

# Sensor Based Smart Lighting: A Survey

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**Abstract** - Conservation of energy is an important topic in the current research. Lighting system places its vital role in homes, offices, industrial sectors, urban and rural areas. For longer efficiency and to reduce the power consumption, many methods have been developed. They have already installed lighting of different method which are outdated and energy inefficient. For smart lighting and to reduce the energy storage requirement, Light emitting diodes (LED) and hybrid power system can be used. Here, this paper gives a review on the available smart lighting systems and it also gives the idea to develop low cost, adaptable, easy to install, wireless sensor based smart lighting system which automatically adjust the intensity of light for energy saving which satisfies the user.

**Key Words:** Lighting system, light emitting diode(LED), Sensors, Arduino, Energy saving, Zigbee.

## 1. INTRODUCTION

Nowadays, energy consumption is more in residential and commercial areas. It is because of the inefficient usage of electrical loads such as heating systems, lighting systems etc. Among these, the lighting system is one of the largest energy consuming units of any building & structure. It is so crucial to use the smart lighting system by automatically switching on/off or dim the lights when needed without disturbing the normal operation of the working environment.

There are two main physical methods to provide light:

- Incandescent
- Fluorescent

The incandescent principle depends on heating a source to a temperature to obtain reddish, yellowish or white light. All incandescent light sources tend to produce more heat than light so they are relatively inefficient in the rate of conversion of energy to light. Sometimes fluorescence occurs under particular conditions like when a material is made to glow with the 'cold light'. Fluorescence is nothing but the atoms in the gas, solid or vapour are excited to emit light which leads to energy wastage. Light emitting diodes(LED) are electronic components that produce light by conversion of electrical energy directly into light by the movement of electrons within the material of the diode. We usually prefer the lighting system using LED because of its own advantages

like efficiency and low power consumption over most of the conventional light sources such as the incandescent bulbs.

Different areas of lighting are commercial, residential, industrial and outdoor lighting. Each of the sector has its own needs and requirements of lighting using different sensors. Residential sector needs low power so low cost simple solution can be employed by using ambient sensors. Commercial lighting in shops and offices uses bit high power, therefore they can make use of passive infrared sensors or ultrasonic sensors to cover large areas. Outdoor and Industrial sectors can make use of PyroelectricInfrared(PIR), light and motion sensors in order to control the light in a safety and cost effective manner.

Smart lighting is a technology which is designed mainly for energy efficiency. In the world, almost 20% of energy is used for lighting and around 6% is for greenhouse emissions. Here, for the low cost and simplicity in implementation, wireless sensor network is used. By using the PIR, light sensor, CO<sub>2</sub> and motion sensors the light can be controlled without affecting the normal working environment which helps for the energy conservation by switching on/off the light only in need and by using LED the carbon dioxide emission can be reduced.

## 2. SENSORS

Sensor is the heart of the smart lighting in the current research. Finding the changes in the light is the key point of developing the energy efficient techniques for homes and offices. In order to reduce the power bill, smart lighting makes use of the sensors. Some approaches are as simple as using photodiode and some are as complex as ultrasonic to implement the lighting system. Sensors like ambient lighting sensors, proximity sensors or photodiodes can also be used for smart lighting. Whenever there is sufficient illumination available, lighting control can be achieved by using ambient lighting sensors. Whenever people are present, to provide lighting proximity sensors are helpful. Based on available light and occupancy, the dimming of light in a room can be controlled by using PyroelectricInfraRed(PIR) sensor, ultrasonic or its combination. For longer range, infrared sensors are also preferable. These are small, inexpensive and are easy to install. Therefore combining the suitable sensors

with microcontrollers, arduino or raspberry pi boards and power management helps to provide the low cost, low power control systems which reduces the energy consumption and money.



Figure 1: PIR sensor

PyroelectricInfraRed or Passive infrared sensors (PIR) is an electronic sensor. It is also named as 'IR morion' sensors. These sensors measures infrared light that is radiating from the objects in its vicinity. If the motion of human body is detected within the coverage area, light will be activated automatically. Otherwise light will be deactivated. These sensors are also helpful in detecting the heat source similar to the human body temperature. It senses only when the object is in motion. It captures the infrared rays radiated from the objects by using the array of Fresnel lens. Security lighting can be provided by using these sensors. But one of the limitations is that it is temperature sensitive.



Figure 2: Light dependent sensors(LDR)

Light sensors are used to detect light. These are passive electronic devices. Light sensors are of several types. Here, electrical output can be obtained by the light energy. Light intensity can be varied by Photoresistors or Light Dependent

Resistors(LDR) by changing the resistance. The intensity of light that falls on LDR is inversely proportional to the resistance. For increase in the illumination, there is improvement in the conductivity with low resistance. Light sensors have many applications. The amount of light in a room can be detected by using these sensors and also the brightness level can be varied to the comfortable level. Barcode scanners also make use of this light sensor technology.

### 3. LITERATURE REVIEW

Literature review is nothing but the study of the previously existing systems and also collection of the information needed to improve our task. It will be helpful to understand recent approaches, methods and also theories regarding the topic. It provides a new platform to develop our new ideas and concepts. There are several journal papers that have been published based on the smart lighting which is the hot topic in the current research. Efforts are made to improve the current approaches for the lighting system for better efficiency and low power consumption with hybrid approach.

Soyoung Hwang et al.[1] proposed a remote monitoring and controlling system which is based on zigbee networks. Real time monitoring is implemented with JMF. It is a multimedia extension API of java.

Richu Sam Alex et al.[2] proposed a system which reduces the power consumption of the street lighting system about 30% compared to conventional design. This system is fully automated. It also uses Zigbee so that control station can also analyze all the performances of the system.

Daeho Kim et al.[3] worked on smart LED lighting system by using Infrared and Ultrasonic sensors together. Here they proposed a model which continuously tracks the human motion. Output based on the human tracking data which is obtained by these sensors are responsible for determining the On-Off control of the LED lighting. Previously existing system fails in continuously monitoring the motion of an object by using each sensors separately. For the same reason, the efficiency of the existing system is low. By the hardware implementation they developed a model to improve the efficiency which helps in smart lighting. The proposed approach make use of sensors in which IR sensor sends the sensed data to the MCU board which in turn sends the same data to the LED control layer. Depending on the results of the sensed data LED control layer turns on the lighting system. Human presence is detected by IR sensor and continuous tracking is possible by the Ultrasonic (US) sensor. As before the sensed values are sent to the MCU board by US sensor which controls the On-Off of the lighting. US-IR positioning based system has to be studied in future.

B. K. Subramanyam et al.[4] have developed a model which provides smart lighting system on streets which is mainly solar based. The people work for late nights and also most of the criminal activities occur during nights. Under these situations, to provide security, controlling and monitoring of street light is developed together with GUI. Even the usage of solar panel is helpful for saving the power and money. At the PC side, graphical user interface (GUI) takes part in controlling the street light. For monitoring and controlling the lamps on streets, Zigbee technology is used. More power and energy is saved by using LDR and IS sensors. Basically this proposed model works on the two operational modes. They are Auto and Manual mode. In Auto mode On-Off of the light are done by using LDRs which measures the intensity of light. Controlling is by use of relays. In the Manual mode, the controlling and monitoring of the street lights is made successful by using the specially designed GUI and by using the Zigbee technology. This proposed system is helpful to provide the street lighting in the rural and urban areas where the traffic is low at times. This system maintains the user satisfaction and is versatile.

Raja R et al,[5] worked on the energy saving concepts. Here, smart sensor networks in DC electrical appliances like lighting, helps for monitoring of energy usage. Conventional lamps are powered by AC grid but for LED DC supply is sufficient. Dimming of light can also be achieved by using appropriate protocol helps in energy saving. Replacing the traditional lamp by LED makes 44% energy saving.

Michele Mango et al.[6] proposed a low cost, wireless, adaptable sensor based smart lighting system which makes use of PIR sensors and motion sensors. It is helpful for controlling the light intensity and power consumption using LED light. Dimming of light is achieved using PIR sensor only in presence of obstacles around. Main advantage of this system is energy conservation.

In this paper we are planning to propose a system which make use of PyroelectricInfrared (PIR) sensor, CO2 sensor & Light sensors ( LDR). The dimming of light is achieved using PIR sensor. Intensity measurement and power consumption is measured by using Light sensors. The microcontroller platform used is Arduino uno R3 at sender side and at the receiver end PIC16F877a is used. PIC microcontroller usage helps in linear programming. The intensity, CO2 emission, power consumption comparisons are displayed using LCD display. These sensors are helpful for energy saving. The usage of solar panel further help to save some more power and energy.

#### 4. CONCLUSIONS

A novel system to control LED lighting with low cost and low power wireless sensor network is to be proposed. This method requires the sensors along with zigbee which generates PWM signal to control the existing LED drivers and it reduces the power consumption of LED lighting. The

combination of CO2, PIR and light sensors allows the distributed intelligence to save energy by reducing the light intensity. It also gives the idea to make use of the renewable energy sources to conserve the energy.

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