A Unique Home Automation System through MEMS based Applience Control

[1] B.Sukumar, [2]G. Gopi [3]A. Sri Abhigna, [4]Ch. Harshitha, [5]K. Sai Pushpa, [6]S.Sri Lakshmi

[1]*Assistant Professor, ECE Department, N.E.C., Nellore*
[2]*Adjunct Faculty, ECE Department, NEC, Nellore*
[3] *UG Scholor , N.E.C., Nellore,*
[4] *UG Scholor , N.E.C., Nellore,*
[5] *UG Scholor, N.E.C., Nellore,*
[6] *UG Scholor, N.E.C., Nellore*

Abstract: *This project describes a system that allows users to securely control multiple home appliances using hand gestures. It uses a MEMS sensor to detect motion in the X and Y axes. When a user moves in a certain direction, the Arduino generates a command to turn on or off a corresponding appliance, such as a fan or light. This project uses MEMS technology to control home appliances for people with physical disabilities. Home automation systems can monitor and control a variety of home attributes, including lighting, climate, entertainment systems, and appliances. They can also include home security features like access control and alarm systems. This project explores the development of a home automation system utilizing Micro-Electro-Mechanical Systems (MEMS) technology. The system is designed to enhance user convenience and energy efficiency by enabling gesture-based control of home appliances. MEMS sensors detect hand gestures, which are then processed by a microcontroller to control various devices through relay drivers. This approach not only simplifies the user interface but also incorporates a gesture-based password system to ensure security against unauthorized access. This project investigates the application of Micro-Electro-Mechanical Systems (MEMS) technology in the development of an advanced home automation system.*

Keywords: *MEMS Technology; Arduino IDE*

I. INTRODUCTION

Home automation systems using MEMS (Micro-Electro-Mechanical Systems) technology and the ESP8266 Wifi module are innovative solutions for creating smart homes. MEMS technology enables the integration of sensors and actuators into compact devices, which can monitor and control various aspects of a home environment, such as temperature, lighting, and security. The ESP8266 Wifi module acts as the communication hub, allowing these devices to connect to the internet and be controlled remotely.

The ESP8266 module is popular for its low cost, ease of use, and ability to connect to Wifi networks. It can be programmed to interact with MEMS-based sensors and actuators, enabling users to control home appliances through a smartphone app or web interface. This combination of MEMS technology and ESP8266 creates a versatile and efficient system for automating home functions, enhancing convenience, energy efficiency, and security. The wheelchair is also designed with a rechargeable battery system, ensuring long-lasting operation and energy efficiency. Its ergonomic design focuses on comfort and ease of use, making it a practical solution for individuals who rely on mobility assistance in their daily lives. The project aims to enhance independence, safety, and healthcare accessibility, making mobility assistance more intelligent, user-friendly, and adaptable to various environments.

II. FUNCTIONAL OVERVIEW

Home automation systems utilizing MEMS (Micro-Electro-Mechanical Systems) technology combined with the ESP8266 WiFi module provide a smart, efficient, and user-friendly way to control and monitor household appliances. MEMS sensors, such as accelerometers, gyroscopes, and pressure sensors, enable real-time monitoring of environmental factors like motion, temperature, and humidity. The ESP8266 module serves as the communication hub, connecting these sensors and the actuators to the internet, allowing users to remotely control and manage their devices through a mobile app or web interface. The system employs actuators to operate appliances like lights, fans, and security systems, based on user commands or automation rules. This seamless setup not only enhances convenience and energy efficiency by automating tasks like switching off unused appliances but also strengthens home security by detecting unusual activities and triggering alerts. Overall, the integration of MEMS technology and the ESP8266 module creates a flexible, scalable solution for building smarter home.

Integrating the Blynk app into home automation systems that use MEMS technology and the ESP8266 WiFi module enhances the functionality and user experience significantly. The Blynk app serves as a versatile interface, allowing users to control and monitor their smart home devices from anywhere in the world using their smartphones or tablets. MEMS sensors provide real-time data on environmental conditions, while the ESP8266 module ensures seamless communication between the sensors, actuators, and the internet.

With the Blynk app, users can create customized dashboards to visualize sensor data, set automation rules, and control appliances like lights, fans, and security systems. The app also supports real-time feedback, enabling users to monitor the status of their devices instantly. For example, MEMS sensors can detect motion or temperature changes, and the Blynk app can trigger actions such as turning on lights or adjusting the thermostat accordingly.

The integration of the Blynk app simplifies the setup process, as it provides an intuitive platform for configuring the ESP8266 module and connecting it to the MEMS-based system. This combination of MEMS technology, ESP8266, and the Blynk app creates a powerful and user-friendly solution for building smart homes that are efficient, secure, and convenient.The Blynk app is a powerful IoT platform that simplifies the process of controlling and monitoring smart devices. When paired with MEMS sensors and the ESP8266 module, it creates a seamless and interactive home automation system. MEMS sensors, such as accelerometers and gyroscopes, provide real-time data on environmental conditions, while the ESP8266 module ensures reliable communication between the sensors, actuators, and the internet.

The Blynk app allows users to design custom dashboards with widgets like buttons, sliders, and graphs to visualize sensor data and control appliances. For example, MEMS sensors can detect motion or temperature changes, and the Blynk app can trigger actions like turning on lights or adjusting the thermostat. The app also supports real-time feedback, enabling users to monitor the status of their devices instantly.

III.METHODOLOGY

EXISTING SYSTEM

Existing home automation systems are designed to enhance convenience, security, and energy efficiency in households by integrating advanced technologies like IoT (Internet of Things). These systems typically include smart devices such as lighting controls, climate management systems, intrusion alarms, and entertainment setups. Wireless communication protocols like Wi-Fi, Zigbee, and Z-Wave are commonly used to connect and control these devices, enabling seamless operation without extensive wiring. Cloud-based systems allow users to monitor and control their homes remotely through smartphone apps or voice assistants, providing real-time feedback and automation capabilities. For instance, users can schedule appliances to turn on or off, adjust room temperatures, or receive alerts for security breaches. These systems not only improve the quality of life but also contribute to energy savings and increased property value.

Key Features of the Existing System: -

1. Centralized Control
2. Remote Access
3. Voice Assistant Integration
4. Energy Management
5. Scheduling

Disadvantages of the Existing System: -

1. High Initial Costs
2. Compatibility Issues
3. Cybersecurity Risks
4. Dependency on Internet
5. Complex Setup

PROPOSED SYSTEM

The proposed home automation system using the ESP8266 WiFi module and the Blynk app offers a cost-effective and user-friendly solution for creating smart homes. The ESP8266 module acts as the central communication hub, connecting various sensors and actuators to the internet. This enables users to remotely monitor and control home appliances such as lights, fans, and security systems. The Blynk app provides an intuitive interface, allowing users to create custom dashboards with widgets like buttons, sliders, and graphs to manage their devices efficiently. Key features of this system include real-time control, where users can operate appliances instantly through the app, and automation capabilities, such as scheduling tasks or triggering actions based on sensor inputs. For example, a motion sensor can detect movement and automatically turn on lights, while temperature sensors can adjust the thermostat. The system also supports real-time feedback, ensuring users are always aware of the status of their devices.

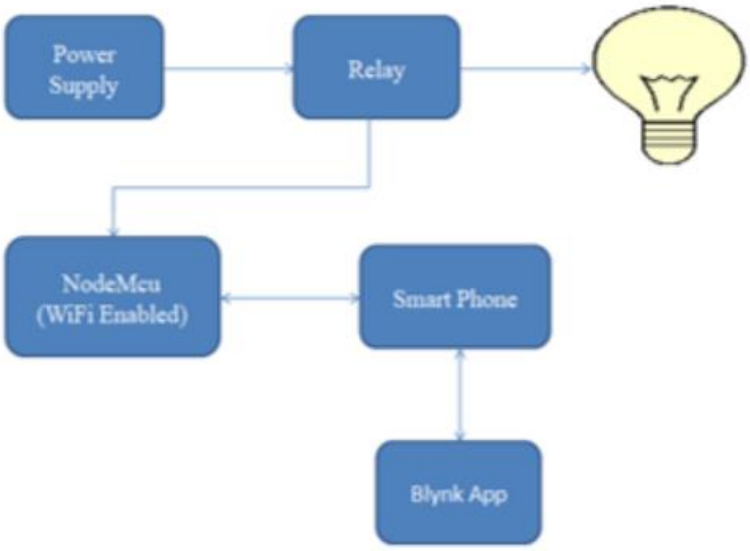


Fig.3.1: Block Diagram of Proposed System

Features: -

1. Control home appliances with Wi-Fi (Blynk IoT app).
2. Control home appliances with Blynk web dashboard.
3. Control home appliances with manual switches or push buttons.
4. Monitor real-time feedback in the Blynk IoT App
5. ESP32-Based Microcontroller System
6. Voice-Controlled Navigation via Bluetooth
7. IoT-Based Monitoring System

IV.COMPONENTS

The components in the home automation system using MEMS Sensor is explained in this section. This contain both hardware and software components.

Let's talk about them one by one:

HARDWARE COMPONENTS

(1) NODE MCU (ESP8266- 12E): -

The heart of project is the WiFi enabled board that needs no introduction; the ESP8266 based Node MCU development board. Node MCU is an open-source Lua based software and development board specially targeted for IoT based Applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Express if Systems, and hardware which is predicated on the ESP-12 module. Node MCU was born out of the desire to overcome the limitations associated with the first versions of the ESP8266 module which was not compatible with the breadboards, it was difficult to power and had more difficulty in programming. The Node MCU board is easy to use at a very low cost and that quickly endeared it to the heart of makers and it is one of

the most popular boards today. It uses many opensource projects, like SPIFFS. Thanks to resource constraints, users got to select the modules relevant for their project and build a firmware tailored to their needs. Support for the 32-bit ESP32 has also been implemented. NodeMCU is an open-source, Lua-based firmware and development board designed for IoT applications, built around the ESP8266 Wi-Fi SoC.

Fig.4.1: Node MCU

The Node MCU ESP8266 development board comes with the ESP-12E modul containing ESP8266 chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and function at 80MHz to 16 MHz adjustable clock frequency. Node MCU has 128 KB RAM and 4MB of non-volatile storage to store data and programs. Its higher processing power with the in-built Wi-Fi / Bluetooth and Deep Sleep Operating features makes it best for IoT projects.Node MCU are often powered using the Micro USB jack and VIN pin (External Supply Pin). It supports UART, SPI, and I2C interface. Figure: Node Mcu (ESP8266-12E)

The ESP8266 has seen a wide adoption as a cost-effective solution for IOT and Wi-Fi-capable devices. The ESP8266 was developed by Shangai-based Express if systems, as a Serial (UART) to Wi-Fi SoC (System on a Chip) based around a Tensilica Xtensa LX3DPU. This tiny IC includes an RF front end, RAM, and (usually) an onboard TCP/IP stack that allows it ready to connect to a nearby Access Point, to act as an Access Point itself, or both.

Applications:

- Smart power plugs
- Home automation
- Mesh network
- Industrial wireless control
- Baby monitors
- IP Cameras
- Sensor networks
- Wi-Fi location-aware devices
- Security ID tags
- Wi-Fi position system beacons

(2) **CHANNEL RELAY MODULE**: -

The relay is that device that open or closes the contacts to cause the operation of the opposite electric control. It detects the intolerable or unwanted condition with an assigned area and gives the commands to the circuit breaker to disconnect the affected area. Thus isolates the system from damage.

The 4 Channel Relay Module may be a convenient board which may be used to control high voltage, high current load like motor, solenoid valves, lamps and AC load. It is designed to transmit and receive data with microcontroller such as Arduino, PIC and etc. The relay 's terminals (COM, NO and NC) are being brought out with screw terminal. It also comes with a LED indicator to indicate the status of relay. A relay module is an electrical switch that is operated by an electromagnet. The electromagnet gets activated by a separate low-power signal from a micro controller. When activated, the electromagnet pulls to either open or close an circuit.

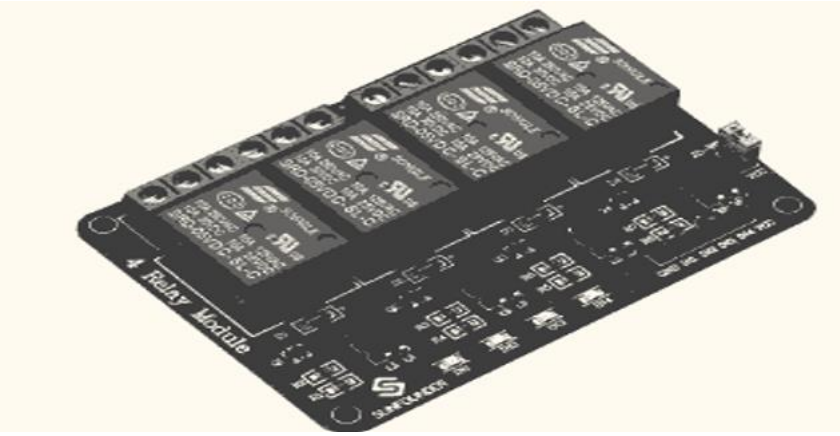


Fig.4.2: Relay Module

Relays are used in electronics to switch a smaller current which in turn will control larger current. They prevent the user to have direct contact to the main device being controlled that might be holding high voltage. These devices are comparable to a remote control which is used to make a big electronic equipment work. The larger relays or contactors are being utilized in industries to provide energy on machineries such as pumps and motors.

(3) **JUMPER WIRES:-**

A jump wire (also known as jumper, jumper wire, jumper cable, DuPont wire or cable) is an electrical wire, or group of them in a cable, with a connector or pin at each end which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

The motor serves as the system's actuator, converting electrical energy into mechanical energy. It performs tasks such as driving mechanical systems, rotating components, or moving loads based on commands

from the ESP32. The motor's operation is closely monitored and controlled to ensure efficiency, safety, and reliability. Its performance is influenced by inputs from the potentiometer and speed sensor.

Fig.4.3: Jumper Wires

(4) Tilt Sensor: -

A tilt sensor is a device that detects the inclination or angular movement of an object with respect to gravity. It is widely used in various applications, including safety systems, robotics, and assistive devices like wheelchairs. In this system, the tilt sensor plays a critical role in detecting abnormal movements, falls, or inclinations ensuring user safety**.**

Fig.4.4: Tilt Sensor

(5) **POWER SUPPLY**: -

Almost all basic household electronic circuits need an unregulated AC to be converted to constant DC, in order to operate the electronic device. All devices will have a certain power supply limit and the electronic circuits inside these devices must be able to supply a constant DC voltage within this limit. That is, all the active and passive electronic devices will have a certain DC operating point (Q-point or Quiescent point), and this point must be achieved by the source of DC power. The DC power supply is practically converted to each and every stage in an electronic system. The best method used is in the form of an unregulated power supply –a combination of a transformer, rectifier and a filter. The diagram is shown below. As shown in the figure above, a small step down transformer is used to reduce the voltage level to the devices needs. In India, a 1 Ø supply is available at 230 volts. The output of the transformer is a pulsating sinusoidal AC voltage, which is converted to pulsating DC with the help of a rectifier. This output is given to a filter circuit which reduces the AC ripples, and passes the DC components.

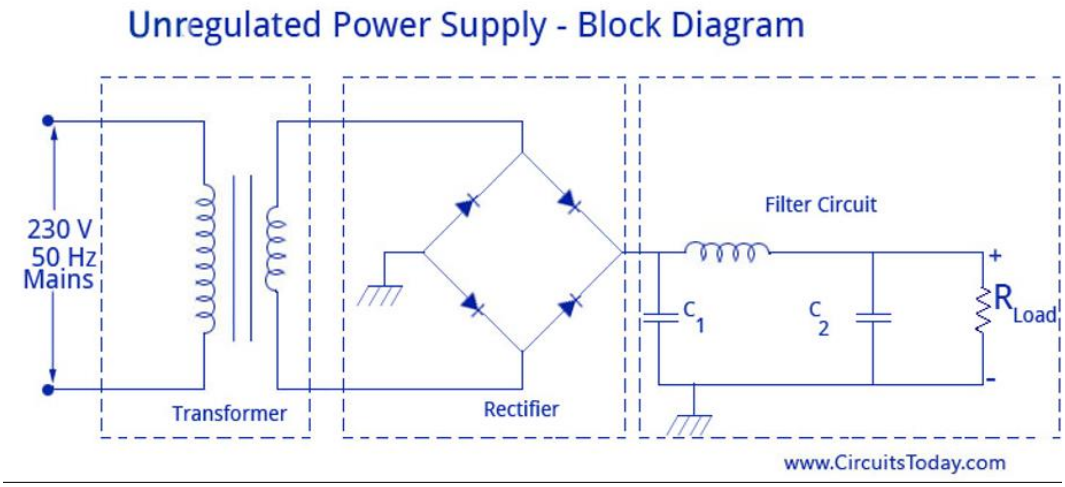


Fig.4.5: Block Diagram of Power Supply

(6) **BUZZER**: -

The electric buzzer was invented in 1831 by Joseph Henry. They were mainly used in early doorbells until they were phased out in the early 1930s in Favor of musical chimes, which had a softer tone. Piezoelectric buzzers, or piezo buzzers, as they are sometimes called, were invented by Japanese manufacturers and fitted into a wide array of products during the 1970s to 1980s. This advancement mainly came about because of cooperative efforts by Japanese manufacturing companies.

Early devices were based on an electromechanical system identical to electic an electric bell without the metal gong. Similarly, a relay may be connected to interrupt its own actuating currents, causing the contacts to buzz. Often these units were anchored to a wall or ceiling to use it as a sounding board. The word "buzzer" comes from the rasping noise that electromechanics buzzers made.

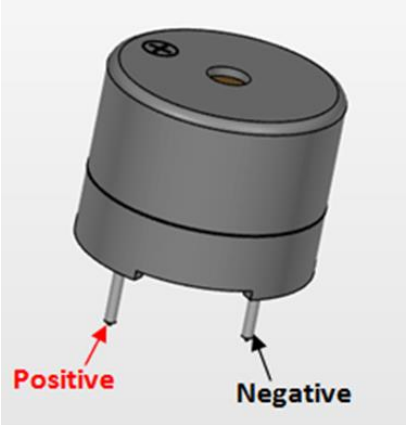


Fig.4.6: Buzzer

(7) **IR SENSOR** r: -

The IR Sensor-Single is a general purpose proximity sensor. Here we use it for collision detection. The module consists of an IR emitter and IR receiver pair. The high precision IR receiver always detects an IR signal. The module consists of 358 comparator IC. The output of sensor is high whenever it IR frequency and low otherwise. The on-board LED indicator helps user to check status of the sensor without using any additional hardware. The power consumption of this module is low. It gives a digital output.

Based on a simple basic Idea, this IR obstacle sensor is easy to build, easy to calibrate and still, it provides a detection range of 10- 30 cm. This sensor can be used for most indoor applications where no important ambient light is present. It is the same principle in ALL Infra-Red proximity sensors. The basic idea is to send infrared light through IR-LEDs, which is then reflected by any object in front of the sensor.

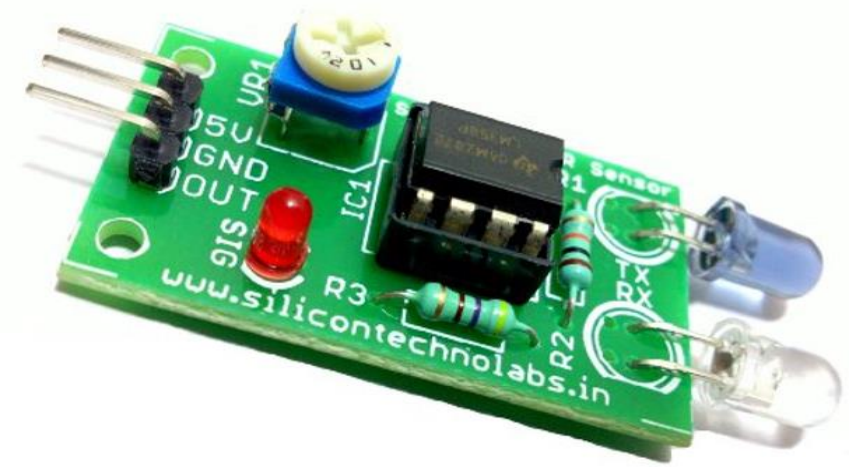


Fig.4.7: MAX30102 Heart Rate and Pulse Oximeter Sensor Module

(8) **LIGHT – DEPENDENT SENSOR (LDR)**

A light-dependent resistor alternatively called an LDR, photo resistor, photoconductor is a variable resistor whose value decreases with increasing incident light intensity. An LDR is made of a high-resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band

A photoelectric device can be either intrinsic or extrinsic. In intrinsic devices, the only available electrons are in the valence band, and hence the photon must have enough energy to excite the electron across the entire band gap. Extrinsic devices have impurities added, which have a ground state energy closer to the conduction band - since the electrons don't have as far to jump, lower energy photons (i.e. longer wavelengths and lower frequencies) are sufficient to trigger the device.

Two of its earliest applications were as part of smoke and fire detection systems and camera light meters. Because cadmium sulfide cells are inexpensive and widely available, LDRs are still used in electronic devices that need light detection capability, such as security alarms, street lamps, and clock radios.

SOFTWARE COMPONENTS

(1) Arduino IDE: -

The Arduino IDE provides a user-friendly interface for programming Arduino boards, making it accessible to beginners and experienced developers alike. It supports a wide range of Arduino-compatible boards, including the popular Arduino Uno, Nano, Mega, and others, as well as third-party boards based on the Arduino platform. The IDE is available for Windows, macOS, and Linux operating systems, allowing users to develop Arduino projects on their preferred platform.

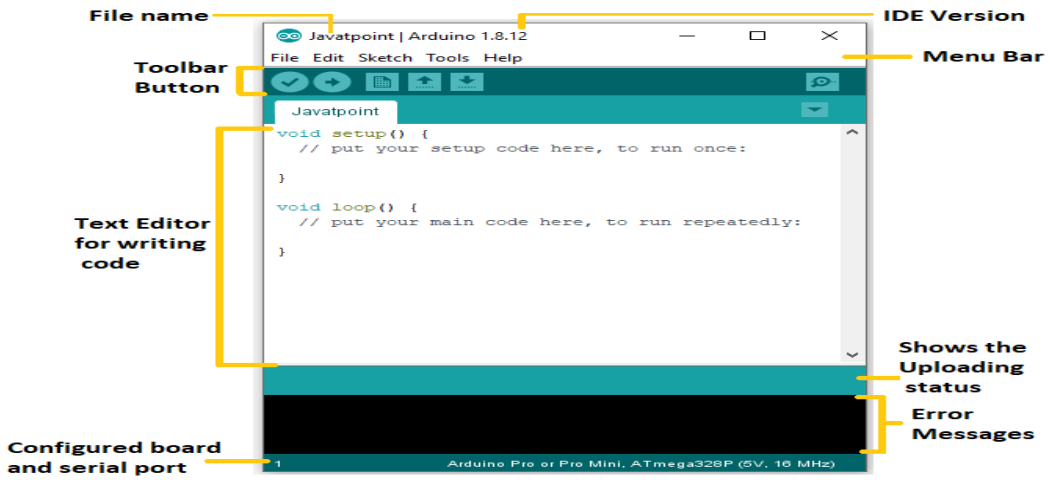


Fig.4.8**:** Arduino IDE

The code includes the hotspot name and password match with the android. The code does not need to identify the relay input, as it is included in [Arduino IDE]. When access point is given by the microcontroller sent as password and SSID is the name of smart phone hotspot.

Web Browser. The processor then controls the switches based on the commands received from the user and also updates the user about the status of the switches after the control operation is performed to the cloud.

(2) **BLYNK APPLICATION**: -

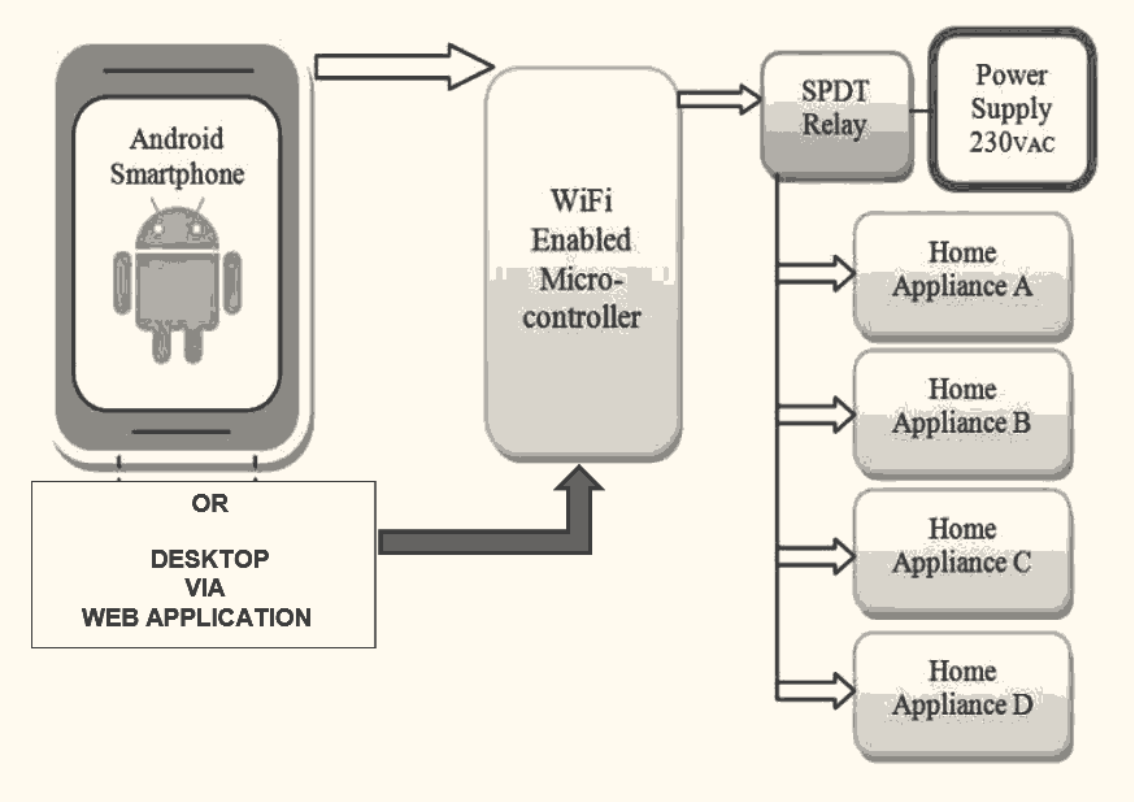
- Blynk App - allows to you create amazing interfaces for your projects using various widgets we provide.
- Blynk Server - responsible for all the communications between the Smartphone and hardware. You can use our Blynk Cloud or run your private Blynk srever locally. Its open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.

Blynk Libraries - for all the popular hardware platforms - enable communication with the server and process all the incoming and out coming commands.

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other cool things.

Now imagine: every time you press a Button in the Blynk app, the message travels to the Blynk Cloud, where it magically finds its way to your hardware. It works the same in the opposite direction and everything happens in a blink of an eye.

V. WORKFLOW OF PROPOSED SYSTEM



The heart of this project is the WiFi enabled board that needs no introduction; the ESP8266 based Node MCU development board. It is an opensource platform for developing WiFi based embedded systems and it is based on the popular ESP8266 WiFi Module, running the Lua based Node MCU firmware. Node MCU was born out of the desire to overcome the limitations associated with the first versions of the ESP8266 module which was not compatible with breadboards, it was difficult to power and even more difficult to program. The Node MCU board is easy to use, low cost and that quickly endeared it to the heart of makers and it is one of the most popular boards today. For this project, we will add a 4-channel relay module to the ESP8266 board. The project flow involves the control of Node MCU's GPIOs from a webpage on any device connected on

The status of the GPIOs control the coils of the relays and that causes the relay to alternate between normally open (NO) and normally closed (NC) condition depending on the state of the GPIO, thus, effectively turning the connected appliance "ON" or "OFF".

To make the connections easy to follow, here is a pin map of the connection between the NODE MCU and the Relay Module:

Node MCU – Relay Module

3.3V – VCC

GND - GND

D1 - IN1

D2 - IN2

D5 - IN3

D6 - IN4

One of the easiest way to program Node MCU is via the Arduino IDE. This, however, requires setting up the Arduino IDE by installing the board support file for Node MCU. The code is based on the ESP8266WiFi.h library which allows the easy use of WiFi functionalities of the board. It contains all we need to create or join a WiFi access point and also create a server and client which are all important for this project. The library comes attached with the Node MCU board files for the Arduino, so there is no need to install it once the board files have been installed.

VI. CONCLUSION & FUTURE SCOPE

Conclusion: -

Based on the results of analysis of all data obtained by testing the smart home with the Internet ofThings based Node MCU ESP6288 module, the following conclusions can be drawn:

Smart Home with Internet of Things (IoT) based Node MCU ESP8266 Module can be designed with various components hardware and software support so that it can be arranged into a smart home system that is controlled with the Web application according to what is intended.

The Smart Home with this Internet of Things (IoT) based Node MCU ESP8266 Module can be implemented to control some of the home electronics performance including lighting controls, fan control, temperature monitoring, early warning systems and etc. Main purpose of home automation system is to provide ease to people to control different home appliances with the help of the web application using their mobile phones or desktop and to save time and money.

Future Scope: -

The combination of the ESP8266 Wi-Fi module and the Blynk app offers a promising future for home automation systems. Here's a look at its potential:

- **IoT Advancements**: The ESP8266, paired with the Blynk app, enables seamless integration of IoT devices. This setup allows users to control and monitor home appliances remotely, paving the way for more interconnected and intelligent homes.

- **Energy Efficiency**: With the ability to monitor energy consumption in real-time, this system can help optimize energy usage. Future developments may focus on integrating AI to provide personalized energy-saving recommendations.
- **Scalability**: The modular nature of the ESP8266 and the flexibility of the Blynk app make it easy to expand the system. This scalability ensures that users can add new devices or features as needed.
- **User-Friendly Interfaces**: The Blynk app's intuitive design simplifies the process of controlling home automation systems. Future updates may include enhanced customization options and support for voice commands.
- **Security Enhancements**: As home automation systems become more widespread, ensuring data security will be crucial. The ESP8266 can be equipped with advanced encryption protocols to safeguard user data.

REFERENCES

1. BOHORA, Bharat; MAHARJAN, Sunil; SHRESTHA, Bibek Raj. IoT Based Smart Home Using Blynk Framework. Zerone Scholar, [S.l.], v. 1, n. 1, p. 26-30, dec. 2016. ISSN 25422774. Google scholar.
2. DC-DC Step Down Converter Power Supply Provides Regulated 5VDC Output with Range Input of 10-32VDC, Model GTD21088L-1505-T2.
3. Home Automation Using Internet of Thing 2016 IEEE 7th Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON) Published: 2016. Google Scholar.
4. Internet of Things in Home Automation and Energy Efficient Smart Home Technologies Simon G. M. Koo Department of Computer Engineering, Santa Clara University, CA 95053, USA
5. Low Cost Implementation of Smart Home Automation Ravi Kishore Kodali Department of Electronics and Communication Engineering National Institute of Technology, Warangal , 506004 India
6. NodeMCU Features and Pinout. A Brief Tutorial on the Introduction to NodeMCU V3.
7. Yoyosteven in Circuits Microcontrollers. NODEMCU 1.0 (ESP8266) CONTROLLED RELAY USING BLYNK (OVER THE WEB).
8. 5V 4-Channel Relay Interface Board, Standard Interface that can be Controlled Directly by Microcontroller.
9. 15-17 March 2018 U. Venkanna IoT Based Smart Home Automation System Using Sensor.
10. "Home Automation Using ESP8266" by Rui Santos and Sara Santos - This book provides step-by-step guidance on using ESP8266 for home automation projects.