the relay coil is cut off or removed, as this de-energizes the coil. The bulb shuts off in this situation as the electricity supply to it is cut off. The NodeMCU or microcontroller can control the bulb by applying electrical signals to the relay, which basically functions as a remote-controlled switch. Relays offer several benefits for controlling bulbs, including electrical separation between NodeMCU and the power circuit (bulb), which ensures protection. They are capable of handling high current and voltage, which enables the management of many types of bulbs. Relays additionally possess mechanical toughness, which enables them to manage repeated switching without losing performance.

Power supply

The system's main source of electrical power is the power supply circuit. The available AC mains voltage (for example, 110V or 220V) is often converted into a steady and controlled DC voltage sufficient for powering the system's electrical components, such as the NodeMCU, relays, and control circuitry. The power supply circuit makes sure that there is a steady and dependable source of power, avoiding any potential voltage fluctuations or instability that can have an impact on the functionality and longevity of the components. The power supply circuit in a system that controls both a lamp and a fan must deliver enough power to satisfy both devices' electrical needs. The fan has its own power requirements, while the light has requirements for voltage and current. The power supply circuit makes sure that these devices get the power they require to function securely and effectively. It controls the voltage and current to keep the devices from being harmed and to maximize their efficiency. The relays utilized in the system must receive power from the power supply circuit. Relays often need a lower voltage to ignite their coils and activate the switching mechanism (typically 5V or 12V). The relay coils' ability to operate properly is made possible by the power supply circuit's delivery of this lower voltage. The power supply circuit enables the NodeMCU or microcontroller's control signals to activate the relays, which in turn operate the lamp and fan by supplying the relays with the required power. The isolation the power supply circuit offers between the low-voltage control circuitry and the AC mains voltage is a crucial component. The users' security is guaranteed, and the delicate electronic components are shielded from any potential electrical surges or malfunctions by this isolation. To keep the control circuit and relays safe and separated, the power supply circuit may include transformers, regulators, and other safety features. The power supply circuit also enables the integration of additional functions, such as powering auxiliary devices or putting in place energy-saving technologies. When the lamp or fan is not in use, the power supply circuit could include energy-saving features such standby power reduction. To protect the system from any electrical failures, it can also integrate safety measures like overload

protection and short-circuit protection. In order to successfully manage the light bulb and fan, steady and dependable power is required. The power supply circuit also ensures the overall security and operation of the smart home system.

In the working module, a programming code written in the Arduino language for the NodeMCU development board. It is a code snippet that demonstrates how to control relays connected to a NodeMCU to switch a bulb and a fan on and off using commands received over a Wi-Fi connection. The first line of code creates global variables to hold the Wi-Fi network credentials and includes the libraries required for Wi-Fi communication. Additionally, it defines two integer variables for the GPIO pins that are linked to the relays. The code initializes the GPIO pins as output pins and sets their initial state to LOW, meaning the relays are initially switched off, in the setup () method. For debugging reasons, serial communication is initiated, and the NodeMCU tries to join the specified Wi-Fi network using the supplied SSID and password. The code prints the local IP address to the serial monitor after waiting for the connection to be established. The Wi-Fi server is then started, and a message is produced to show that the configuration is finished. An infinite loop is continuously run using the loop () function. It begins by looking for incoming client connections that are made through the server function called accessible (). An alert is printed to the serial monitor if a client is connected. The function then processes any data available from the client after reading it. The code executes the relevant action in accordance with the command that is given (A, B, C, D, X, or Y). Relay1 is activated, for instance, if the command is "A," and a response is transmitted to the client. Relay1 is also disabled if the command is "B." The fan's Relay2 is managed using the same approach. A one-second delay is added after each action. The code enables the NodeMCU to perform the role of a Wi-Fi server, allowing clients to connect and submit instructions to operate the relays.

To enable user control and interaction through smartphones, a dedicated mobile application is installed on users' devices, establishing a connection with the NodeMCU. This application serves as an interface through which users can send commands or instructions to the NodeMCU, which in turn processes these commands to control various functionalities or devices in the smart home system. By utilizing the mobile application's user-friendly interface, users can conveniently and remotely operate the system, adjusting settings, activating or deactivating specific functions, and monitoring the status of connected devices in real-time. The communication between the mobile application and the NodeMCU occurs over a Wi-Fi network, providing seamless and responsive control for an enhanced smart home experience. Relays are engaged or deactivated in response to commands received, turning on or off the light bulb and fan, respectively. This shows how relays and Wi-Fi connectivity are be used to control devices in a simple manner.

IV. RESULT AND ANALYSIS

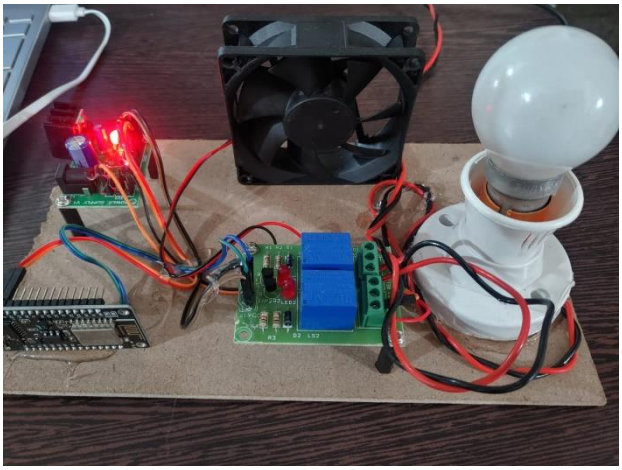


Fig .1. Home automation setup

Fig1. Shows the interconnected smart home setup that incudes power supply, NodeMCU, Relays, an electrical bulb, and a fan.

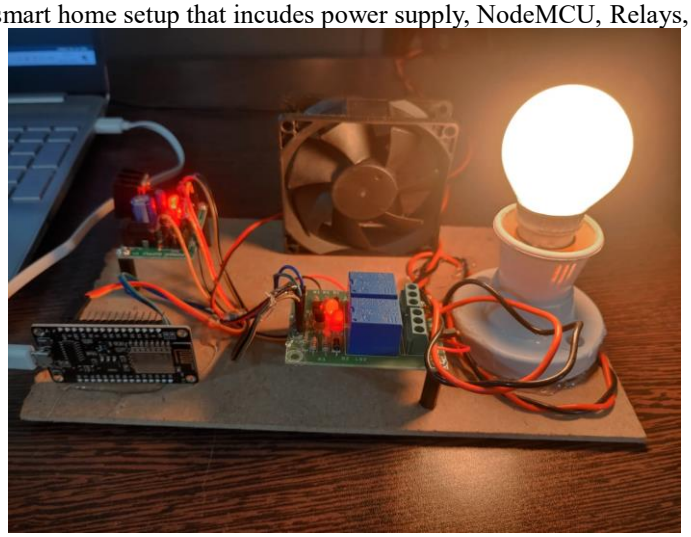


Fig.2. Bulb turns ON.

A series of events occur inside the home automation circuit when a command "A" is delivered from a smartphone using a TCP/IP app, and the bulb eventually turns on as a result. The procedure starts when the smartphone connects to the NodeMCU, which serves

as the main controller. The user picks the option to switch on the lightbulb through the TCP/IP app, and this input is converted into the command "A." The smartphone then sends the command "A" as a data packet to the NodeMCU over the established TCP/IP connection. The NodeMCU interprets the command as a request to turn on the light bulb when it receives it. The relay connected to the bulb is activated by the NodeMCU once it interprets the command it receives. As a switch, this relay completes the circuit between the power source and the lightbulb. The bulb receives the required electrical current once the relay is turned on, enabling the flow of electricity. The bulb lights in reaction to the electric current, illuminating the space. To validate that the light was turned on, the NodeMCU may send a status update back to the smartphone after acknowledging the command's successful execution.

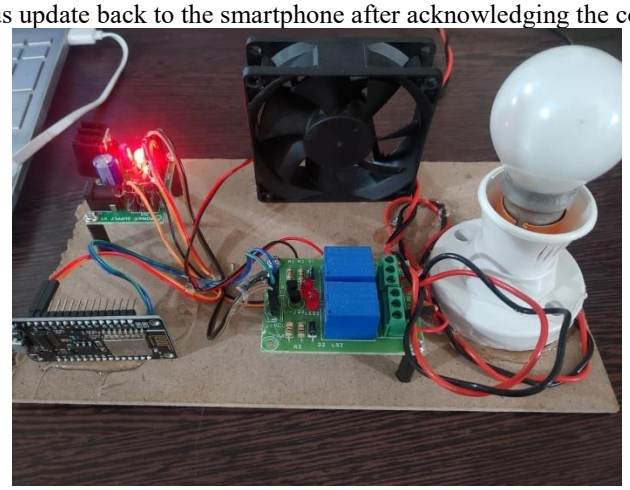


Fig. 3. Bulb turns OFF.

The TCP/IP app on a smartphone that receives the command "B" causes the lamp to be turned off by the home automation circuit. The process starts with the smartphone connecting to the NodeMCU, the system's central controller. The user chooses the option to switch off the lightbulb through the TCP/IP app, which is translated into the command "B". The created TCP/IP connection is then used to send this command as a data packet from the smartphone to the NodeMCU. The NodeMCU recognizes the command as a request to turn off the light bulb when it receives it. The relay connected to the bulb is deactivated by the NodeMCU, which is built to handle such commands. The electrical circuit between the power supply and the bulb is broken by deactivating the relay, stopping the flow of electricity. The bulb stops producing light as a result since it is no longer receiving the electrical current needed for illumination. The NodeMCU confirms that the command was successfully carried out and may provide a status update to the smartphone indicating that the light has been switched off.

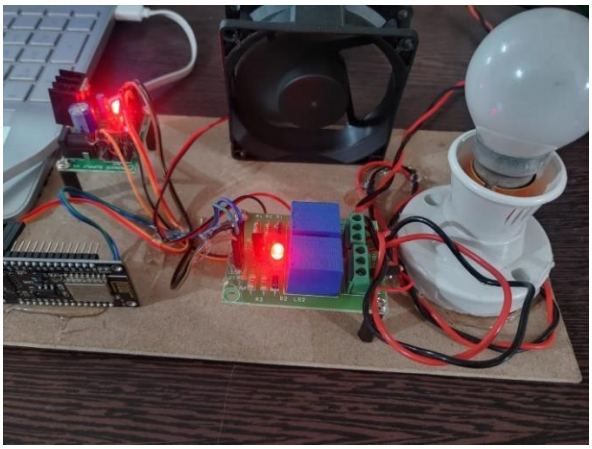


Fig.4. Fan turns ON.

The home automation circuit responds to a command "C" from a smartphone via a TCP/IP app by turning on the DC-powered fan. The process begins with the smartphone connecting to the NodeMCU, the system's central controller, using the TCP/IP app. When the user chooses to turn on the fan, the command "C" is converted and delivered to the NodeMCU. The NodeMCU recognizes the command as a request to turn on the fan when it receives it. It activates the connected fan's relay or control module, allowing DC current from the power supply circuit to flow to the fan. The fan starts to spin as soon as the DC current enters it, which causes the fan to work. Like this, the circuit executes the appropriate operations to switch off the fan when the command "D" is sent from the smartphone. The command "D" is received by the NodeMCU, which interprets it as a directive to turn off the fan as shown in Fig 5. By activating the associated relay or control module, it stops the DC current from flowing to the fan. As a result, the fan stops moving and stops functioning.

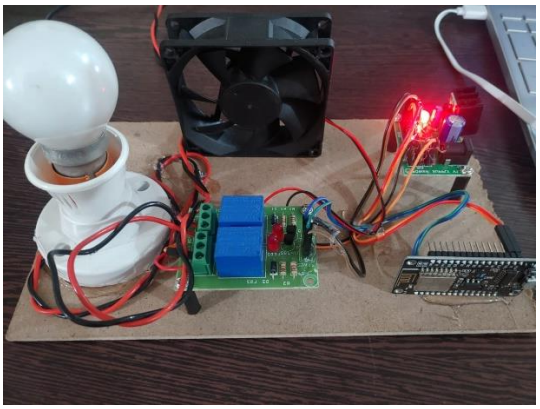


Fig 5. Fan turns OFF.

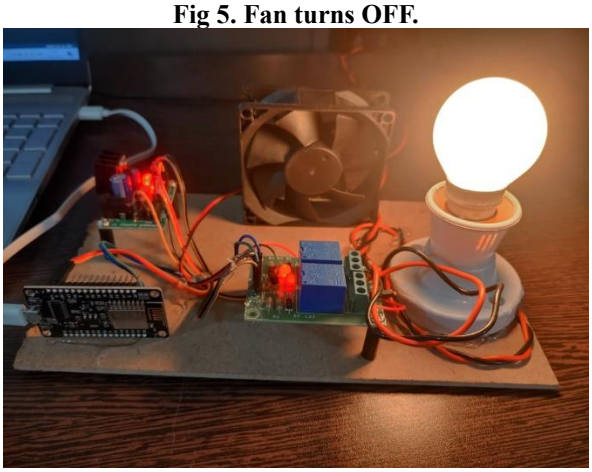


Fig 6. Electrical bulb and Fan turn ON.

The home automation circuit reacts by turning on the fan and the bulb simultaneously in response to a command "X" sent from a smartphone via a TCP/IP app. The NodeMCU, which acts as the main controller, and the smartphone connect, and the process starts. The user chooses the option to simultaneously turn on the fan and the light bulb through the TCP/IP app. When the NodeMCU receives the command "X," it interprets it as a request to start the fan and lamp operating simultaneously. It activates the relevant relays or control units connected to each gadget. The relay that is attached to the fan permits the flow of DC power, causing the fan to turn on and circulate air in the surrounding area. The relay that is attached to the light bulb simultaneously permits the flow of AC power, illuminating the light bulb. The atmosphere of the house changes when both the fan and the light are turned on. The bulb emits light to create the appropriate mood, while the fan offers cooling or air circulation. Because customers can conveniently operate the fan and the light simultaneously with a single command, this functionality improves user convenience and control.

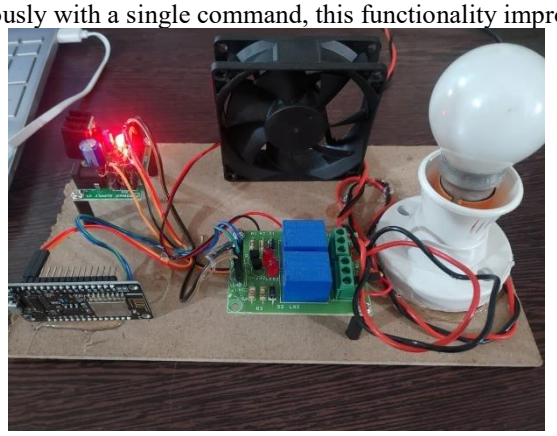


Fig 7. Electrical Bulb and Fan turns OFF.

The home automation circuit acts by simultaneously turning off the fan and the bulb in response to the command "Y" sent from a smartphone via a TCP/IP software. The process starts with the smartphone connecting to the NodeMCU, which acts as the system's main controller, using the TCP/IP app. When the user chooses to switch off both the fan and the light bulb, the command "Y" is converted and delivered to the NodeMCU.

The NodeMCU interprets the command as a request to turn off the fan and the light bulb when it receives it. It stops the passage of electrical current to both devices by activating the corresponding relays or control modules linked to each device. As a result, the fan loses the DC power required for functioning and shuts off when it is connected to its relay. The bulb, which is attached to its relay, simultaneously stops receiving the AC power needed for illumination and goes off. When the fan and bulb are turned off, they stop performing their respective tasks and no longer use any electricity. The NodeMCU confirms that the fan and light have been switched off and notifies the smartphone of the command's successful execution by sending a status update.

V. Conclusion

In conclusion, a smart home automation system offers homeowners a wide range of advantages and conveniences. Users can remotely control and automate different parts of their home environment by integrating multiple components like as a central controller (e.g., NodeMCU), relays, power supply circuit, and devices like lighting and fans. Using a TCP/IP app, the system enables users to easily control appliances like fans and lightbulbs from their cellphones. Users may turn devices on or off, change settings, and build up custom schedules by sending specified requests. The central controller acts as the system's brain, receiving and processing commands and relaying information to the other components. Relays provide the function of switches, regulating the flow of electrical current to the attached devices in accordance with instructions from the central controller. Homeowners can improve their houses' energy efficiency, security, and comfort by remotely controlling various gadgets. They can remotely control lighting systems and turning on and off lights as necessary. They can also manage fans, managing airflow and preserving a cozy environment. Additionally, the smart home automation system provides the freedom to extend and include new gadgets and features, including voice assistants, security systems, and sensor technology. Homeowners' options for convenience and customization are increased as a result.

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