IOT Based Load Management System.



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Declaration

It is declared hereby that this thesis paper or any part of it has not been submitted to anywhere else for the award of any degree.

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Certification

This is to certify that this project entitled "**IOT based load management system**" is done by the following students under my direct supervision. This project work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering, Sonargaon University (SU) in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering.

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ABSTRACT

The IOT based load management system is an advanced approach to modern home automation that enables remote monitoring and control of electrical appliances. This system integrates the Internet of Things (IOT) technology with traditional electrical circuits, allowing users to manage their devices through a smartphone or web application. The primary objective of this project is to enhance energy efficiency, reduce electricity wastage, and provide convenience in daily life. By using IOT, users can turn lights on or off, adjust brightness levels, and schedule operations from anywhere in the world. This system employs microcontrollers such as NodeMCU, which communicate with IOT platforms to execute commands in real time.

The system consists of a light dimmer circuit that adjusts the intensity of a single light according to user preferences. It utilizes a triac-based AC dimming mechanism, which ensures smooth control of the light without flickering. A zero-crossing detector is included in the design to synchronize the AC signal with the microcontroller, improving operational stability and accuracy. Users can interact with the system through a mobile application, which provides an intuitive interface for controlling brightness levels and monitoring energy consumption. The IOT-based approach also allows integration with smart assistants like Alexa or Google Home for voice-controlled operation.

Furthermore, this system contributes to energy conservation by allowing precise control over lighting according to actual requirements. It is particularly suitable for residential, commercial, and industrial environments where automation and energy management are crucial. The project also highlights the potential for scalability, as multiple dimmers or devices can be controlled within the same IOT network. Security features are incorporated to protect against unauthorized access, ensuring safe operation. In conclusion, the IOT-based load control and single light dimmer system represents a practical and cost-effective solution for modern smart homes, promoting energy efficiency, convenience, and seamless automation.

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LIST OF ABBREVIATIONS

AC	**Alternating Current**
DC	**Direct Current**
SMPS	**Switched Mode Power Supply**

CHAPTER I
INTRODUCTION

1.1 Introduction

The rapid advancement of the Internet of Things (IOT) has significantly transformed modern automation systems, enabling smart monitoring and control of electrical loads. An IOT-based load control and single light dimmer system is designed to provide intelligent management of electrical devices, particularly lighting, using internet connectivity. This system allows users to remotely switch a load on or off and adjust the brightness level of a single light according to their preference or requirement. By integrating microcontrollers, sensors, and wireless communication modules, the system ensures real-time control and energy-efficient operation.

In addition, the system can be controlled through mobile applications or web interfaces, giving users the flexibility to manage their devices from anywhere in the world. It also supports automation features such as scheduled switching, gradual dimming, and customized lighting levels, which improve comfort and user experience. The ability to monitor power usage in real time makes it possible to reduce wastage and promote sustainable energy practices.

This type of system is highly relevant in modern smart homes, commercial spaces, and industrial facilities where intelligent energy management is a growing necessity. It not only enhances safety by reducing manual handling of electrical systems but also extends the lifespan of connected devices by regulating voltage and load conditions. Moreover, it contributes to global energy-saving goals by minimizing unnecessary electricity consumption.

Overall, the IOT based load management system represents a practical and innovative approach to achieving automation, energy efficiency, and user convenience in today's technology-driven society.

1.2 Background Study

In modern electrical systems, energy management and efficient control of electrical appliances have become increasingly important due to the growing demand for electricity and the rising cost of energy. Traditional manual switching systems are often inefficient, as they require human intervention and cannot optimize energy usage. This has led to the development of automated systems that provide better control, convenience, and energy efficiency.

IOT (Internet of Things) technology has revolutionized the way electrical devices are monitored and controlled. By connecting appliances to the internet, IOT allows real-time monitoring, remote control, and data-driven decision-making. Load control systems, when integrated with IOT, enable users to manage power consumption effectively, reduce wastage, and enhance the lifespan of electrical devices.

A single light dimmer system is a practical application within this context. Dimmers allow users to adjust the brightness of a light according to preference, which not only improves comfort and ambiance but also saves energy. When combined with IOT, a dimmer system can be controlled remotely via smartphones or web applications, programmed to operate at specific times, and monitored for energy usage.

Moreover, IOT based load management system provide data analytics that can identify patterns in energy consumption, helping users make informed decisions to further reduce costs. Such systems also enhance safety by allowing remote shutdown of devices in case of overload or fault. The integration of sensors and actuators makes it possible to automate lighting based on occupancy or natural light availability, adding another layer of efficiency. Additionally, IOT-enabled dimmers support integration with voice assistants and home automation platforms, creating a seamless smart home experience.

The integration of IOT with load management and dimming technology represents a step toward smart homes and intelligent energy management systems. It provides a foundation for future advancements, such as automated energy optimization, integration with renewable energy sources, and participation in smart grid systems. Overall, this system aims to improve energy efficiency, user convenience, and adaptability in residential and commercial environments.

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1.3 Objectives

The main objective of the IOT-based load management and single light dimmer system is to provide intelligent control over electrical appliances, specifically lighting, to enhance energy efficiency and convenience. This system aims to allow users to remotely control a single light or multiple loads using smartphones or computers, reducing the need for manual operation. By integrating IOT technology, it seeks to enable real-time monitoring of energy consumption, helping users make informed decisions to save electricity. The system also focuses on providing the ability to dim lights to a desired intensity, which enhances comfort and creates a suitable ambiance according to user needs. Moreover, it is designed to support automated schedules, turning lights on or off based on predefined times, which further reduces unnecessary energy wastage.

Another objective is to ensure that the system is user-friendly, secure, and reliable. It aims to provide seamless communication between the user interface and the hardware through Wi-Fi or other IOT communication protocols. The system is intended to be scalable, allowing integration with other smart home devices or future expansion to control multiple appliances. It also targets improved safety by including overload protection and monitoring features. Additionally, the system is expected to reduce human intervention, making it suitable for both residential and commercial applications. A critical goal is to minimize installation complexity while maintaining high performance, enabling users to adopt smart lighting solutions with ease.

Furthermore, the project seeks to contribute to energy conservation and sustainability goals. By providing precise control over light intensity and timing, it helps reduce electricity bills and lowers the overall carbon footprint. The system is also intended to offer insights into consumption patterns, assisting users in optimizing their energy usage habits. By combining dimming capability with remote access, the system enhances user comfort and convenience. Ultimately, the objectives include creating a cost-effective, efficient, and modern lighting control solution that leverages IOT technology to transform traditional lighting systems into intelligent, automated setups suitable for smart homes, offices, and industrial environments.

CHAPTER II

THEORY OF THE PROJECT

2.1 Introduction

An **IOT-based load management system** for a single load dimmer allows users to remotely control and adjust the brightness of a connected electrical load, such as a light, using internet-enabled devices. The system integrates sensors, microcontrollers, and IOT platforms to provide real-time monitoring and efficient energy usage. By offering remote access and automation, it enhances convenience, reduces power wastage, and supports smart home applications.

2.2 Theory

An **IOT-based load management system for a single load dimmer** allows users to control the brightness of an AC-powered device, such as a light, through the internet. The system uses a Triac-based circuit to regulate the AC power supplied to the load, enabling smooth dimming control. A microcontroller (like ESP8266/ESP32) acts as the control unit, receiving commands via a mobile app or web interface. Through IOT connectivity, users can adjust the load intensity remotely and monitor power usage in real time. This system improves energy efficiency, user convenience, and automation in smart home or industrial applications. Additionally, it provides flexibility to integrate with voice assistants or scheduling features for enhanced functionality.

2.3 Circuit Breaker

A Circuit Breaker is a protective electrical device designed to automatically stop the flow of current in a circuit when the current exceeds 10 amperes**.** Its main function is to protect electrical wiring, appliances, and devices from damage caused by overcurrent, overload, or short circuits**.**



Fig-2.3: Circuit Breaker

When the current in the circuit rises above the rated value (10 A), the breaker “trips” and disconnects the supply, preventing overheating, fire hazards, and equipment damage. Once the fault is cleared, the breaker can be reset manually, unlike a fuse that needs replacement after blowing.

2.4 SMPS

Switched-mode power supplies (SMPS), sometimes referred to as switch mode power supplies, have become the workhorse of efficient power conversion, taking mains voltage AC input and converting it down to a low voltage DC output.

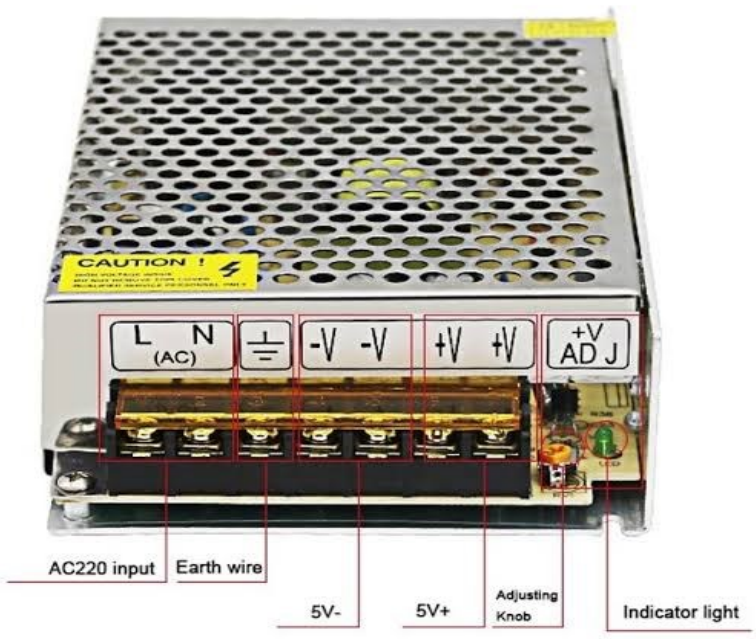


Fig-2.4: SMPS

An SMPS (Switched Mode Power Supply) is used to provide stable DC voltage to power the microcontroller and other components. The system includes a 4-channel relay module that allows multiple loads, such as lights or appliances, to be controlled independently. Each relay acts as an electronic switch that can turn the connected device ON or OFF based on commands received from the IOT controller. This setup ensures efficient power management, reliable switching, and flexibility for smart home or industrial automation.

2.5 Relay Module

A Relay Module is an essential component in an IOT based load management system. It works as an electronically operated switch that allows a low-power microcontroller (such as NodeMCU, or ESP8266) to control high-voltage electrical devices like lights, fans, or appliances. Since microcontrollers cannot directly handle high current or high voltage, the relay module provides safe electrical isolation between the control circuit and the load circuit.



Fig-2.5: Relay Module

The relay module usually consists of an electromagnetic relay**,** driver circuit (such as a transistor), protection diode, and status indicator LED. When the microcontroller sends a control signal, the relay coil gets energized, creating a magnetic field that pulls the internal switch contacts to either open or close the load circuit. This way, the relay can turn AC or DC appliances ON and OFF based on IOT commands.

In a load management system, the relay module helps switch electrical devices remotely through a smartphone app, web server, or cloud platform. In a dimmer system, the relay works with additional circuits (like TRIACs or PWM-based controllers) to adjust brightness or speed of appliances.

Key features of a relay module in IOT-based systems:

- Provides safe switching of high-voltage devices.
- Works with microcontroller control signals (typically 3.3V or 5V).
- Can control single or multiple loads depending on the number of relay channels?
- Ensures electrical isolation between control logic and power circuit.
- Compatible with smart home automation and energy management applications.

2.6 ESP8266 (Node MCU)

The ESP8266 is essentially a Wi-Fi-enabled microcontroller. It works by combining two main functions:

1. Microcontroller Unit (MCU

Has a 32-bit Xtensa LX106 CPU.

Can run code (C/C++ using Arduino IDE, MicroPython, Lua, etc.).

Provides GPIO pins to interact with external sensors, relays, motors, and other devices.

2. Wi-Fi Transceiver (2.4 GHz)

Handles all the wireless communication using 802.11 b/g/n.

Supports Station mode (connects to router) and Access Point mode (creates its own Wi-Fi network)

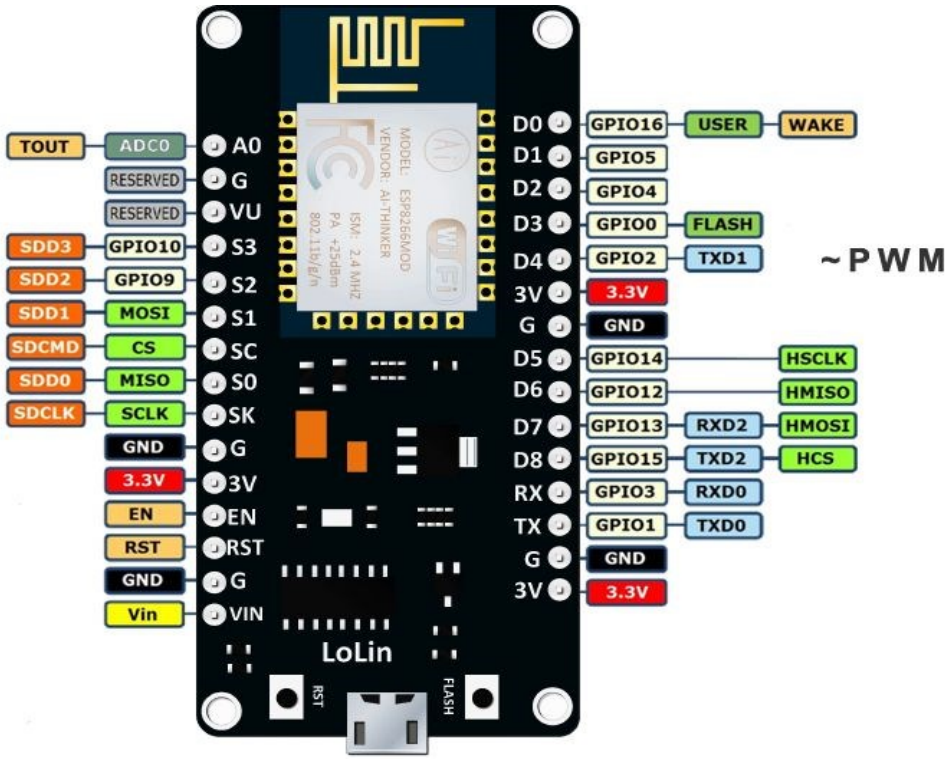


Fig-2.6: ESP8266

2.7 ESP8266 Development Board

The ESP8266 Development Board, specifically the NodeMCU, plays a central role in this project. It is a low-cost, Wi-Fi-enabled microcontroller module that enables wireless communication between the user's smartphone and the electrical appliances connected in the system.

The ESP8266 has built-in Wi-Fi capabilities, digital input/output pins, analog input, PWM (Pulse Width Modulation), and UART communication features, making it ideal for IOT applications. In this project, the ESP8266 is programmed to receive commands from the Blynk mobile application via the internet. Based on the received commands, it controls the relay module to turn ON/OFF loads like lights and fans, and it sends PWM signals to the dimmer circuit to adjust fan speed.

Key Features of ESP8266 (NodeMCU):

- Built-in Wi-Fi module for wireless communication
- GPIO (General Purpose Input/Output) pins for connecting external components
- Supports PWM, I2C, and SPI communication protocols
- Compatible with Arduino IDE for easy programming
- Compact size and low power consumption

In the context of the IOT Load management & Dimmer System**,** the ESP8266 acts as the brain of the operation. It continuously listens for user input from the internet and triggers the appropriate hardware actions. This allows users to monitor and control home appliances from anywhere in the world, as long as they have an internet connection.



Fig-2.7: ESP8266 Development Board

2.8 Incandescent Bulb

Filament: Made of tungsten (because it has a very high melting point ~3400°C).
When electric current passes through, it heats up and glows, producing light.

Glass Bulb (Envelope):
The outer glass covering.
Usually filled with inert gas (argon, nitrogen, or krypton).
Protects the filament from air/oxygen, which would burn it out quickly.

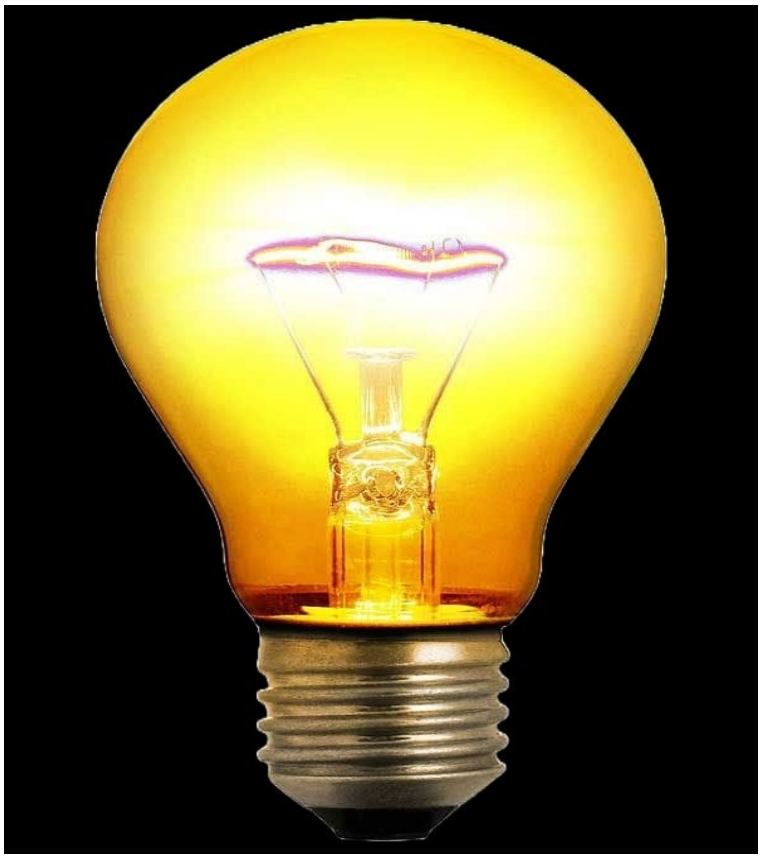


Fig-2.8:Incandescent Bulb

In an IOT-based load management and dimmer circuit, the incandescent bulb works as the primary load to demonstrate brightness control. When the system adjusts the firing angle of the TRIAC or uses PWM signals through a microcontroller, the voltage supplied to the bulb changes, resulting in dimming or brightening. The IOT interface allows users to remotely control the bulb's intensity via a smartphone or web application. This makes the incandescent bulb an effective example for testing real-time load management and smart lighting systems.

2.9 AC Fan

The IOT based load management system (AC Fan) is a smart automation project that allows users to remotely control, monitor, and regulate the speed of an AC fan through the Internet of Things (IOT). Using a microcontroller platform such as ESP8266/NodeMCU, the system connects to Wi-Fi and can be operated via a web server or mobile application**.**



Fig-2.9: AC Fan

The project integrates a dimmer circuit with TRIAC and zero-crossing detection to provide smooth fan speed control**.** Users can switch the fan ON/OFF**,** adjust its speed level**,** and monitor real-time load status (power consumption, voltage, and current if sensors are used).

This system enhances energy efficiency, safety, and user convenience by allowing control from anywhere. It is suitable for smart homes, offices, and industrial automation, where load management and comfort are essential

CHAPTER III

DESING & FEBRICATION

3.1 Introduction

In this chapter fully cover with discuss design and fabrication of this project. Here we will discuss about developed block diagram and briefly describe about the circuit description and learn about working principle. Total project flow chart is also available in this chapter.

3.2 Block Diagram

This block diagram represents a home automation system controlled using a NodeMCU (ESP8266/ESP32) microcontroller and a smartphone application (Blynk App). Here is a breakdown of the components and their functions:

1. **AC 220V Input**
    - The main power supply.
2. **SMPS (Switched Mode Power Supply)**
    - Converts 220V AC to the required DC voltage to power the NodeMCU and connected devices.
3. **Circuit Breaker**
    - Provides protection against overcurrent or short circuits.
4. **NodeMCU (Microcontroller Unit)**
    - Central control unit that manages inputs/outputs.
    - Connects with Wi-Fi to communicate with the Blynk App on a smartphone.
    - Controls connected loads such as lights and fan.
5. **Room Light-1 & Room Light-2**
    - Electrical loads controlled by NodeMCU.
6. **Room Fan**
    - Another controlled load.
7. **Blynk App (Smartphone Application)**
    - Interface for the user to send commands via the internet/Wi-Fi.
    - Commands are received by NodeMCU to control lights and fan.

Working Principle:

- The user operates the Blynk App on their smartphone.
- The command is sent over Wi-Fi to the NodeMCU.
- The NodeMCU then switches ON/OFF the appliances (lights and fan).
- Power is supplied through SMPS and is protected by a circuit breaker.

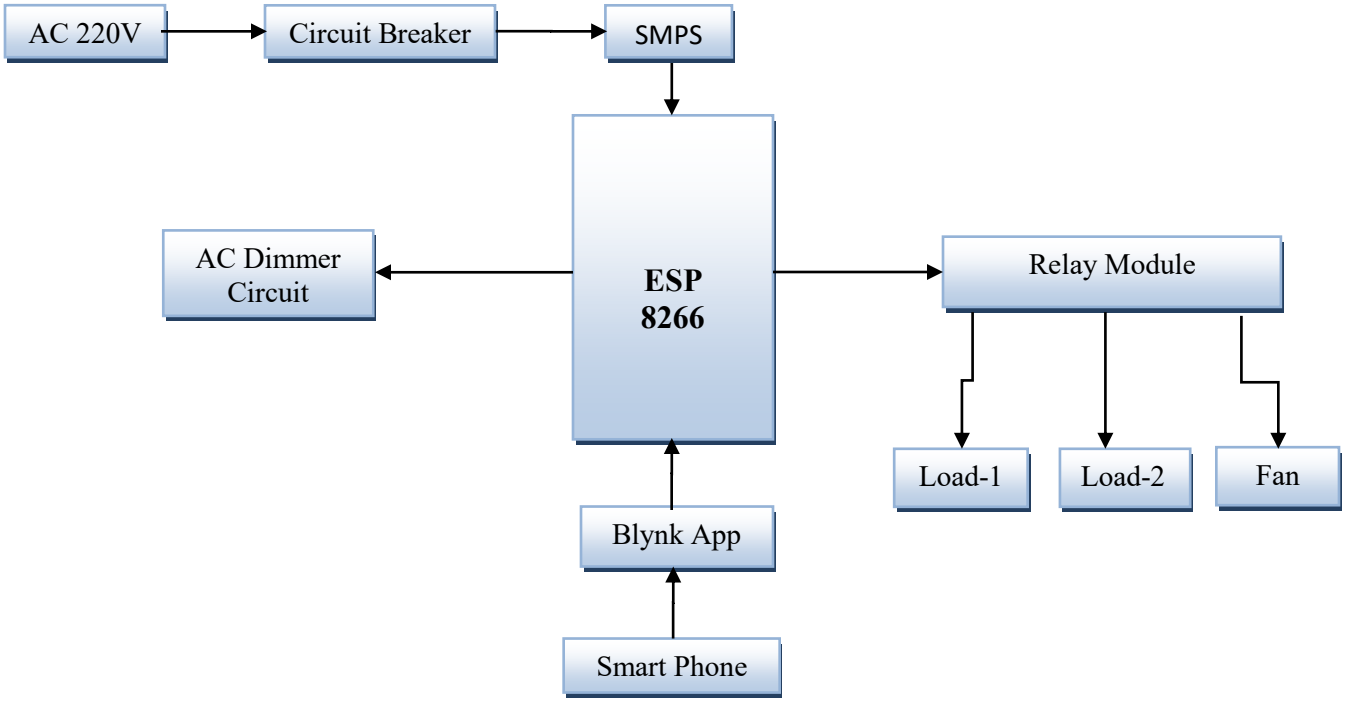


Fig-3.2: Block diagram of Proposed System

3.3 AC Dimmer Circuit Diagram

Components:

1. Transformer
2. Bridge Rectifier
3. Optocupler (MCT2E, MOC3021)
4. Arduino Uno
5. Triac
6. AC Load (light bulb)
7. Wires
8. Breadboard

A dimmer circuit is an electronic device used to control the brightness of a light by adjusting the power supplied to it. It works by regulating the voltage or current flow, often using components like TRIACs, DIACs, or transistors. Dimmer circuits are commonly applied in lighting systems to save energy and create a comfortable environment. They can be designed for incandescent bulbs, LEDs, and other lighting technologies

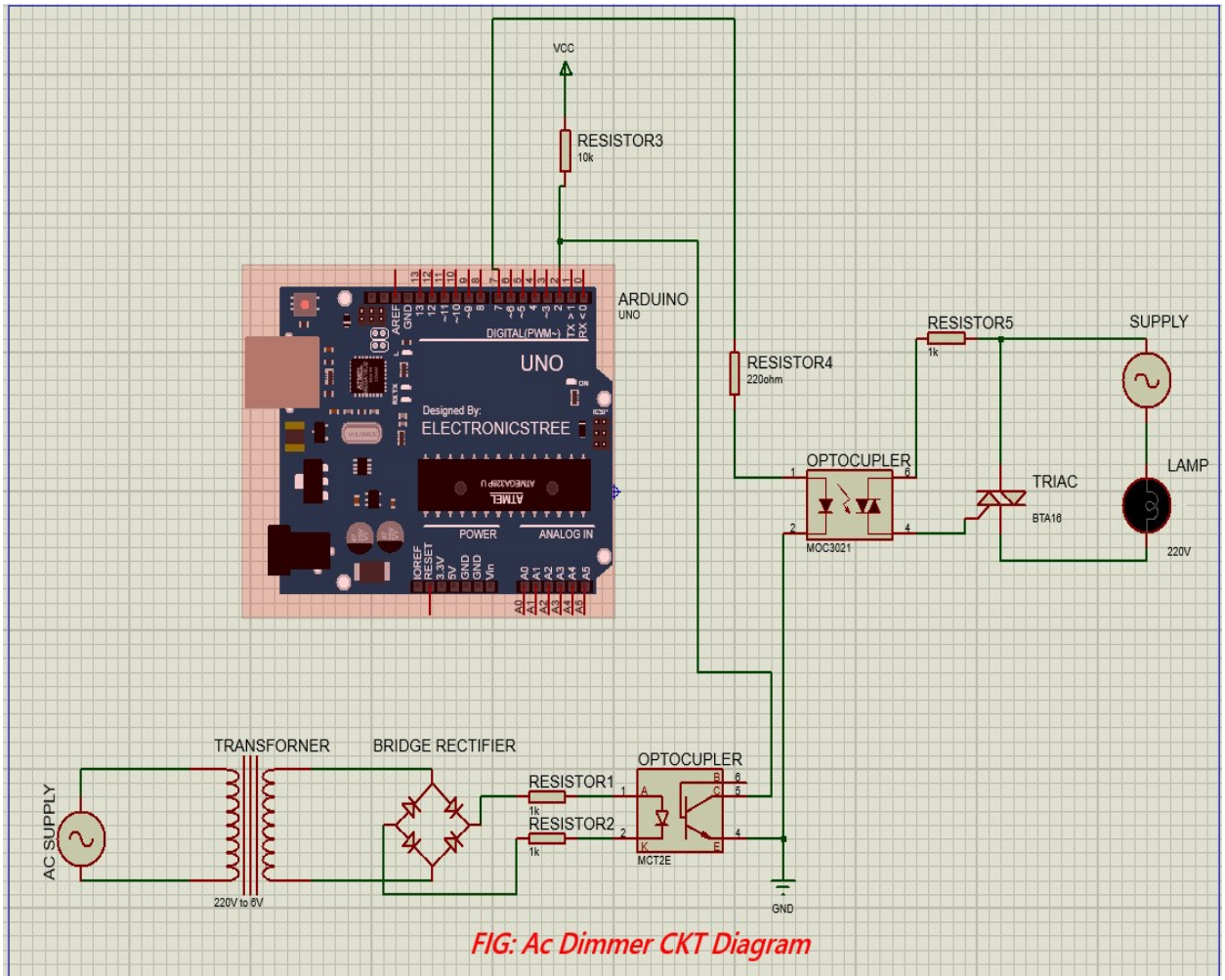


Fig-3.3.1: AC Dimmer CKT Diagram

MCT2E (Optpcupler)

Input Stage (LED side)

→When a voltage is applied across the anode and cathode of the LED, current (IF) flows through it.

→This LED emits infrared radiation proportional to the current.



Fig-3.3.2: MCT2E (Optocupler)

Output Stage (Phototransistor side)

→The phototransistor's base region is exposed to the IR light.

→When light falls on it, electron-hole pairs are generated inside the transistor's base.

→This acts like an automatic "base current", turning the NPN transistor ON.

Electrical Isolation

→Input and output are electrically isolated (typically withstands 5kV).

→Only the light couples the two stages.

→This makes it safe to connect a low-voltage microcontroller with a high-voltage power circuit.

AC Waveform and Zero-Crossing:

The AC waveform is a sinusoidal wave that oscillates back and forth 50 or 60 times per second depending on your location. Each cycle of the wave has two zero-crossing points, where the voltage passes through zero, neither positive nor negative. These points mark the transitions between positive and negative half-cycles of the waveform.

MOC3021 (Optocupler)

Input Side (LED)

→When current flows through the anode and cathode of the LED, it emits infrared light.

→The intensity of emitted light is proportional to the LED current (IF).

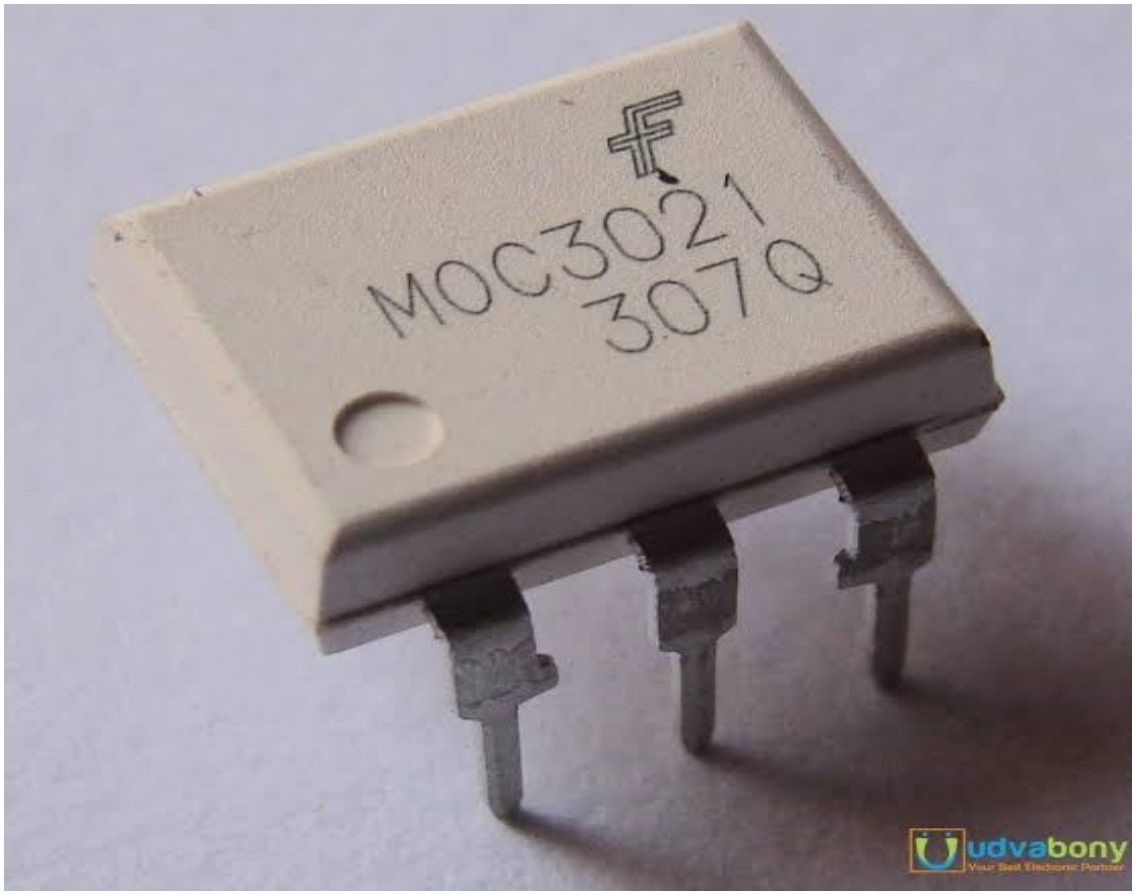


Fig-3.3.3: MOC3021 (Optocupler)

Output Side (Phototriac driver)

→On the output side, instead of a transistor, the MOC3021 contains a light-sensitive TRIAC structure.

→When the infrared light strikes it, the structure behaves like a DIAC.

→It conducts briefly, providing a trigger pulse to the gate of an external TRIAC.

→This turns ON the external TRIAC, allowing the AC load to be powered.

Continuous Conduction of Main TRIAC

→Once triggered, the external TRIAC remains conducting until the AC current crosses zero.

→The MOC3021 itself doesn't carry the main load current — it only provides the gate triggering pulse.

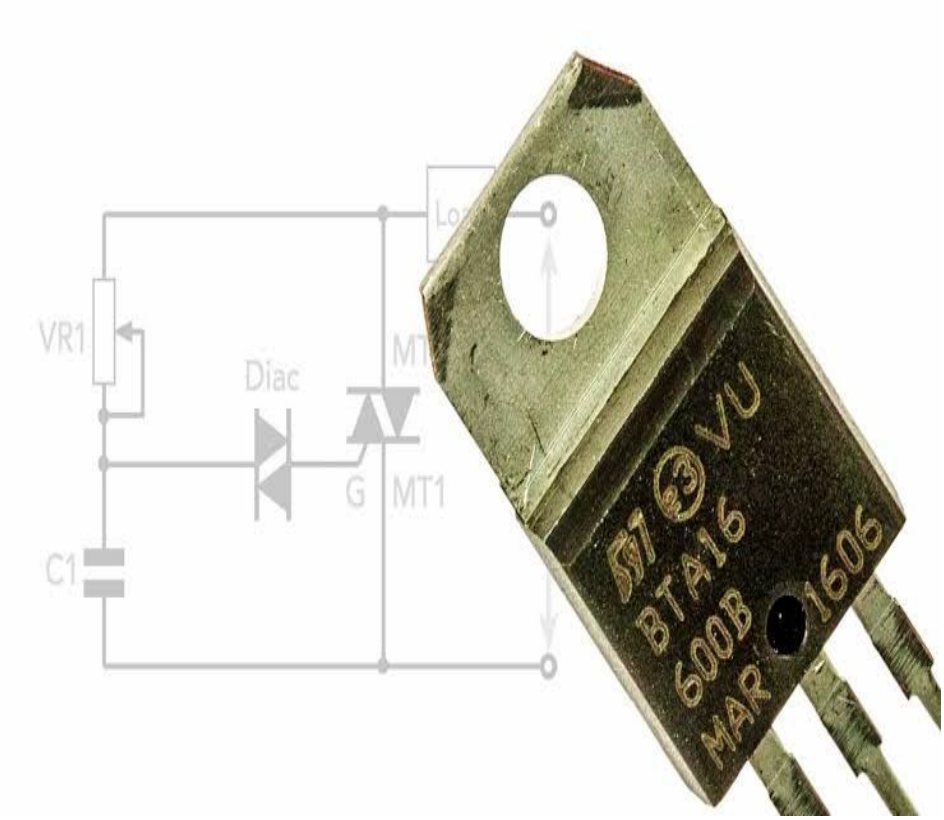


Fig-3.3.4: Triac (BTA16)

Triac and its Activation:

A triac is a bidirectional switch that can control the flow of AC current. However, it does not turn on automatically. It requires a trigger signal to initiate conduction. This trigger signal can be a voltage pulse at the gate terminal of the triac.

Phase-Angle Control and Cut-Off Portion:

Phase-angle control involves precisely delaying the trigger signal applied to the triac after each zero-crossing of the AC waveform. This delay can be expressed as a phase angle, measured in degrees. The longer the delay (higher phase angle), the greater the portion of the sine wave that is cut off before the triac starts conducting.

3.4 Overview

This is the full over view of our project. Here We provide AC 220V power to SMPS and then it will be converted to 5V DC voltage.

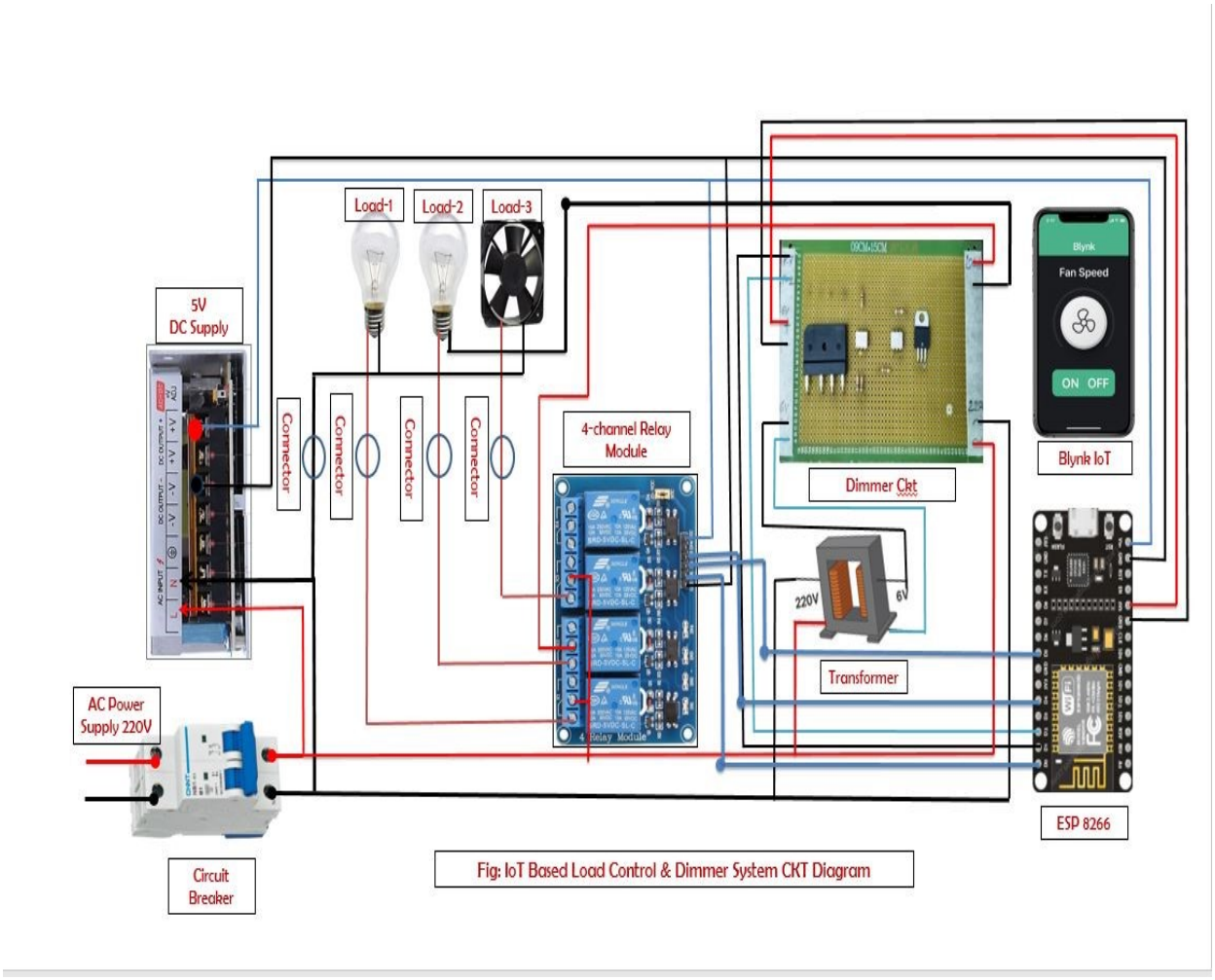


Fig-3.4: Overview of Proposed System

Microcontroller (e.g., ESP32, NodeMCU): Acts as the central processing unit, managing communication between the user interface and the dimmer hardware.
TRIAC Driver (e.g., MOC3021): Controls the power delivered to the lighting load by adjusting the phase angle, enabling dimming functionality.
Zero-Crossing Detector: Detects the point where the AC voltage crosses zero, allowing precise timing for triggering the TRIAC and ensuring smooth dimming transitions.
User Interface: Typically a mobile app or web interface that communicates with the microcontroller via protocols like MQTT or HTTP, allowing users to adjust light intensity remotely.

Functionality:

- **Remote Dimming Control:** Users can adjust the brightness of lights from anywhere, providing convenience and energy savings.
- **Scheduling:** Lights can be programmed to turn on/off or adjust brightness at specified times, enhancing automation.
- **Energy Monitoring:** Some systems include features to monitor energy consumption, helping users identify and reduce energy usage.
- **Voice Control Integration:** Compatibility with voice assistants like Amazon Alexa or Google Assistant allows hands-free operation.

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3.5 Working Principle

The IOT based load management system is designed to remotely monitor and control electrical appliances, adjusting their power consumption efficiently. The working principle involves the integration of microcontrollers, sensors, wireless communication modules, and triac-based dimmer circuits.

Microcontroller Processing:
The microcontroller (like Arduino, ESP8266, or NodeMCU) receives the sensor data and processes it. It determines the appropriate action based on pre-defined settings or user commands received through the IOT interface.

Wireless Communication:
The system communicates with a cloud server or mobile application via Wi-Fi or other IOT protocols. Users can remotely turn on/off appliances, adjust brightness, or set schedules through a smartphone or web application.

Load Control and Dimming:
The processed commands from the microcontroller control the power delivered to the appliance using a TRIAC-based dimmer circuit or relay. For dimming, the TRIAC adjusts the phase angle of the AC supply, reducing the voltage and controlling the brightness of lamps or the speed of AC fans.

Feedback and Automation:
The system can provide feedback on power consumption and device status, enabling energy-efficient operation. Automated rules can also be implemented, such as turning off lights when no one is present or adjusting brightness based on ambient light.

3.6 Flow Chart

This is the Flow chart of our project.

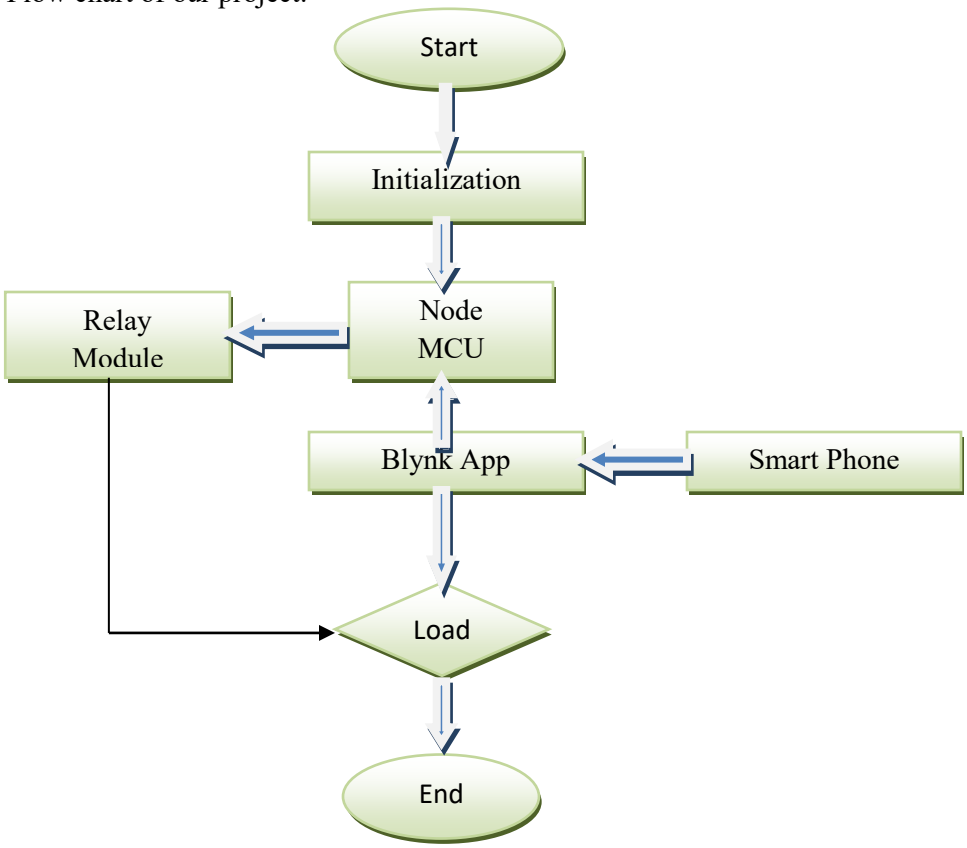


Fig-3.6: Flow chart of Proposed System

3.7 Conclusion

In this chapter, we have discussed the block diagram, circuit description, working principle, flow chart also shows the real image of the project and others. In the later part of this paper, we discussed the result & discussion of the project to make the concept clear to anyone.

CHAPTER IV

RESULT & DISCUSSION

4.1 Result:

The IOT-based load management and dimmer system was successfully designed and implemented. The system allows electrical loads such as lights and fans to be remotely controlled and dimmed through a mobile application.

- The bulbs can be switched ON/OFF and their brightness can be adjusted using the dimmer function.
- The fan can be turned ON/OFF through the IOT mobile app.
- The system operates reliably with real-time response to user commands.
- This demonstrates the practical use of IOT in home automation, providing convenience, energy saving, and efficient control of electrical appliances.

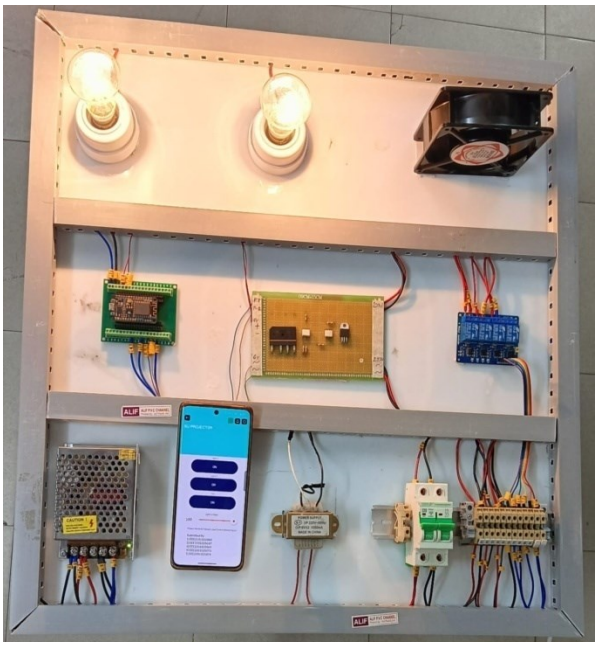


Fig-4.1.1:Dimmer Position High (Light-2)

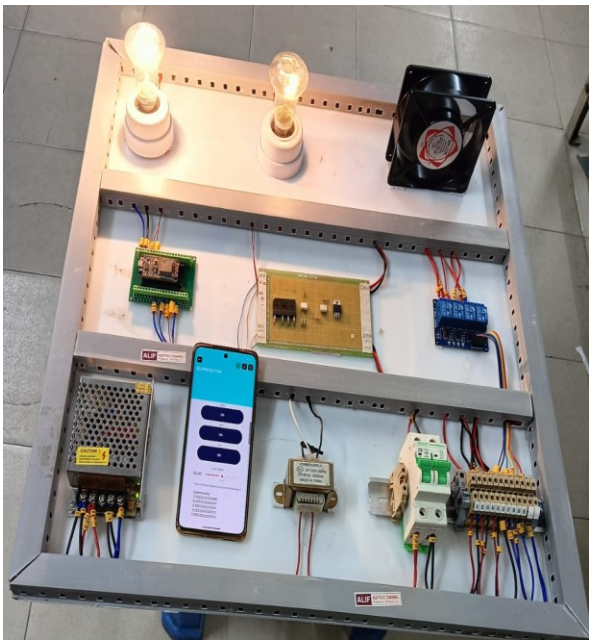


Fig-4.1.2:Dimmer Position Medium (Light-2)

A single light dimmer circuit controls the brightness of a lamp by adjusting the power delivered to it. It typically works by using a TRIAC and a phase-control method, where the AC voltage is switched on at different points in each cycle. When the switching delay is small, the lamp glows brighter; when the delay is increased, the lamp becomes dimmer. This allows smooth control of light intensity, reducing energy consumption and providing a comfortable lighting environment.



Fig:Dimmer Position Low (Light-2)

4.2 Advantages

• Precise **Control** – Arduino allows accurate phase angle control, providing smooth and fine adjustment of brightness or power.
•**Low Cost** – The circuit is inexpensive to build using readily available components like ESP8266, TRIAC, and optocouplers.
•**Energy Saving** – By reducing the RMS voltage supplied to the load, it helps save electricity when full power is not required.
•**Microcontroller Flexibility** – The ESP8266 can be programmed for different dimming profiles, automation, or integration with IOT systems.
•**Electrical Isolation** – Optocouplers provide safe isolation between the low-voltage ESP8266 and high-voltage AC mains.
• **Versatility** – The circuit can be used not only for lamps but also for controlling fan speed, heaters, or other resistive and inductive AC loads.
•**Compact and Efficient** – Unlike bulky rheostats or variable transformers, this electronic dimmer is compact, efficient, and reliable.
•**Scalability** – The design can be expanded to control multiple loads or integrated into smart home and industrial automation systems.

4.3 Disadvantages

•**Complexity Compared to Manual Dimmers** – Unlike simple potentiometer-based dimmers, this circuit requires programming and extra components.
•**Limited to Certain Loads** – Works best with resistive loads (like incandescent lamps or heaters); performance with inductive loads (motors, CFLs, LEDs) may not be smooth.
•**Electromagnetic Interference (EMI)** – Phase angle control can generate electrical noise, which may interfere with nearby electronic devices.
•**Heat Dissipation in TRIAC** – At high loads, the TRIAC may heat up and require a heatsink for safe operation.
•**Dependency on Zero Crossing Detection** – If zero crossing detection is not accurate, dimming performance will be unstable or flackery.
•**Limited Power Handling** – The circuit can only handle loads within the current rating of the TRIAC; higher power applications need stronger components.
•**Not Suitable for Purely Digital Loads** – Sensitive electronic devices or appliances with SMPS (like TVs, computers) cannot be dimmed using this method.

4.4 Discussion

By integrating IOT devices and intelligent algorithms, such a system can provide unprecedented visibility into power consumption patterns, enable proactive load management strategies, and optimize energy usage in alignment with operational requirements and environmental considerations. This paper presents an in-depth exploration of the design, implementation, and benefits of an IOT-based Load control and dimmer System. It discusses the key components, functionalities, and capabilities of the system, along with its potential applications across diverse sectors. Furthermore, it examines the challenges and opportunities associate width deploying such systems in real-world scenarios, and highlight the implications for future developments in the field of electrical power management.

4.6 Applications

Smart the applications of an IOT based load management system are diverse and span across various sectors. Here are some notable applications:

Smart Home Automation

- Enables users to remotely control and dim lights, fans, and other appliances through a smartphone app or voice assistants.
- Improves user comfort and convenience by allowing personalized lighting levels and scheduled operations.

Energy Management

- Helps in reducing electricity consumption by providing dimming control instead of just ON/OFF switching.
- Prevents energy wastage by monitoring and controlling loads remotely.

Office and Commercial Buildings

- Provides centralized control of multiple lights and fans.
- Useful for maintaining optimal lighting levels in conference rooms, workspaces, and lobbies.
- Reduces operational cost through efficient power usage.

Smart Classrooms and Libraries

- Teachers or staff can easily adjust lighting conditions for projectors, study environments, or presentations.
- Improves focus and energy efficiency.

Hotels and Hospitality Industry

- Enhances customer experience by providing smart room controls for fans, lights, and ambiance.
- Enables automated control linked with occupancy sensors.

Industrial Automation

- Controls lighting systems in factories and warehouses depending on the time of day or requirement.
- Can be integrated with IOT sensors for smart energy optimization.

Street Lighting Systems

- Smart IOT dimming can automatically adjust brightness based on time, weather, or traffic conditions.
- Leads to significant cost savings for municipalities.

Elderly and Disabled Assistance

- Provides convenience for elderly or physically challenged people who may find it difficult to reach switches.
- Remote or voice-based load control makes their daily life easier.

Chapter V

CONCLUSION

5.1 Conclusion

The IOT based load management system for a single light exemplifies a significant advancement in modern lighting technology. By integrating Internet of Things (IOT) capabilities, this system offers enhanced control, energy efficiency, and user convenience.

Through the use of IOT-enabled dimmer switches, users can remotely adjust the brightness of their lights, tailor lighting conditions to specific needs, and automate lighting schedules. This not only contributes to energy conservation but also extends the lifespan of light sources by reducing unnecessary usage

Furthermore, the system's integration with other smart home functionalities allows for synchronized control with security systems and climate controls, thereby enhancing overall home automation and user experience

In conclusion, the IOT-based load control and dimmer system for a single light represents a pivotal step towards smarter, more efficient lighting solutions. As technology continues to evolve, such systems will play an increasingly vital role in sustainable energy management and the creation of intelligent living environments.

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5.2 Future Work

The proposed IOT based load management system provides a foundation for smart home automation. However, there are several opportunities to extend and improve the system in the future:

Integration with Voice Assistants
The system can be integrated with popular voice assistants such as Amazon Alexa, Google Assistant, or Apple Siri. This will allow users to control lights and appliances through voice commands for greater convenience.

Energy Monitoring and Optimization
Real-time energy consumption data of connected loads can be collected and displayed on the mobile application. This will help users monitor usage patterns, reduce wastage, and optimize electricity bills.

Machine Learning for Automation
By applying machine learning algorithms, the system can learn user habits (such as preferred lighting levels and timings) and automatically adjust loads without manual intervention.

Scalability to Larger Networks
Future versions can be designed to control not just a few lights and fans, but an entire building or industrial setup with multiple nodes communicating over IOT networks like MQTT or Zigbee.

Renewable Energy Integration
The system can be enhanced to work with solar panels or other renewable sources, intelligently switching between grid power and renewable energy based on availability.

Enhanced Security Features
Security mechanisms such as user authentication, encrypted communication, and intrusion alerts can be implemented to prevent unauthorized access.

Offline Functionality
Although IOT systems depend on the internet, adding local Bluetooth or RF-based fallback control will ensure usability even during internet outages.

Smart Scheduling
Advanced scheduling features can be included to automatically turn appliances ON/OFF at specific times or based on environmental conditions such as temperature, motion, or ambient light.

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Appendix

```
#define BLYNK_PRINT Serial
#define BLYNK_TEMPLATE_ID "TMPL6YHtayS6G"
#define BLYNK_TEMPLATE_NAME "SU PROJECT09"
#define BLYNK_AUTH_TOKEN "JJEtqlxUCrk-WjrHPw5L6I9eSMlKD4MO"

#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

// ------------------ WiFi ------------------
charssid[] = "shorazit";
char pass[] = "00000000";

BlynkTimer timer;

// ------------------ Pins ------------------
constint light1 = 16;   // D0
constint light2 = 14;   // D5
constint Fan1   = 2;    // D4 → Fan relay

// TRIAC dimmer
constintZCpin    = 5;  // D1 → Zero Cross (Optocoupler)
constintTRIACpin = 4;  // D2 → TRIAC Gate

// ------------------ Variables ------------------
volatileintdimDelay = 5000; // µs delay for dimmer
float Voltage = 0, old = 0;

// ------------------ Function Prototypes ------------------
void ICACHE_RAM_ATTR zeroCrossISR();
void ICACHE_RAM_ATTR triacPulse();
voidVoltageloop();

// ------------------ BLYNK CONTROL ------------------
BLYNK_WRITE(V0) { digitalWrite(light1, param.asInt()); }
BLYNK_WRITE(V1) { digitalWrite(light2, param.asInt()); }
BLYNK_WRITE(V2) { digitalWrite(Fan1, param.asInt()); }

// Fan speed (dimDelay control)
BLYNK_WRITE(V3) {
int slider = param.asInt(); // 0–100 from Blynk slider
```

```
dimDelay = map(slider, 0, 128, 8000, 0); // Phase delay
Serial.print("Fan Speed %: ");
Serial.println(slider);
}

// ------------------ SETUP ------------------
void setup() {
Serial.begin(115200);

pinMode(light1, OUTPUT);
pinMode(light2, OUTPUT);
pinMode(Fan1, OUTPUT);

pinMode(ZCpin, INPUT);
pinMode(TRIACpin, OUTPUT);
digitalWrite(TRIACpin, LOW);

  // Attach Zero-cross Interrupt (FALLING এ বেশির ভাগ সার্কিটে ভালো কাজ করে)
attachInterrupt(digitalPinToInterrupt(ZCpin), zeroCrossISR, FALLING);

  // Blynk Start
Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass);

  // প্রতি ১ সেকেন্ডে ভোল্টেজ সেন্সর পড়া হবে
timer.setInterval(1000L, Voltageloop);
}

// ------------------ LOOP ------------------
void loop() {
Blynk.run();
timer.run();
}

// ------------------ TRIAC CONTROL ------------------
void ICACHE_RAM_ATTR zeroCrossISR() {
  timer1_disable();
  timer1_attachInterrupt(triacPulse);
  timer1_write(dimDelay * 5); // µs → timer ticks (approx for 50Hz)
  timer1_enable(TIM_DIV16, TIM_EDGE, TIM_SINGLE);
}

void ICACHE_RAM_ATTR triacPulse() {
digitalWrite(TRIACpin, HIGH);
delayMicroseconds(200);  // Fan/inductive load এর জন্য যথেষ্ট সময়
```

```
digitalWrite(TRIACpin, LOW);
}

// ------------------ VOLTAGE MEASUREMENT ------------------
#define ADC_PIN A0
#define SAMPLES 500

voidVoltageloop() {
long sum = 0;
for (inti = 0; i< SAMPLES; i++) {
intval = analogRead(ADC_PIN) - 512;
sum += (long)val * val;
  }

float mean = (float)sum / SAMPLES;
floatrms = sqrt(mean);
float voltage1 = rms * (3.3 / 1023.0);
floatacVoltage = voltage1 * 520.0;  // ক্যালিব্রেশন ফ্যাক্টর

if (fabs(acVoltage - old) > 2) {
   Voltage = acVoltage;
old = acVoltage;
Serial.print("Voltage: ");
Serial.println(Voltage);
Blynk.virtualWrite(V4, Voltage);
  }
}
```