REPORT

ON

The Multifunctional Desk Lamp with Versatile Lighting and Modern Connectivity

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Abstract

This project presents the design and development of a smart multifunctional desk lamp that responds to ambient light conditions by automatically switching on in low-light environments and turning off when sufficient light is detected. The lamp is equipped with practical features such as USB charging ports, a built-in rechargeable battery, and adjustable brightness levels to suit user preferences. Using a Light Dependent Resistor (LDR) sensor, the system monitors surrounding light and manages the lamp's operation accordingly. Designed for modern spaces like study rooms, bedrooms, and home offices, this project emphasizes energy efficiency, user convenience, and aesthetic appeal. It offers a practical upgrade over conventional desk lamps while supporting the shift toward intelligent home solutions.

Chapter 1

Introduction

This project proposes the design and implementation of a multi-functional intelligent desk lamp, primarily focusing on the feature of automatically turning on when the room is dark and turning off when the ambient lighting is sufficient. As a household lighting device, the desk lamp is frequently used and essential in daily study and work. However, traditional desk lamps provide only basic lighting and require manual switching, limiting their functionality.

Modern smart desk lamps integrate multiple features that make them adaptable to various environments. The core function, however, remains: to provide a comfortable and efficient lighting environment for the user.

A multi-purpose desk lamp is a versatile lighting solution designed for spaces such as home offices, bedrooms, and study areas.It combines aesthetics with functionality—featuring automatic light sensing, USB charging ports, and often directional lighting using flexible arms or rotating heads. These features enable the lamp to support tasks like reading, working, or mood lighting, promoting ergonomic use in today's dynamic and tech-integrated settings.

1.1 Overview

The project aims to design a smart desk lamp that can automatically respond to ambient light levels—turning on in dark environments and switching off in bright conditions. Unlike conventional lamps, this smart lamp eliminates the need for manual control, offering convenience and energy efficiency.

It also supports directional lighting for task-specific use and includes additional features such as USB charging ports and a rechargeable battery, enhancing portability and user convenience. This project aligns with the growing trend of smart home devices, offering a modern and adaptive solution to everyday lighting needs.

1.2 Existing System

Several intelligent desk lamp systems have been proposed and developed over the years:

- Gupta et al. (2017) developed a multipurpose table lamp with enhanced functionality, forming a foundation for future designs.
- Zhang et al. (2019) designed a smart lamp using the STC89C52 microcontroller, incorporating features like automatic brightness adjustment and timer settings.
- Xu et al. (2023) introduced a lamp with intelligent posture correction, gesture recognition, and auto-brightness adjustment using MCU.
- Lin et al. (2022) focused on health-oriented smart lamps with features like UV sterilization, auto-brightness, and reminders.
- Lian et al. (2021) utilized the STM32 microcontroller to design a lamp with gesture recognition, timers, and light automation.

These existing designs illustrate the evolution of desk lamp systems toward user friendliness, health-conscious features, and enhanced smart capabilities.

1.3 Objectives

• To design and implement a desk lamp that automatically switches on in the dark and off in bright environments using light sensors.

• To integrate a USB charging port for powering external devices.

• To incorporate a rechargeable battery for portability and uninterrupted use

Chapter 2

BACKGROUND WORK

The use of lighting in our daily lives has become an essential aspect of human comfort and productivity. Traditional lighting systems, however, often lack the flexibility and adaptability required to meet the diverse needs of modern users. With the advent of advanced technologies such as microcontrollers, sensors, and artificial intelligence, the development of intelligent lighting systems has become increasingly feasible.

Intelligent lighting systems represent a new paradigm in lighting technology, characterized by their ability to adapt to changing user needs and environmental conditions. These systems typically employ advanced sensors, microcontrollers, and communication protocols to enable real-time monitoring and control of lighting parameters. Despite the growing interest in intelligent lighting systems, there remains a significant research gap in the development of adaptive and user-centric lighting solutions, which this project aims to address.

Survey Papers

• **Jingzhuo Xu, Jingyi Xu et al.**, in their work “Design and Implementation of a Multifunctional Desk Lamp with Intelligent Posture Correction Based on MCU”, proposed a smart desk lamp structure that includes components such as a lamp body, controller, and sensors. The lamp body typically consists of parts like a lamp base, lamp head, and lampshade, with the main function of providing lighting services along with posture correction features [1].

• **Haige Lin and Xinxin Zhou**, in their paper “Design and Implementation of a Desk Lamp Based on Intelligence and Health”, proposed a multifunctional intelligent desk lamp capable of both automatic and manual brightness adjustment. The system adjusts brightness by monitoring the distance between the user and the lamp [2].

• **Yuyang Lian and Dong Wu**, in their work “STM32-Based Intelligent Desk Lamp Design and Implementation”, emphasized designing a lamp using a microcontroller as the control core, combined with sensor modules. The lamp supports automatic lighting, intelligent dimming, posture correction reminders, night light functions, and smartphone app-based control through wireless sensor data transmission. It also collects environmental parameters to support energy-saving and convenience [3].

Chapter 2

DESIGN METHODOLOGY

3.1 Block Diagram

The proposed system focuses on automating LED lighting based on ambient light while integrating features like a rechargeable battery and USB charging support. The system begins with a power supply, which charges a rechargeable battery, enabling backup during power cuts and supporting portability.

A **switch** is included for manual control, letting the user operate the lamp directly when needed. Power from the battery or supply passes through a step down converter to regulate voltage for safe operation of the LED and USB port.

The **USB** port allows users to charge mobile devices or power small electronics, adding multifunctionality to the desk lamp.

An **LDR** sensor continuously monitors surrounding light levels. When the light intensity falls below a set level (like during night), the sensor sends a signal to the relay module, which then turns on the LED light. If enough light is detected (like in daytime), the relay turns the LED off.

The **LED** provides illumination as the final output, triggered either automatically via LDR or manually using the switch. This complete system offers convenience, energy savings, and modern utility, ideal for use in homes, hostels, and study areas.

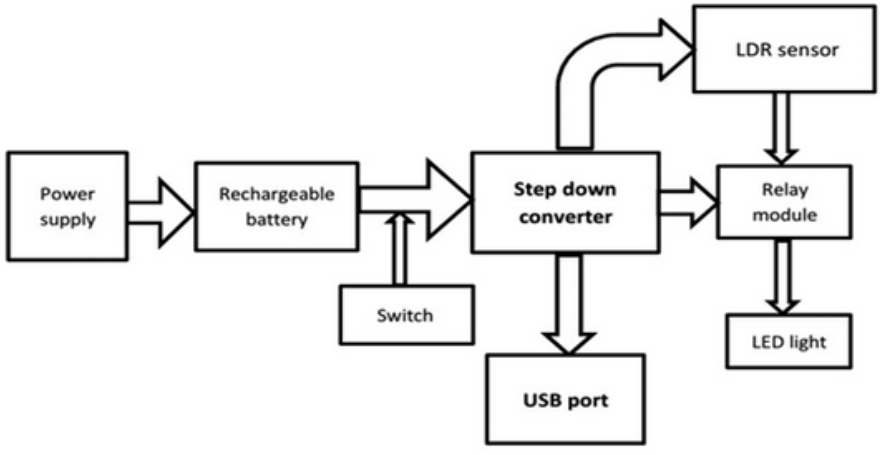

Fig 3.1: Block diagram

3.2 Hardware Components

Rechargeable battery

Battery Used – Eastar ICR18650

The Eastar ICR18650 is a widely used lithium-ion rechargeable battery known for its high energy density and stable performance. It is ideal for portable electronics and energy-efficient systems like this multifunctional desk lamp.

Key Specifications:

Nominal Voltage: 3.7V

Fully Charged Voltage: 4.2V

Capacity: 2000–2200mAh

Rechargeable: Supports multiple charge-discharge cycles

Applications: This battery is commonly used in flashlights, smart electronics, and portable gadgets — making it a suitable and reliable power source for the proposed desk lamp system.

Step down convertor

LM2596 Step-Down Converter

Input Voltage: 4V–40V

Output Voltage: Adjustable (1.23V–37V)

Output Current: Continuous: Up to 2A

Peak: 3A (with sufficient cooling)

Efficiency: Up to 92% (varies with input-output difference)

Features:

- Built-in thermal and overcurrent protection.
- Adjustable output voltage with a potentiometer.
- Compact size, ideal for low-power applications.
- Easy to use and affordable.

Relay module

A relay module is an electronic device used to control high-voltage or high current devices with a low-power control signal. It acts as an electrically operated switch, allowing a small input signal to control larger loads like motors, lights, and appliances.

Key Features of a Relay Module

- Control Voltage: Typically, 3.3V, 5V, or 12V (depending on the module).
- Load Voltage: Supports AC or DC loads up to 250V AC or 30V DC.
- Can handle currents up to 10A or more, depending on the relay's capacity.
- Available in single, dual, 4-channel, 8-channel, and more, based on the number of relays on the board.
- Provides electrical isolation between the control circuit and the load for safety.
- Shows the status of the relay (ON/OFF).
- Normally Open (NO): Circuit is open when the relay is deactivated.
- Normally Closed (NC): Circuit is closed when the relay is deactivated.

LDR SENSOR

A Light Dependent Resistor (LDR) sensor, also known as a photoresistor, is a passive electronic component whose resistance changes based on the intensity of light falling on it. It is commonly used in light-sensing applications.

Key Features of an LDR Sensor

- The resistance of the LDR decreases as the intensity of light increases.
- High resistance in darkness (typically in the mega-ohm range).
- Low resistance in bright light (a few hundred ohms).
- Made of semiconductor materials like cadmium sulfide (CdS).
- Slow response time for changes in light intensity (milliseconds to seconds).
- Longer response in transitioning from dark to light than from light to dark.
- Sensitive to visible light spectrum, typically in the range of 400–700 nm.
- Operates at low voltages, usually 3.3V or 5V, depending on the circuit.
- Small and lightweight, making it easy to integrate into projects.
- No moving parts, ensuring long life and reliability in most environments.

USB PORT

The Universal Serial Bus (USB) is a standard that defines the cables, connectors, and protocols used for communication and power supply between electronic devices. Initially developed in the mid-1990s, USB revolutionized the way computers and peripherals interacted, offering a simple, standardized connection method for data transfer, power delivery, and device synchronization. Over time, USB has evolved to meet the increasing demands for higher speeds, more power, and greater versatility in various applications. USB ports, particularly the newer USB-C connectors, are designed for longevity and durability.

Durability:

USB-C connectors are rated for around 10,000 insertion/removal cycles, making them much more durable than older versions.

Environmental Resistance:

Some USB connectors are designed for use in rugged environments, with features like water-resistance and shock proofing.

LED LIGHT STRIPS

• LED light strips consume less power compared to traditional lighting, making them cost-effective and eco-friendly.
• They are flexible and can be cut or extended to fit various spaces, allowing for tailored designs and installations.
• Available in a range of brightness levels and colors, including RGB options for dynamic lighting effects.
• LED strips typically last longer than traditional bulbs, offering durability and reduced maintenance costs.
• Equipped with adhesive backing and plug-and-play designs, they are easy to install on different surfaces.

SWITCH

A switch is an electrical component used to interrupt or complete the flow of electricity in a circuit. It operates by opening or closing the electrical path, allowing or stopping the current from passing through.

Chapter 4

RESULTS AND DISCUSSION

In this chapter will discuss about the results obtained from the project work implementation.

4.1 Results

The intelligent desk lamp worked well in different lighting conditions. It turned on automatically when the room was dark and off when it was bright. The lamp used very little power and the USB port worked well for charging devices. The battery lasted for 8 hours on a single charge. Overall, the lamp was convenient, energy-efficient, and worked well.

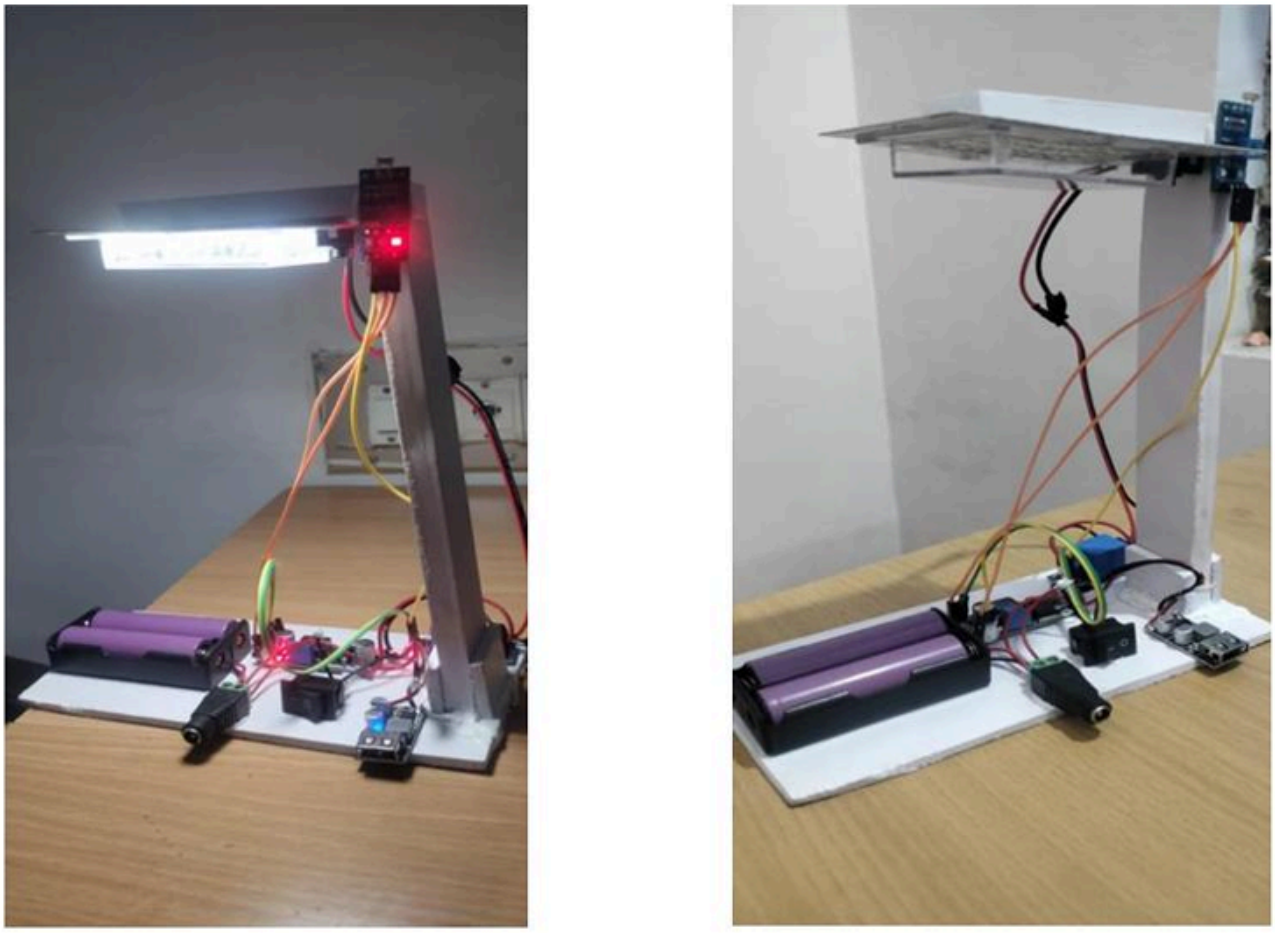

Fig 4.1: Working of Smart desk lamp

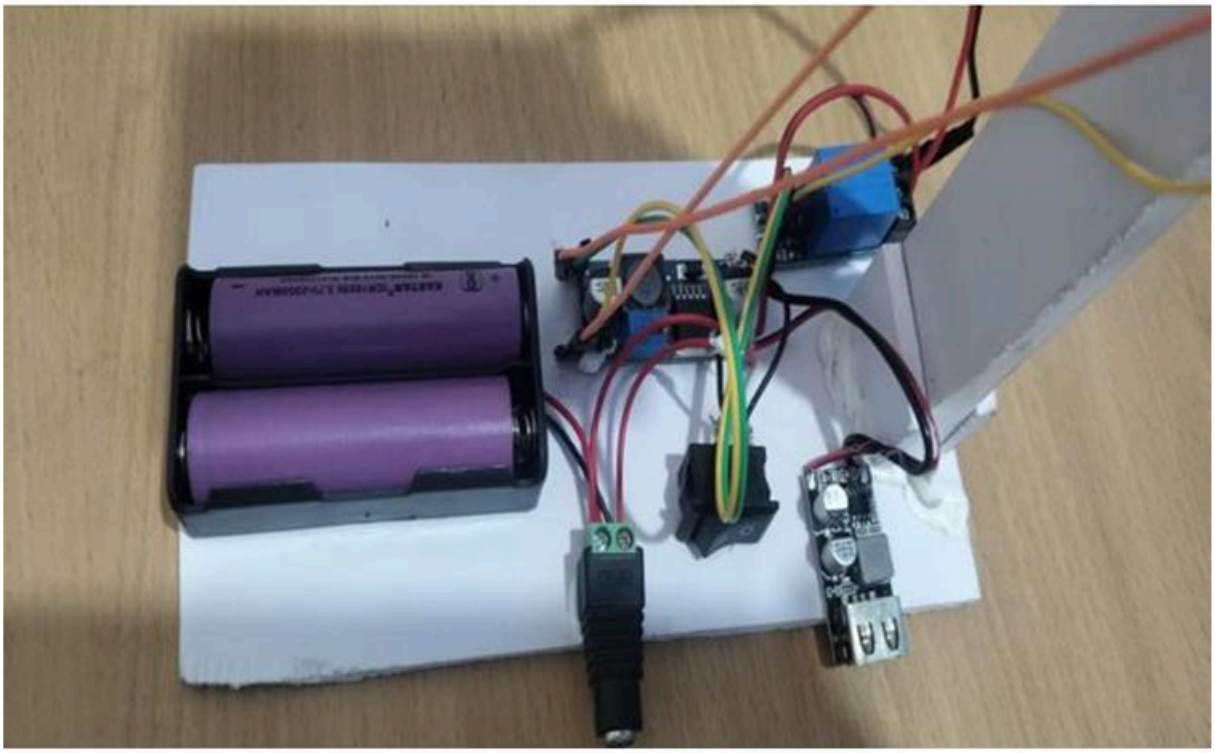

Fig 4.2: Circuit of the project

4.2 Advantages

- Automatic Lighting Control: The lamp automatically turns on when the room is dark and off when it's well-lit, providing convenience and energy efficiency.
- Multi-Functionality: The lamp integrates features such as USB charging ports, a rechargeable battery, and adjustable brightness, making it a versatile lighting solution.
- Energy Efficiency: The use of LED light strips and a step-down converter ensures low power consumption, making the lamp eco-friendly and cost effective.
- Portability: The rechargeable battery provides the convenience of portability, allowing users to move the lamp around without being tethered to a power source.
- User-Centric Design: The lamp's design prioritizes user comfort and convenience, with features such as adjustable brightness and directional lighting.
- Durability: The use of high-quality components, such as the Eastar ICR18650 battery and USB-C connectors, ensures the lamp's durability and longevity.
- Flexibility: The lamp's flexible design allows it to be used in various settings, such as home offices, bedrooms, and study areas.
- Easy Installation: The lamp's plug-and-play design and adhesive backing make it easy to install and use.
- Cost-Effective: The lamp's energy efficiency and long lifespan make it a cost effective lighting solution in the long run.
- Innovative: The lamp's advanced features and user-centric design make it an innovative solution in the field of smart lighting.

4.3 Challenges

- Dependence on Sensors: The lamp's performance may be affected by the accuracy and reliability of its sensors, which can be impacted by factors like dust, moisture, or interference.
- Limited Battery Life: The rechargeable battery may not last as long as expected, requiring frequent recharging.
- Potential for Glitches: Like any electronic device, the intelligent desk lamp may be prone to glitches or malfunctions, which can be frustrating to deal with.
- Limited Customization: The lamp's automatic features may not be fully customizable, which can limit its adaptability to different users' preferences.
- Environmental Impact: The production and disposal of the lamp's electronic components can have a negative environmental impact.

4.4 Applications

- Home Offices: Provides focused lighting for tasks, automatic brightness adjustment, and USB charging for devices.
- Study Areas: Helps students stay focused with adaptive lighting, reduces eye strain, and offers a convenient charging station.
- Bedside Tables: Offers a convenient reading light, automatic dimming, and USB charging for phones or tablets.
- Workstations: Enhances productivity with task-oriented lighting, reduces eye fatigue, and provides a built-in charging hub.
- Smart Homes: Integrates with smart home systems to provide automated lighting control, energy efficiency, and enhanced convenience.
- Healthcare: Offers adjustable lighting for patients, reduces eye strain for healthcare professionals, and provides a hygienic lighting solution.
- Gaming Stations: Enhances gaming experiences with customizable lighting, reduces eye fatigue, and provides a convenient charging station.
- Assistive Technology: Helps individuals with visual impairments or disabilities with adaptive lighting, automatic brightness adjustment, and voice control integration.

CONCLUSION AND FUTURE ENHANCEMENT

This project has successfully designed and implemented a multi-functional intelligent desk lamp that offers automatic lighting control, power efficiency, and USB charging capabilities. The lamp's adaptive lighting feature, rechargeable battery, and compact design make it a convenient and energy efficient solution for various lighting applications. The project demonstrates the potential of intelligent lighting systems in enhancing user experience, reducing energy consumption, and promoting sustainable development.

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