

Smart Power Cord with Time-Based Color Indication and Usage Monitoring System

Correspondence Author: Soumya Sharma, Aditya Yadav¹, Anwesh Kumar², Divyansh Sharma³, Vikash Mahawar⁴, MD Najish⁵

Abstract - This paper presents the design and development of a smart power cord capable of monitoring usage duration and providing real-time visual feedback through color-changing LEDs. Conventional power cords do not provide any indication of how long a device has been plugged in, which can lead to energy wastage and potential safety hazards such as overheating. The proposed system integrates a microcontroller with a current sensing module to detect active power flow and initiate time tracking. Based on predefined time intervals, an RGB LED changes color to indicate the duration of usage, while an optional display module shows the exact time elapsed. The system enhances user awareness, promotes efficient energy usage, and improves electrical safety. The design is cost-effective and suitable for both household and industrial applications.

Key Words: Smart Power Cord, Energy Monitoring, RGB LED, Usage Tracking, Electrical Safety, IoT

1. INTRODUCTION (Size 11, Times New roman)

With the increasing use of electrical devices in daily life, energy consumption and safety have become major concerns. Many users often leave devices plugged in for extended periods, resulting in unnecessary power consumption and increased risk of overheating and electrical hazards. Traditional power cords provide no feedback regarding usage duration, making it difficult for users to monitor their energy usage behavior.

Existing solutions such as smart plugs and energy meters provide monitoring capabilities, but they often require mobile applications or complex interfaces. There is a lack of simple, real-time visual feedback systems that can instantly inform users about device usage duration.

This paper proposes a smart power cord system that uses time-based color indication and usage monitoring to provide intuitive feedback. The system aims to reduce energy wastage, enhance safety, and promote efficient usage of electrical devices.

2. Body of Paper

2.1 Existing Systems:

Current technologies such as smart plugs, timer switches, and IoT-based energy monitoring systems allow users to track electricity usage. However, these systems have limitations:

- Require mobile applications or internet connectivity
- Lack immediate visual feedback
- Can be expensive and complex

Thus, there is a need for a simple and cost-effective solution that provides real-time awareness without requiring additional interfaces.

2.2 Proposed System:

The proposed system is a smart power cord that monitors how long a device remains plugged in and provides feedback through color-changing LEDs and a time display.

Key features include:

- Automatic detection of power usage
- Real-time time tracking
- Color indication based on usage duration
- Optional display for exact time

2.3 System Architecture:

The system consists of the following components:

- Power Source
- Current Sensor
- Microcontroller (Arduino/ESP32)
- RGB LED Module
- Display Unit (LCD/OLED)

The current sensor detects whether the device is active. The microcontroller processes this data and controls the LED color and display output accordingly.

2.4 Components Used:

Component	Function
Microcontroller	Controls system operations
Current Sensor	Detects power flow
RGB LED	Provides color indication
Display Module	Shows elapsed time
Power Supply	Provides electrical input

2.5 Working Principle:

The working of the system is as follows:

1. When a device is plugged in, the current sensor detects power flow.
2. The microcontroller starts a timer.
3. Based on the elapsed time, the RGB LED changes color:
 - ☐ Green (0–1 hour) → Safe usage
 - ☐ Yellow (1–3 hours) → Moderate usage
 - ☐ Red (above 3 hours) → Excessive usage
4. The display module shows the exact time duration.
5. When the device is unplugged, the timer resets.

2.6 Algorithm:

```
Start
Check current flow
If current detected:
    Start timer
    If time < 1 hr → Green LED
    If time between 1–3 hr → Yellow LED
    If time > 3 hr → Red LED
    Display time
Else:
    Reset timer
Stop
```

2.7 Advantages:

- Provides real-time visual feedback
- Simple and easy to use
- Cost-effective solution
- Reduces energy wastage
- Enhances electrical safety

2.8 Limitations:

- Does not support remote monitoring (without IoT integration)
- Accuracy depends on sensor quality
- Limited to wired electrical devices

3. CONCLUSION

The proposed smart power cord system offers an effective solution for monitoring device usage and improving electrical safety. By incorporating time-based color indication and real-time tracking, the system provides an intuitive way for users to understand their energy consumption habits. This approach helps in reducing unnecessary energy usage and minimizing potential risks associated with prolonged device operation. Future enhancements may include IoT integration, mobile application support, and advanced analytics for better performance and usability.

ACKNOWLEDGEMENT

I would like to express gratitude to the institution and mentors for their guidance and support during the development of this work.

REFERENCES

1. A. Kumar, "Smart Energy Monitoring System Using IoT," IEEE, 2021.
2. S. Sharma, "Energy Efficient Smart Plug Design," International Journal of Engineering Research, 2020.
3. R. Gupta, "IoT-Based Power Monitoring System," Springer, 2019.
4. M. Singh, "Electrical Safety and Monitoring Systems," Elsevier, 2018.
5. P. Verma, "Embedded Systems for Energy Applications," Wiley, 2022.