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Analysis And Implementation Of An Iot Base Home Automation System

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ABSTRACT
Home automation is a technological system that is designed to automate and control various circuits and electrical devices within residential, commercial, and other types of buildings. Home automation refers to a type of technological advancement known as Internet of Things (IoT) development, which facilitates communication and control between various devices by means of internet connectivity. The objective of this project is to develop a prototype for Home Automation specifically focusing on lighting equipment, including lamps, light sensors for light activation, and the integration of multiple lights controlled by mobile devices. The research methodology employed in this study utilises the prototype approach, wherein the emphasis is placed on the outcomes derived from customer feedback, which then informs the process of software development evaluation. The research process starts with an analysis of device requirements, followed by a comprehensive literature review. Subsequently, the system design, hardware design, and user interface design are undertaken. Rigorous testing is then conducted to evaluate the efficacy of the aforementioned designs, culminating in the acquisition of data. The research result will be presented in the form of a prototype, according to the prescribed layout as indicated in the design. This system facilitates users in remotely managing household equipment, enabling operation from any location and at any time. It incorporates light sensors to receive input for the purpose of activating or deactivating lighting fixtures.

Key words: *Internet of Things, Devices, Control Equipment, Light Sensors, Design Testing*

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I. INTRODUCTION

1.1 Background of Study

The concept of home automation systems has been in existence for a number of years. The terms "Smart Home" and "Intelligent Home" have been utilised to advocate for the concept of a home automation system based on the Internet of Things (IoT). The system has seen substantial acceptance and extensive adoption in countless families worldwide, attributable to the rapid technological advancements in current society. The utilisation of this technology offers several benefits, particularly for persons who have disabilities or are elderly. It enables the streamlined and enhanced administration of domestic appliances. The home automation system may be classified into two forms of connectivity: wired and wireless. The differentiation is in the method of connectivity, whereby wireless home appliances are connected to a central controller using a wireless electrical control system, but wired connections include physically establishing connections between the system and a central controller. The implementation of the wireless system aimed to eradicate the necessity of wired connections between household equipment. The proliferation of intelligent gadgets, such as smartphones, smart televisions, and different home appliances, has been shown to be experiencing a significant and rapid increase, as evidenced by research findings. As a result, there has been a growing dependence on these technological devices, posing difficulties for individuals in maintaining a significant level of detachment from them for prolonged durations. Time magazine conducted a survey with a representative sample of 5,000 individuals from several countries like the United States, United Kingdom, South Korea, India, China, South Africa, Indonesia, and Brazil.The results revealed that a substantial majority of persons display a pronounced attachment to their mobile phones, as almost 84% affirm their reliance on these gadgets for their existence. The increasing prevalence of several communication protocols utilised in domestic automation contributes considerably to the growing intricacy of the Internet of Things (IoT). The domain of Internet of Things (IoT)

covers a wide array of intelligent entities, numbering in the billions, which are networked to perceive, collect data, and engage in communication with nearby entities through the utilisation of mobile, wireless, and sensor technologies. The principal objective of the Internet of Things (IoT) is to efficiently and intelligently govern and control tangible entities in our environment, hence augmenting the general standard of living. This objective is accomplished by offering cost-effective residential options that include several dimensions, including safety, security, and recreational amenities. Smart objects autonomously gather vital contextual data and transfer it to remote application servers for the purpose of delivering context-aware or location-based services.

II. REVIEW OF RELATED LITERATURE

2.1 A Brief outline of the chapter

This chapter explains the historical background and theories related to home automation, and its operation systems, android development tools, WIFI technology, WIFI module, Arduino and it will contain some examples to home automation projects in real world.

2.2 Historical Background of the project

The concept of home automation system pertains to the computerization of several facets within a residential setting, encompassing tasks related to household chores and other domestic activities. The incorporation of a control unit inside home automation systems facilitates the supervision and regulation of many components, such as lighting, HVAC (heating, ventilation, and air conditioning), household appliances, and other related systems. The primary objective of this integration is to enhance convenience, comfort, energy efficiency, and security. The notion of home automation has been in existence for a considerable while, with several devices being available for an extended duration. Nevertheless, thus far, there has been no implementation that has attained extensive adoption. The use of home automation technology in the context of older adults and those with disabilities has promise for improving their overall quality of life. This technology has the capacity to enhance their freedom and decrease their dependence on caretakers or institutionalised care. Moreover, it possesses the capacity to build a wireless connectivity between domestic devices or the automation system itself, employing telephone lines, wireless transmission, or the internet. This technology facilitates the management, surveillance, and scrutiny via cellphones or a web-based browser application.

The origins of home automation can be attributed to the emergence of labor-saving gadgets. The introduction of electric power distribution during the 20th century enabled the development of autonomous household appliances that operate on either electric or gas power. This technical innovation facilitated the progress of several household equipment, including washing machines (1904), water heaters (1889), refrigerators, sewing machines, dishwashers, and clothes dryers.

The inception of the inaugural comprehensive domestic automation network technology, commonly referred to as X10, occurred in the year 1975. The communication protocol being discussed relates to the transmission of data between electronic devices. The primary approach utilised involves the use of electronic power transmission wires for the purpose of signalling and control. This approach is predicated on the use of concise radio frequency bursts containing digital data as signals, and remains the most widely available alternative. The X10 devices available in 1978 included a 16-channel command console, a light module, and an appliance module. Subsequently, the wall switch module and the first X10 timer were added. According to a study conducted by ABI Research, it was found that around 1.5 million home automation systems had been installed in the United States by the year 2012. Based on the findings of Statistic, it is anticipated that the number of smart home devices installed in American households would exceed 45 million by the end of 2018.

Applications and Technologies

I. Heating, ventilation and air conditioning (HVAC): it is possible to have remote control of all home energy monitors over the internet incorporating a simple and friendly user interface.

II. Lighting control system: a "smart" network that incorporates communication between various lighting system inputs and outputs, using one or more central computing devices.

III. Occupancy-aware control system: it is possible to sense the occupancy of the home using smart meters and environmental sensors like CO 2 sensors, which can be integrated into the building automation system to trigger automatic responses for energy efficiency and building comfort applications.

As technology becomes more and more affordable, and with the majority of western populations having home internet and a smart phone, smart technologies are slowly integrating into our homes. Today, the focus is on convenience, security and energy efficiency through connectivity and interactivity.

2.3 Theories, Concept Relevant to the Research

There exist several perspectives and methodologies regarding home automation, with one prevalent example being the use of Wifi or internet-based systems for this purpose.

2.3.1 WiFi Based Home Automation

The objective of this project is to design and implement a home automation system using the ESP32 microcontroller. This system allows for the management of a range of household devices over Wi-Fi connections, use either a website or an Android application that has an established internet connection. The home automation system, which is built on the Esp32 platform, enables the remote control of household devices from any global location, provided that both the system and the user possess internet connectivity.The below elements are the constituents employed in a Esp32-based home automation system:

- ESP32 (Wi-Fi module): This is very cheap and inexpensive wifi module. It works on UART communication and it is very easy to connect this module with internet.
- RELAY_Module: Four relays are used in this project to control four loads.

The concept entails the user establishing wireless connections with several devices through the use of Wi-Fi technology, hence facilitating remote control over these devices. The Wi-Fi module possesses the capability to receive a wireless signal from a mobile device. The aforementioned signal is subsequently transferred from the microcontroller's transmitter to its receiver. The received signal is analysed by the microcontroller, which then generates a corresponding signal to be transmitted over the designated port. The ports are initialised as output ports. Relay interfacing is utilised to facilitate the functioning of gadgets that necessitate a greater current requirement.The fundamental operation of the project may be described as follows:
A USB to serial bus was used to initialize the Wi-Fi module's initial settings for instance the baud rate was initialized to 9600bps and the CWMODE of the module was set to mode 3.
ESP32 was initialized via the following commands:
AT
AT+CWMODE = 3
AT+CIFSR
AT+CIPMUX = 1
ESP32 was then connected to the mobile hotspot by the following commands:
AT+CWLAP (returns the list of the available Wi-Fi networks available)
AT+CWJAP = "SSID", "password"

Following the completion of the configuration process, the module was then connected to the microcontroller utilising the previously delineated circuitry. The transmitter was linked to the receiver of the microcontroller, whereas the receiver was connected to the transmitter of the microcontroller. The module has the capability to receive a signal wirelessly using a cellular phone. The UART connection of the microcontroller receives a signal that is comprised of a sequence of characters. The provided string was thereafter analysed in order to ascertain which button had been pressed on the mobile phone. The comparison was conducted using preloaded strings, and upon identifying a match, a strong signal was transmitted to the relevant port bit. The activation and deactivation of a device connected to an output port of a microcontroller is achieved through the utilisation of a wireless method. The wireless capability is enabled by the utilisation of a Wi-Fi module, which has been configured to work at the same IP address as the mobile phone.

The underlying concept governing the interpretation of signals received at the UART terminal and their subsequent processing for the purpose of activating a specific device can be summarised as follows:

The reception of a signal at the UART terminal leads to the storing of a character string. An illustration of the text '0 Connect, 0 Closed, 2:1' signifies the initial key press, which establishes the value of portb.b0 as 1. In a similar manner, when the key press is executed to assign a value of 1 to portb.b1, the resulting text received follows the format of '0 Connect, 0 Closed, 2:9'. The analysis undertaken involved comparing the provided string to each individual character inside it, until the third-to-last character, which is represented as '2'. At this juncture, a variable denoted as 'state' was assigned a numerical value of 1. Following that, the variable 'state' was modified to 2, as the succeeding character in the text was recognised as a colon sign ':'.Following this, the character that is received subsequently at the UART is considered as the distinguishing character, which is then compared inside the aforementioned if conditions. As a result, this procedure initiates the corresponding bit of the port.

2.3.2 Arduino integration development environment

The Arduino platform is a tangible processing system that functions based on an open source framework. The system comprises a microcontroller board and an integrated development environment (IDE) that facilitates programming functionalities. The Arduino platform exhibits the capacity to receive a multitude of inputs, like switches or sensors, and proficiently govern various outputs, such as lights and engines. In contrast to other microcontroller frameworks that exhibit compatibility just with the Windows operating system, Arduino demonstrates compatibility with a broader range of operating systems, including Windows, Macintosh, and Linux.

The Arduino is a device that is employed for the creation of an advanced version of a computer system, which possesses the ability to exercise control, facilitate interaction, and perceive inputs that beyond the capabilities of a typical desktop computer. The subject of analysis pertains to a physical processing stage that is characterised by an open-source nature, with a primary focus on a fundamental microcontroller board. The platform offers a favourable setting for programming the board, facilitating the development of interactive goods. These items have the capability to accept inputs from a diverse array of switches or sensors, enabling them to regulate a multitude of physical outputs, including lights, motors, and other devices. Arduino activities possess the capability to operate independently or be seamlessly connected with computer-based software programmes, like Flash, Processing, and Maxmsp.
The board may be either manually fabricated or acquired in a preassembled condition, whilst the open-source integrated development environment (IDE) can be downloaded free of charge by downloading.
Due to advancements in technology, several variations of the Arduino platform have been produced, each possessing unique qualities. Several primary Arduino models include Arduino Uno, Arduino Nano, Arduino Mega, Arduino Mini, and Arduino Leonardo, among other variants.

2.3.3 IOT Modules

An IoT module is a small electronic device that is embedded into different objects, equipment, and entities, allowing them to establish wireless connections and simplify the exchange of data. The IoT module, sometimes referred to as a "radio chip," comprises the technical and data circuits found in mobile phones, excluding elements such a display or keypad.
A wide array of modules may be found, including Wifi modules, Bluetooth modules, Rf modules, 3G/4G modules, and GPS modules.

i. Wireless fidelity (WiFi) Module

The Arduino Uno WiFi is a modified version of the Arduino Uno microcontroller board, with an integrated WiFi module. The board use the ATmega328P microprocessor in combination with an integrated ESP8266 WiFi Module. The ESP8266 WiFi Module is a system-on-a-chip (SoC) that integrates a TCP/IP protocol stack, facilitating the establishment of access to a WiFi network. Moreover, the module possesses the capacity to operate as an access point.

ii. Bluetooth Module

The Arduino Uno board does not possess built-in functionality for Bluetooth connections, hence making it unfeasible to create a wireless connection with an Android device. Hence, it is imperative to build a mechanism for facilitating communication between the Arduino-Uno board and an android device. An example that might be cited is the HC-06. The HC-06 module is specifically engineered to cater to users with less technical proficiency, since it needs just a rudimentary comprehension of its features. Furthermore, it may be programmed by utilising AT commands. The gadget is offered in a singular pre-established mode, which may be either a master or a slave.

iii. IR (Infrared Ray) Module

The IR sensor module comprises several key components, including the IR Transmitter and Receiver, Opamp, Variable Resistor (Trimmer pot), and output LED, to summarise. The subject of discussion is an infrared light-emitting diode (IR LED) transmitter. The infrared light-emitting diode (IR LED) generates light within the frequency range of infrared radiation. In the perceptual realm of human vision, infrared (IR) light remains imperceptible due to its far longer wavelength range of 700 nanometers to 1 millimetre, beyond the boundaries of the visible light spectrum.

iv. 3G/4G Modules

A 3G/4G card is a modem that facilitates wireless Internet access for computing devices by using the cellular network of a service provider that offers 3G or 4G services. Wireless network adapters commonly have integrated antennas and are offered in several physical forms, including inside PCI cards, external USB sticks, PCMCIA cards, and Express cards.

v. GPS Module

A GPS navigation module, often known as a GPS receiver, is a device designed to receive and process information transmitted by GPS satellites in order to determine the precise geographical coordinates of the device. By employing appropriate software, the device has the capability to exhibit the geographical coordinates on a cartographic representation, while also providing navigational guidance.

2.3.5 Android application

An android application refers to a software programme that operates on the Android platform. The Android platform is specifically developed for mobile devices, hence a typical Android application is meant to be compatible with smart phones or tablet PCs that operate on the Android operating system.

2.3.6 Electronics Sensors

An electronic sensor is a purpose-built instrument designed to detect or measure different characteristics of the immediate environment in which it is situated. The aforementioned data or information is produced through mechanical or electrical processes, and then transmits environmental information by creating an electrical signal. Several types of sensors may be found in various applications, such as the infrared (IR) sensor, temperature sensor, and ultrasonic sensor. Vishwakarma (2019) asserts that many types of sensors may be employed across diverse applications. The aforementioned components encompass touch sensors, proximity sensors, pressure sensors, level sensors, as well as smoke and gas sensors.

This article presents a methodical approach for the construction of a smart home automation controller. The integration of Internet of Things (IoT) technology enables the conversion of home appliances into intelligent and networked devices by including design control mechanisms. A system has been created that is energy efficient and can be accessed remotely. This system leverages Internet of Things (IoT) connectivity to establish communication with a smart dwelling. The proposed system principally requires the use of the Node MCU as the microcontroller unit, IFTTT for voice command interpretation, Adafruit as a library that enables MQTT and serves as a MQTT broker, and the Arduino IDE for microcontroller programming. The current multimodal solution utilises Google Assistant in combination with a web-based application to effectively oversee and control the operations of a smart home. The smart home system is outfitted with a central controller unit that is connected to a perpetually accessible Wi-Fi network. To provide uninterrupted Wi-Fi connectivity, the primary controller is equipped with the capability to autonomously establish a connection with an accessible network. Additionally, it is integrated with an automated power backup system.

Shaunak Oke, Parth Medhi, and Professor P. P. Laturkar.

This article focuses on a system that utilises Internet of Things (IoT) technology to enhance the functionality of Home Automation features. Moreover, it integrates a video module in order to increase the security of residential properties. The research study titled "IoT-Based Smart Security and Home Automation" was authored by Shardha Somani and Parikshit Solunke. The android application effectively converts a Smartphone into a device that can be used to remotely manage various household appliances. The establishment of security is efficiently achieved by employing motion sensors, which instantly detect any movement taking place at the entrance of a residential premises. In the case that the system detects any movement, an immediate notification is expeditiously sent, including an image of the entry to the residence. The recipient of this message will get it over the internet, and the software may trigger a notice. The proprietor possesses the power to engage an alarm system in the occurrence of an unauthorised intrusion, or alternatively, they have the capacity to manage diverse domestic apparatus, such as unlocking the entrance, provided that the person is recognised as a guest. The system use Raspberry Pi, a little device that functions as the server for the system. The concept of a smart house consists of two distinct components. The home automation system is composed of many components, including a fan light and door controller, alongside a security module that encompasses a smoke sensor, motion sensor, and camera module.

Tui-Yi Yang, Chu-Sing Yang, and Tien-Wen Sung.

This paper introduces a potential optimisation technique for domestic electricity use using Power Line Communication (PLC) technology. The objective is to enable simple monitoring and management of household energy usage.The scholarly paper entitled "A Dynamic Distributed Energy Management Algorithm of Home Sensor Network for Home Automation System" presents a unique algorithm designed to effectively manage energy consumption inside a home sensor network integrated into a home automation system.Furthermore, a suggested approach is the deployment of a Zigbee and PLC-based renewable energy gateway with the aim of monitoring the energy production of renewable sources. The ACS and DDEM algorithms have been proposed as solutions for the development of an intelligent power management system aimed at guaranteeing uninterrupted power provision for residential networks. To enhance power management efficiency, the power supply models of home sensor networks are classified into many categories. The various forms encompass the following: primary power supply only, primary power supply with supplementary battery backup, power supply reliant on rechargeable batteries, and power supply reliant on non-rechargeable batteries. Devices with specific attributes

are classified into these categories. The aim of this study is to devise a real-time processing methodology that can efficiently manage dynamic sensor network topologies.

Tushar Churasia and Prashant Kumar Jain.

This work introduces a revolutionary methodology with the objective of alleviating the computational challenges commonly encountered in existing smart home solutions. This is achieved by constructing a model that integrates many encryption algorithms, including AES, ECHD, hybrid, and others.The study entitled "Enhancing Smart Home Automation System based on Internet of Things" by Tushar explores several strategies that entail the use of an intermediary gateway for the purpose of establishing connections among diverse sensor devices. The proposed paradigm presents a methodical approach to automation by employing sensor-based learning approaches. The system utilises a temperature sensor in its creation, however other sensors may be employed depending on individual requirements. These technologically advanced home devices, which are coupled with sensors, has the potential to autonomously organise themselves and operate without requiring human intervention. The objective of this study is to minimise the computational burden linked to encryption and decryption procedures, with a focus on enhancing authentication methods and integrating automated features for smart home devices, such as machine learning algorithms. The proposed approach bypasses the local gateway mentioned in the existing system to bolster the security of smart home devices and sensor data, while also reducing computational burden. The real-time broker cloud is closely interconnected with smart home systems and functions as a central hub for the management of incoming and outgoing requests between users and their interconnected devices. The main goal of implementing real-time broker cloud is to enhance the efficiency of cryptographic operations by minimising their execution time.

The research paper presents a machine intelligence system that employs vision-based technology for the purpose of identifying the operational state of frequently utilised domestic appliances (Suraj et al., 2003). The approach put forward for the detection of household appliance status culminates in the creation of a novel home automation system. The capability to remotely access the array of devices within a household is facilitated by the employment of IP addressing techniques within the framework of the Internet of Things (IoT). This project employs two distinct boards, namely the Raspberry Pi and the Intel Galileo Gen 2. Data communication between user devices, Raspberry Pi, and Intel Galileo boards takes place over a wireless network. The User Datagram Protocol (UDP) is utilised for the purpose of facilitating wireless communication between nodes inside the home automation network. Two separate servo motors are employed to facilitate the rotation of a Raspberry Pi Camera and a USB Logitech camera. The cameras capture photographs, which are then utilised as inputs for Machine Learning models that have been trained using dlib-C++. The primary objective of these models is to ascertain the operating state of the appliances. The technique being presented utilises the visual modality as a means to automate home appliances. Nevertheless, the usage of photographs derived from specific geographical areas may give rise to privacy problems. In order to tackle this problem, the Raspberry Pi integrates a Single Pole Double Throw (SPDT) switch. When the switch is in the off position, the pictures received from webcams are only used as inputs for machine learning models and are not shown on the website accessible by users via the server address acquired from the Ras.

Vikram.N, Harish.K.S, Nihaal.M.S, Raksha Umesh, Shetty Aashik and Ashok Kumar.

This article introduces a methodology for the implementation of a cost-efficient Home Automation System (HAS) using Wireless Fidelity (Wi-Fi) technology. The research named "A Low Cost Home Automation System Utilising Wi-Fi based Wireless Sensor Network Incorporating Internet of Things" explores the concept of interconnection among intelligent devices. A Wireless Sensor Network (WSN) has been designed using Wi-Fi technology to enable the monitoring and control of many environmental, safety, and electrical parameters inside a connected residential environment. The Home Automation System (HAS) is composed of many components, which encompass a temperature and humidity sensor, a gas leakage warning system, a fire alarm system, a burglar alarm system, a rain detection system, and load control, as well as devices for measuring voltage and current. The management and regulation of devices inside a Home Automation System (HAS) is predominantly accomplished through the usage of a Smartphone application. The application has been developed using the Android Studio integrated development environment (IDE) on the JAVA programming platform. The user interface (UI) of the programme is depicted. The primary aim of this research is to develop a cost-effective and versatile system for device control, including a wide range of sensors to capture several metrics.

III. METHODOLOGY

3.1 Brief Outline of the Chapter

This chapter expounds about the methodology and trajectories that must be pursued in order to achieve the purpose of the project. This covers both hardware and software systems, which collectively form an integral part of the overall system architecture. The project encompasses several hardware elements, such as a microcontroller equipped with an integrated wifi module for the transmission and processing of data and information. Furthermore, the use of an 8-channel relay module is implemented to ease the process of power switching for the device. A rectifier is employed to perform circuit filtration and transform direct current (DC) into alternating current (AC). In addition, a power supply is utilised to furnish the requisite electricity to the system, together other components.

The project has many elements, including block-to-block schematics, schematic diagrams, and considerations related to material selection for construction reasons.

3.2 Research Design

The current study utilised a qualitative research approach to conduct an experimental inquiry. A thorough examination of the extant literature was conducted, whereby data and information from several sources were thoroughly scrutinised. The research employed a qualitative methodology, wherein Internet of Things (IoT) devices were created and deployed to gather data for analysis, in order to accomplish the research's aims and objectives.

3.3 Materials

The components utilised in this study encompass the Node Microcontroller Unit (Node MCU), rectifier, cables, 8 Channel Solid State Relay Module, light bulbs, 13 Amp Switch, and Junction Box.

Table 3.1 Materials used

S/N	Material	Location
1	Node Microcontroller Unit (Node MCU), 8 Channel Solid State Relay Module, Jumper Wires	Hob 360 porthercourt
2	Diodes, Resistors, Capacitors, Rectifier, Transformer	Oraimo Incorporated
3	Junction Box, Light bulbs, 13 Amp Switch	Electrical store otuoke
4	Wires and Cables	Electrical store otuoke

NODE MCU

The NodeMCU, sometimes referred to as the Node Microcontroller Unit, is a cost-effective open source platform specifically developed for the purpose of facilitating Internet of Things (IoT) applications. The first design consisted of programming code that functions on the ESP8266 Wi-Fi System-on-a-Chip (SoC) manufactured by Espressif Systems, together with hardware components constructed using the ESP-12 module. Following that, the incorporation of support for the ESP32 32-bit microcontroller unit (MCU) was implemented.

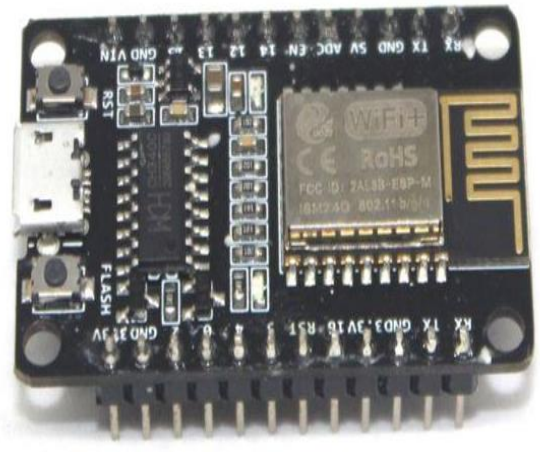


Plate 3.1 Node MCU Development Board.

The NodeMCU firmware is a programme that has been developed as an open-source solution, and it is accompanied with open-source designs for prototype boards. The name "NodeMCU" is coined by combining the terms "node" and "MCU," with "MCU" denoting micro-controller unit. Within the realm of academic discourse, the term "NodeMCU" mostly pertains to the firmware component rather than the development kits that establish an interface with it.

Both the firmware and prototype board designs are readily available as open source.

The firmware employs the Lua programming language. The firmware utilised in this specific situation is derived from the eLua project and created using the Espressif Non-OS Software Development Kit (SDK), specifically designed for ESP8266. The system incorporates other open-source projects, including lua-cjson and SPIFFS. In light of resource limitations, it is imperative for users to apply discretion in the selection of modules that align with their project requirements. Subsequently, they should proceed to build firmware that is specifically designed to cater to their distinct demands. Furthermore, the seamless incorporation of support for the 32-bit ESP32 has been accomplished.

A frequently employed hardware for the aim of prototyping comprises the usage of a circuit board that serves as a dual in-line package (DIP). The present design implements the integration of a USB controller into a compact surface-mounted board, which incorporates both the microcontroller unit (MCU) and the antenna. The use of the Dual In-line Package (DIP) design facilitates uncomplicated prototyping on breadboards. The foundational architecture of the system was derived from the ESP-12 module of the ESP8266, a System-on-Chip (SoC) with Wi-Fi capabilities that incorporates a Tensilica Xtensa LX106 core. This particular core is frequently employed in applications related to the Internet of Things (IoT). The assortment of materials encompasses microcontrollers, Internet of Things (IoT) modules, user control interface (UCI), and relay modules.

Solid state Relay Module

A solid state relay is an electrical device that operates on the fundamental principles of solid state technology. There are control systems as well as controlled systems in existence. The principal objective of its use is the automatic regulation of circuits. The gadget operates as an automated switch that controls the activation of a high-current circuit through the utilisation of a low-current signal.

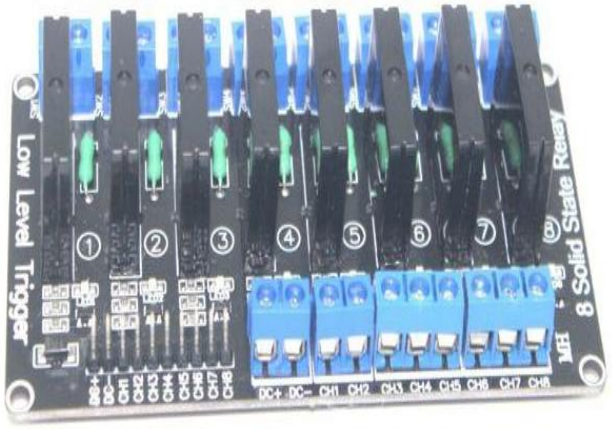


Plate 3.2 A Solid state relay

Rectifier

A rectifier is an electrical apparatus that facilitates the conversion of alternating current (AC), characterised by periodic changes in direction, into direct current (DC), which exhibits unidirectional flow.

3.4 Methods

The NodeMCU microcontroller is equipped with the ESP8266 wifi module, facilitating the establishment of a wireless connection between the microcontroller board and an android device. The NodeMCU board will be equipped with an integrated software system, which will be programmed by establishing a connection between the board and a computer. A total of eight devices or gadgets will be networked in order to facilitate control and monitoring. The microcontroller will enable or disable each device or gadget by utilising the 8 solid state relay.

Upon activation, the microcontroller establishes a connection with an Android device through the internet via a WiFi module. The construction of this connection is accomplished by the coupling of the device's hotspot with the WiFi module that is included into the microcontroller board. The establishment of a connection between the microcontroller board and the android device facilitates the android device's ability to exert control over the system. Control is achieved by the utilisation of a customised application specifically designed for the purpose of home control. The software programme is responsible for managing the activation or deactivation of diverse devices or gadgets that are connected to the home control system.

BLOCK DIAGRAM

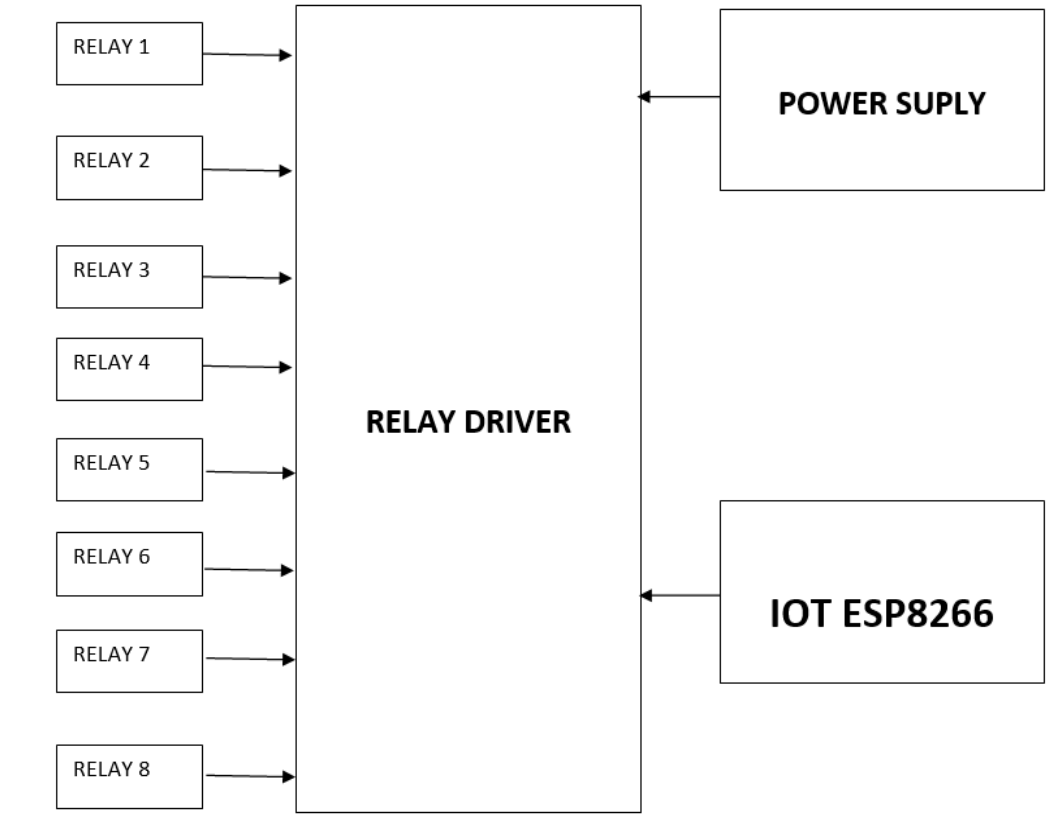


Fig. 3.1 Block diagram for the design of the IOT Home Automation System

The design of the system is divided into two, the software design and the hardware design.
The software design

The fundamental framework of the system is established upon the usage of the NodeMCU board, which serves as a crucial component within the architecture of the Internet of Things. The NodeMCU has the ability to establish an internet connection by utilising the ESP8266 circuit via a wireless fidelity (WIFI) connection. The construction of this connection is facilitated by the use of an internet hotspot accessible via a smartphone.

In order to establish a linkage between a NodeMCU device and a smartphone's hotspot, it is crucial to provide the NodeMCU with the necessary credentials, which encompass the hotspot's designated name, password, and token code. The information supplied facilitates the establishment and administration of the connection between the server of the HTML application and the two devices. The process of transferring code from the Arduino Integrated Development Environment (IDE) to the NodeMCU kit was facilitated by the usage of a computer, enabling the production of the software component of the project. Figure 1 illustrates the operational sequence of the connectivity process between the smartphone and NodeMCU, which is assisted by the server of the HTML application. The HTML application that has been developed may be downloaded and afterwards imported into the library of the Arduino Integrated Development Environment (IDE).

The script will determine the presence of an internet connection by conducting a thorough analysis of the connectivity of a NodeMCU device that is connected to an Android hotspot. The NodeMCU code includes the integration of a token code, along with the specification of the hotspot's name and corresponding password. For the ESP8266 to effectively establish a connection with the WIFI network, it is crucial that the code incorporates accurate and pertinent details that correspond to the hotspot information. The established connection enables the exchange of commands between a smartphone and the NodeMCU, enabling the control of loads linked to the relay kit, as seen in the accompanying diagram.

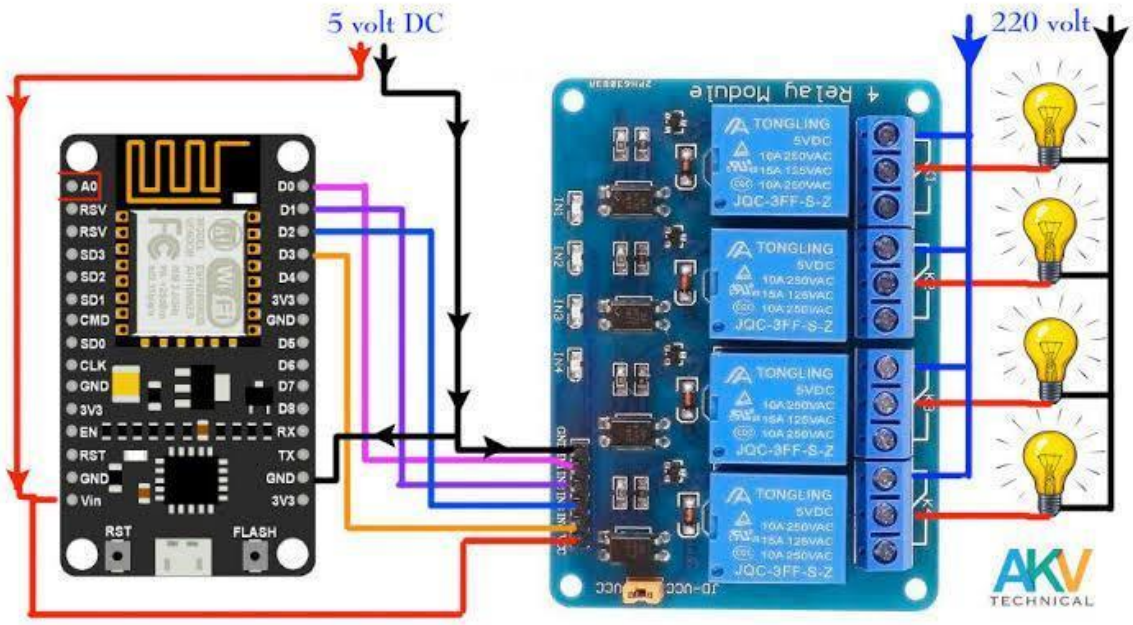


Plate 3.2circuit diagram of the connection of the NodeMCU board and the relay module

2. And the output value is sent reverse to the application from NodeMCU kit.

The NodeMCU device has the ability to convey output values to the connected application by utilising voltage measurements. Following the ON/OFF methodology outlined in the flowchart, the application server will perform a verification procedure to ascertain the presence or absence of an internet connection. Furthermore, the server will verify the specified username and password of the hotspot for authentication purposes. The implementation of these procedural actions is essential in order to guarantee the appropriate initiation of the switch, which is dependent on the output value of the sensor.

The power supply will facilitate the transmission of electrical energy to the system by means of the relay and NodeMCU ESP8266 modules, therefore ensuring the optimal functioning of all equipment.The NodeMCU ESP8266 microcontroller possesses the ability to accept TCP/IP formatted commands from an application server. The aforementioned commands are subsequently run in order to determine the right logic state, either "HIGH" or "LOW", for configuring specific pins via relays. This feature enables the control and administration of household lighting and switches, hence facilitating their activation and deactivation. The utilisation of Wi-Fi enables the seamless integration of cloud computing as the predominant connection between the HTML application and the NodeMCU project.

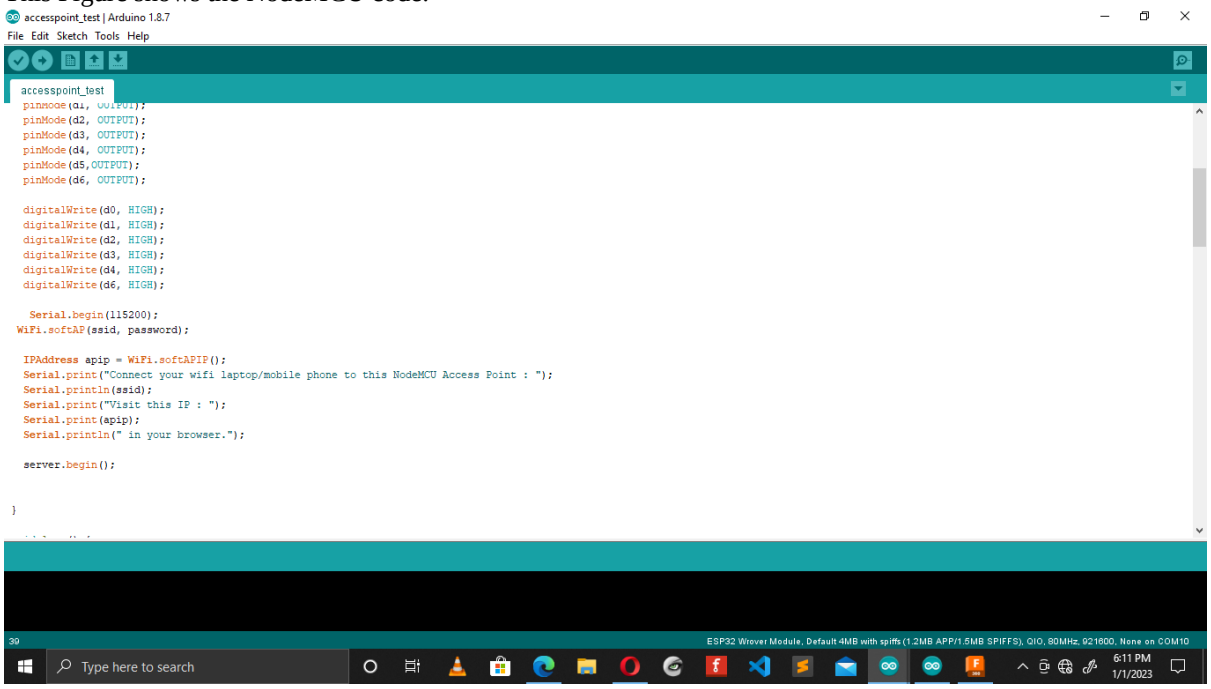
3.4 The application and Arduino IDE preparation and Running

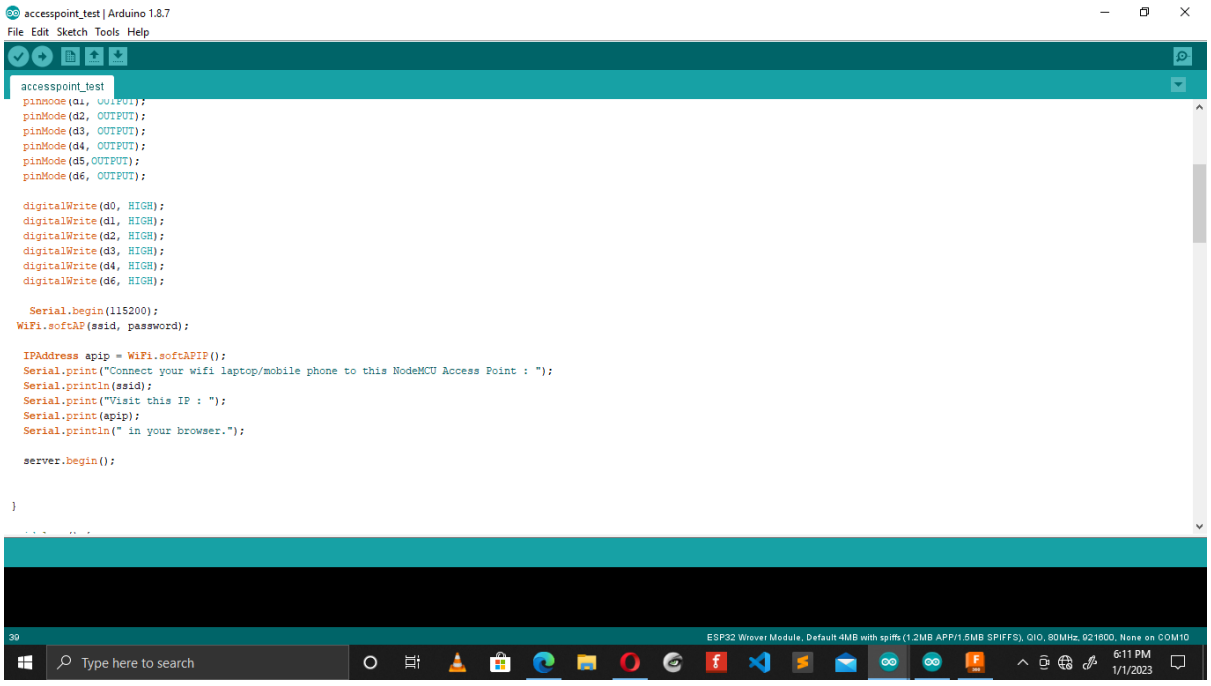
The execution of this project is facilitated by an HTML application. The development and subsequent download of the application onto a smartphone should be facilitated via the Google Play Store. Subsequently, proceed to construct a project within the software application, incorporating a collective sum of six switches. The buttons have to be arranged in the form of switches, wherein each switch is linked to a designated pin on the microcontroller. The pins designated for use in this particular setup are D1, D2, D3, D4, D5, and D6. Figure 3 illustrates the captured image of the application UI.

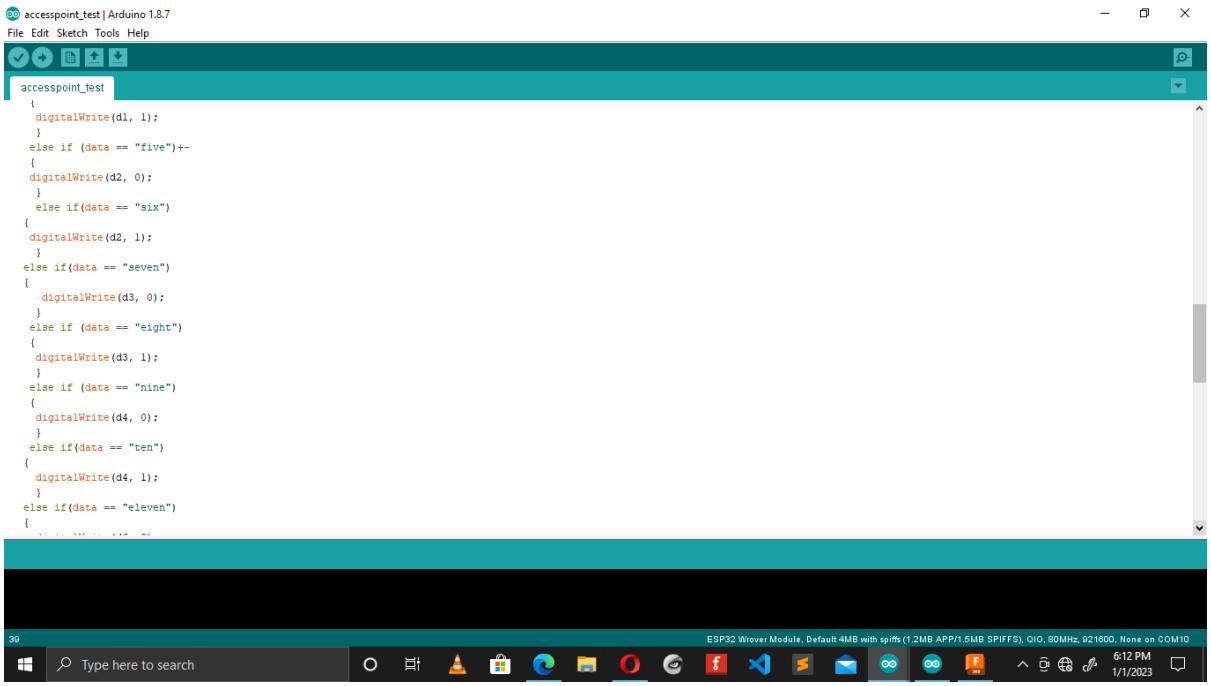
3.5 NodeMCU code via Arduino IDE

To facilitate the programming of the NodeMCU using the Arduino IDE, it is essential to incorporate the NodeMCU into the library of the Arduino IDE. The inclusion of the appropriate address in the settings of the Arduino Integrated Development Environment (IDE) can facilitate this accomplishment. After successfully integrating the reference into the Arduino Integrated Development Environment (IDE), the next step involves downloading NodeMCU from the boards manager. After careful consideration, it is recommended to select the NodeMCU 1.0 [ESP12E module] from the available alternatives. After successfully incorporating the NodeMCU into the Arduino IDE library, proceed with uploading the given code while ensuring appropriate adjustments are made to the hotspot name, password, and token code.

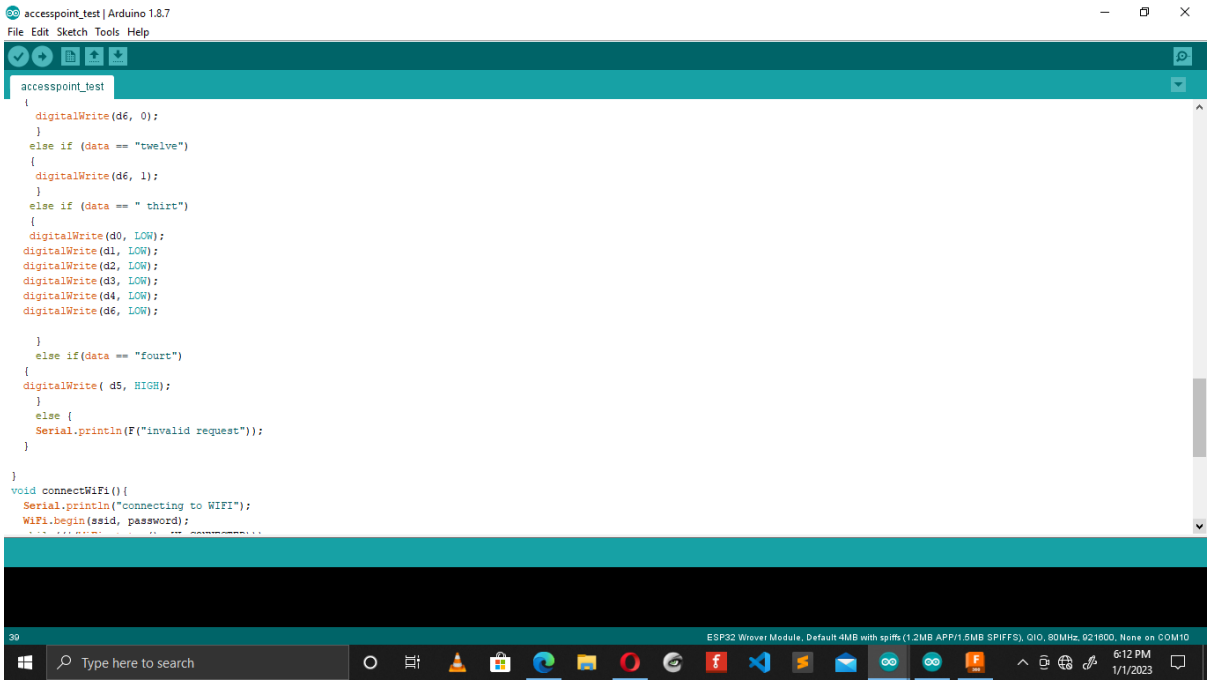
This Figure shows the NodeMCU code.







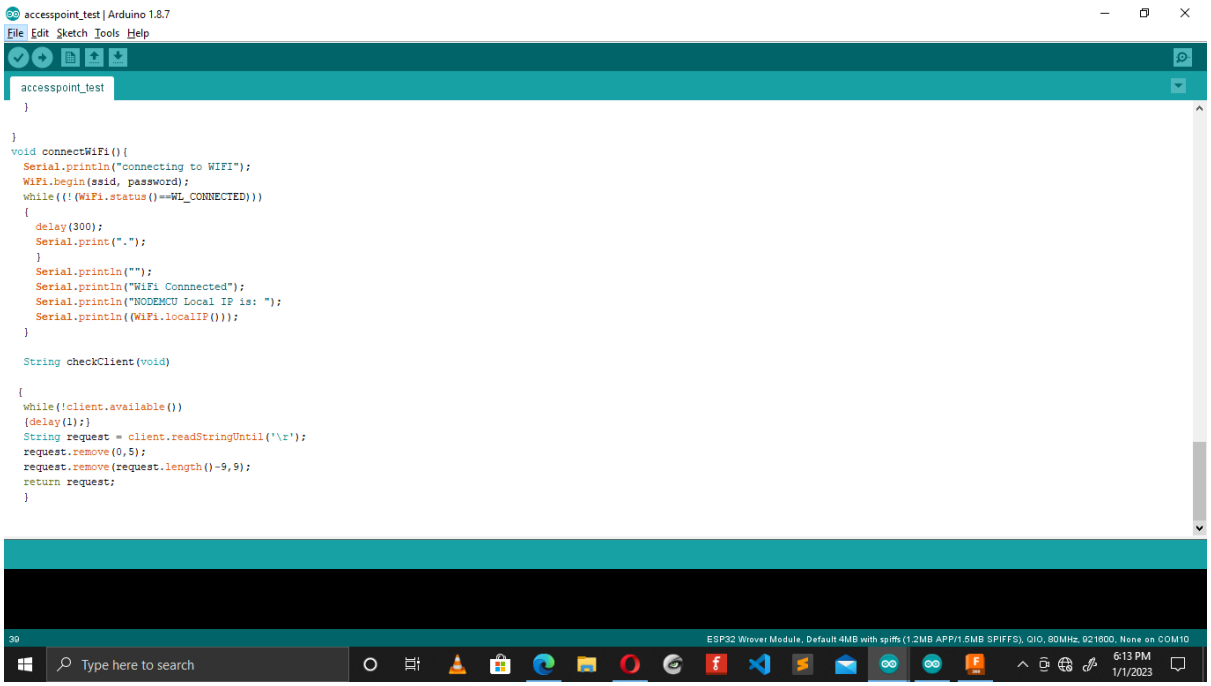
```
accesspoint_test | Arduino 1.8.7
File Edit Sketch Tools Help
accesspoint_test
 {
  digitalWrite(d1, 1);
  }
 else if (data == "five")+-
 {
 digitalWrite(d2, 0);
  }
  else if(data == "six")
{
 digitalWrite(d2, 1);
  }
else if(data == "seven")
{
   digitalWrite(d3, 0);
 }
 else if (data == "eight")
 {
  digitalWrite(d3, 1);
  }
 else if (data == "nine")
 {
  digitalWrite(d4, 0);
  }
 else if(data == "ten")
{
  digitalWrite(d4, 1);
  }
else if(data == "eleven")
{
```



```
accesspoint_test | Arduino 1.8.7
File Edit Sketch Tools Help
accesspoint_test
 {
  digitalWrite(d6, 0);
  }
 else if (data == "twelve")
 {
  digitalWrite(d6, 1);
  }
 else if (data == " thirt")
 {
 digitalWrite(d0, LOW);
digitalWrite(d1, LOW);
digitalWrite(d2, LOW);
digitalWrite(d3, LOW);
digitalWrite(d4, LOW);
digitalWrite(d6, LOW);

  }
  else if(data == "fourt")
{
digitalWrite( d5, HIGH);
  }
  else {
  Serial.println(F("invalid request"));
}

}
void connectWiFi(){
  Serial.println("connecting to WIFI");
  WiFi.begin(ssid, password);
```



3.6 The Hardware of the system

As previously said, the construction of the circuit requires the use of several components. The nodeMCU necessitates a 5-volt direct current (Vdc) supply voltage at its Vin pin, serving as an illustrative instance. To regulate the circuit, a rectifier is employed. In addition, the system is equipped with a step-down converter that transforms a 12-volt alternating current (AC) into direct current (DC), alongside a distinct 5-volt DC-DC step-down converter. However, the utilisation of a 5-volt output AC-DC step-down converter eliminates the necessity of employing a distinct DC-DC converter.Pin used;

1. Vin is connected to power supply output 5VDC.
2. GND is ground.
3. D1,D2,D3,D4,D5 and D6 are used as digital outputs.

Relay module

The relay module may be readily coupled to digital circuits, such as microcontroller kits, in order to facilitate the control of high-power loads using a microcontroller. The six relays, namely IN1, IN2, IN3, IN4, IN5, and IN6, are controlled by input signals that work within a voltage range of 3-5 volts DC.

Plate 3.3

Plate 3.4

IV. Conclusion

Based on the results of analysis of all data obtained by testing the smart home with the Internet of Things, the following conclusions can be drawn:

1. A smart home system utilising the Internet of Things (IoT) may be constructed by integrating several hardware and software components. This arrangement enables the system to be managed through an Android application, in accordance with the user's preferences and objectives.
2. The use of the Internet of Things (IoT) enables the management of various home electronics functionalities such as lighting controls, fan control, and switch control inside the Smart Home environment.

4.1 Recommendation

Additional research can be undertaken to enhance the efficacy of the implemented Internet of Things (IoT) home automation system by optimising the power consumption of the NodeMCU ESP8266 module. This optimisation should be geared towards the advancement of wireless-based technology applications, taking into account the prevailing emphasis on cost-effectiveness and efficiency in contemporary technology.

In order to ensure the efficacy of an Internet of Things (IoT)-enabled smart home system, it is important to conduct comprehensive testing on various electrical gadgets often used in everyday life.

The purpose of this project is to cater to the requirements of home automation systems in various settings such as residential households, engineering laboratories, offices, and industrial environments. The use and maintenance of the aforementioned should be entrusted to individuals with the necessary qualifications.

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