



IMPLEMENTATION OF MULTIPLE DIMMING TECHNIQUES IN SMART LED LIGHTING SCHEME WITH PROTECTION AGAINST OVER TEMPERATURE

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Abstract

The lamps in street lighting system, traffic lights, road lamps, lamps in parks, lamps in sky walks and campus should be replaced with LEDs. LEDs are more efficient than incandescent lamps and have more brightness as compared to the incandescent lamps. Also the life span of LED is more as compared to the incandescent lamps. By replacing the incandescent lamps with LED lamps in street lighting systems, the utility will gain benefits in terms of cost and energy savings. The lamps are often operated for a long time during the whole night. Possibly, the time exceeds eight to ten hours. The main factor to affect the life of the lamp is its increasing temperature. If the temperature of the lamp goes on increasing, then it will reduce the life of the lamp. In the design for temperature protection system, the brightness of the lamp will decrease gradually as the temperature of the lamp increases and the brightness will increase gradually as the temperature of the lamp returns to the normal operating temperature. The temperature sensors help in detecting the temperature of the lamp. The lamp will be whole shut down when the sensor will detect the rise in temperature above certain limits. The system also consists PIR sensor which turns ON and OFF the lamp depending on the movement of humans in the range of sensor. The sensor detects the movement of the human near the lamp and turns ON the lamp. Similarly, when there is no human near the lamp, the lamps brightness reduces gradually and after a specific time, the lamp shuts down. In this system, microcontroller chip, different sensors, temperature sensors and current control circuitry are successfully integrated as a smart LED lighting system. The system has many advantages like human body sensing, LED lamp with multiple dimming and automatic temperature protection capabilities. Our aim is to achieve 'high efficiency', 'low energy consumption' and make a 'user friendly' system by using various techniques.

Index Terms: Microcontroller, PIR sensor, LM35, Reduce Energy Consumption, Over Temperature Protection.

1. INTRODUCTION

Nowadays, the use of electrical energy is increasing. The lamps in the lighting system remain ON for the whole night. The awareness for energy consumption is also increasing. The energy consumed in the lighting system is about 20% of the total annual energy consumption. In recent years, LEDs are replacing the incandescent lamps. LED lamps have many advantages over the incandescent lamps. The main and

attractive advantages of LEDs are high luminous efficiency, energy saving, compact size, long life and environmental friendly. By replacing incandescent lamps with LED lamps, the utility will gain benefits in terms of cost and energy savings. But the main drawback of LED is its increasing temperature. This affects the life of the LED lamps. LED lamps mostly operate for 1,00,000 hours when they are operated properly. But the life of the LED lamp depends on

the junction temperature to which the LEDs are exposed. Increase in temperature affects the life of the LED lamps. This means, as the temperature increases, the life of the LED lamp decreases. To overcome this problem, an effective temperature protection system is designed. In this system, as the temperature of the LED increases, its brightness decreases gradually and as the temperature of the LED lamp decreases, its brightness increases. LM35 temperature sensor is used to sense the temperature of the LED lamp. The increase in temperature is sensed by LM35 sensor and as the increase in temperature crosses a certain limit, the LED will whole shut down. In short, in temperature protection system, the brightness of the LED lamps changes with the change in temperature. This will help in increasing the life span of the LED lamps. The lamps in the lighting system operate for a long time duration for whole night. The time duration often exceeds eight to ten hours. During night, the lamps remain ON even if there is no human near the lamp. This leads to wastage of energy. This problem can be overcome by using a PIR sensor in the LED lighting system. The PIR sensor detects the motion of the human in the range of the sensor and turns ON and OFF the lamp. When there is a human movement in the range of the sensor, the sensor will detect the human movement and the lamp will glow. Similarly, when there is no human movement near the lamp, the lamp will turn OFF after a specific time interval. This will help in saving the energy. A smart LED lighting system consists of microcontroller chip, motion sensors, temperature sensor and current control circuit. The use of PIR sensor and LM35 temperature sensor in LED lighting system have many advantages like reducing energy consumption and increasing the life span of the LED lamps.

2. LITERATURE SURVEY

[1] “Review of an energy efficient Smart Street Lighting System”, Satwinder Singh, International Journal of Research (IJR) Vol-1, Issue-5, June 2014.

In the modern world, there is an increase in use of electricity. At the same time, the environmental awareness among the consumers has also increased. The energy consumption in lighting system is increasing day by day. Now-a-days, LEDs are replacing the incandescent lamps in the street lighting system. LED has many advantages over the incandescent lamps such as longer life span, high efficiency, etc. By replacing the incandescent lamps with LED lamps, the energy consumption can be reduced by 20%. LED lamps provide reduced energy consumption and make lighting system more reliable and economic.

[2] “Implementation of passive infrared sensor in Street Lighting Automation System”, N. L. Ramli, N. Mohd Yamin, S. Ab Ghani, N. Md. Saad, S. A. Md Sharif, ARPN Journal of Engineering and Applied Sciences, December 2015.

The main objective of a smart lighting system is to provide safe environment to the people during night. A smart street lighting system uses a microcontroller and some sensors to achieve energy-saving. Lights remain ON for the whole night even when no one is present near the lamp. Passive Infrared

(PIR) sensors are used in order to sense the movement of the road user in the range of the sensor. By using PIR sensor, the system can automatically turn ON and OFF the lamp depending upon be movement near the sensor. This system with PIR sensor operates during the night and sense the movement of the road users. The lamp will turn ON when there is movement of the road user otherwise, the lamp will turn OFF. This technique saves a lot of energy during night. This also leads to increase in efficiency. This technique is superior as compared to the conventional technique because more amount of energy is saved in smart LED street lighting system than the conventional street lighting system.

3. CIRCUIT ARCHITECTURE

The Block Diagram of the smart LED lighting system with over temperature protection and multiple dimming techniques is shown in Fig-1

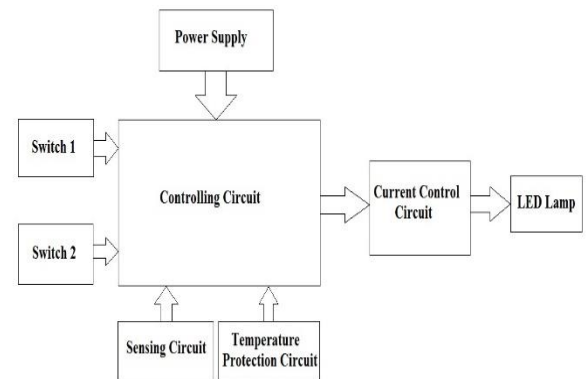


Fig-1: Smart LED Lighting System with Over Temperature Protection and Multiple Dimming Techniques

The figure above consists the following blocks-

- Controlling Circuit
- Power Supply
- Switch 1
- Switch 2
- Sensing Circuit
- Temperature Protection Circuit
- Current Control Circuit
- LED Lamp

The system consists of the following-

3.1 Microcontroller

The microcontroller is used to send controlling signals to the current control circuit by sensing the signals from the sensing circuit and temperature protection circuit. Low-Cost Microcontroller like Arduino Uno is used. Arduino Uno is an open source, computer hardware. It can be powered by external power supply or with the help of a USB connection. It has a number of facilities like communicating with computer, another Arduino or other microcontrollers.

3.2 Sensing Circuit

The Sensing Circuit consists of a PIR sensor. PIR sensor senses the motion of the human within the range of the sensor. They are small, inexpensive and easy to use. Every human body emits low level infrared radiation. The PIR sensor are used to sense this low level radiation. By sensing the movement of the human, the PIR sensor sends signals to the microcontroller which in turns sends signals to turn ON or OFF the LED lamp, depending upon the movement.

3.3 Temperature Protection Circuit

The temperature protection circuit is used for protection of LED against over temperature. LM35 sensor is used to sense the change in temperature. The LM35 is an integrated circuit (IC) sensor that can be used to measure temperature with an electrical output proportional to the temperature (in °C). It has the capabilities to measure temperature more accurately than thermistor. The sensor circuitry is sealed. The main advantage of the sealed circuitry is that it is not subjected to oxidation. The LM35 generates a higher output voltage than the thermocouples and the output voltage of LM35 is proportional to the Celsius temperature.

3.4 Current Control Circuit

The current control circuit is used to supply the current to the LED depending upon the signals given from the microcontroller in order to reduce the brightness of the LED or to turn ON or OFF the LED.

3.5 LED Lamp

LED lamps are used in place of incandescent lamps. LED lamps have many advantages over the incandescent lamps. The main and attractive advantages of LEDs are high luminous efficiency, energy saving, compact size, long life and environmental friendly. By installing the LED lamps in place of the incandescent lamps, the energy consumption can be reduced by 20%. LED lamps provide reduced energy consumption and make lighting system more reliable and economic.

Description of working of the system

The system is mainly composed of a microcontroller (Arduino Uno), sensing circuit (PIR sensor), temperature protection circuit (LM35), current control circuit and LED lamp (Refer Fig.-1). The operation has two modes-

- (1) Over temperature protection mode.
- (2) Dimming mode (Power saving mode).

When the temperature of the LED lamp increases, the over temperature protection mode comes into action. In over temperature mode, the switch 1 gets activated. In over temperature protection mode, the temperature of the LED is sensed with the help of the temperature protection circuit. The brightness of the LED is changed with the change in temperature. When the temperature of the LED increases beyond a certain limit, the temperature protection circuit senses the change in temperature and gives signal to the

microcontroller. The microcontroller reads the signal from the temperature protection circuit and it sends the controlling signal to the current control circuit. After receiving the signals, the current control circuit limits the current to LED lamp. Because of this, brightness of the LED decreases. Similarly, when the temperature of the LED decreases, then the brightness of the LED increases. This helps to increase the life span of the LED lamp. In dimming mode, the switch 2 gets activated. In dimming mode, the sensing circuit comes into operation. The sensing circuit senses the movement of human near the lamp and turns ON or OFF the LED lamp. When there is movement of human near the lamp, it is sensed by the sensing circuit and the sensing circuit gives signal to the microcontroller. The microcontroller reads the signal given by the sensing circuit and it gives the controlling signal to the current control circuit which in turns switches ON the LED lamp. When there is no human near the lamp, the sensing circuit sends the signal to the microcontroller. On receiving the signals from the sensing circuit, the microcontroller sends the controlling signal to the current control circuit to turn OFF the LED. Therefore, the LED will turn OFF after a specific delay whenever there is no human near the lamp.

4. RESULT

4.1 For Over Temperature Protection

In order to increase the life of the LED, the design with over temperature protection technique is very helpful in adjusting the brightness of the LED lamp according to the change in temperature. When the temperature of the LED increases, it is sensed by the LM35 temperature sensor. The LM35 sensor sends signal to the Arduino Uno microcontroller and the brightness of the LED is decreased. This increases the life span of the LED.

4.2 For Increasing Efficiency

To increase the efficiency of the LED lighting system, PIR sensors are used. The PIR sensor detects the movement of human in the range of the sensor and the LED lamp gets activated. When there is no human near the LED lamp, the sensor will detect the empty region and the LED will turn OFF after a delay (up to 6-10 mins for practical applications). This helps in reducing the wastage of energy by turning OFF the LED when the region near the LED is not occupied by radiation emitting body. Thus, it will increase the light operating efficiency.

5. CONCLUSION

In this System, the microcontroller, motion sensor and temperature sensor are integrated in the LED lighting system. This forms a Smart LED lighting system. Use of LED in place of incandescent lamps has helped in increasing the efficiency of the system. This system has many capabilities such as over temperature automatic protection, body motion sensing, multiple dimming technique and reducing energy consumption. This system will provide benefits in terms of cost and also reduce energy consumption. This intelligent

system provides high efficiency and also can be adapted as an energy saving system in lighting system.

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