A Smart Street Light System With Auto Fault Detection

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ABSTRACT

The trending demand of alternative sources of the energy is required to the growing demands of the people. It can be done in two ways; first one is to find alternative resource of energy and another one is by reducing the energy consumption of the present available resources. In this paper we discuss about the second one that is reduce the energy consumption. This is basically the study of streetlights with control lighting based on microcontroller. A smart street light system consists of a LED light, a brightness sensor, a motion sensor, a communication network. The lamps turn on before the vehicles come and turn off or reduce the brightness when no one is there. It will be difficult for walkers and drivers of vehicles to distinguish between smart street lamps and the conventional street lights, since street lamps all turn on before they come. Conventional street lighting systems in areas with a low frequency of vehicles are online most of the night without purpose. The result is that a large amount of energy is wasted senselessly. Public lighting in streets, tunnels, ports and squares etc. can account for about 30% of urban energy consumption. Based on environmental and economic factors, cities need smart lighting system which reduces energy consumption, maintenance cost and CO_2 emission.

INTRODUCTION

An important component of power consumption worldwide is street lighting. Global trends in street lighting show that 18-38% of the total energy bill goes towards street lighting and therefore this is one domain that needs major attention if we look at improving efficiency of power consumption with an objective of saving energy. In most cities, the street lights are installed and maintained by municipalities. Most urban and semi-urban cities and towns are still using a combination of fluorescent, CFL, high pressure sodium lamps or metal halide bulbs, which are not designed to meet area-wise lighting needs. The street lights stay on well past sunrise. This is because the lights are switched off based on a predefined time rather than lighting needs, which vary based on season and location of the city. There is a need for devising a well thought out way to prevent wastage of electricity. Thus, we can think of implementing Smart Street Light System using LDR (Light Dependent Resistor) and microcontroller which automatically switches on lights when pedestrians and vehicles come and switches off or reduce brightness when no one is there. Consider the advantages of usingLED lamps instead of a High-PressureSodium Vapour lamp (SVL). The LED offers 50-80% energy saving over SVL, has a life of over 50,000 hours – working 10 hours a day for 13 years which is more than 5-10 times the life of an SVL or mercury lamp and offers far higher

luminosity over a SVL. A switchover to LED is not only financially favourable but also environmentally beneficial.Poor maintenance of street lights is another problem faced by most citizens, leaving large areas without adequate lighting. Several times the municipalities are not informed that in a particular area the street lights are not working and citizens have to face the brunt. In order to overcome this problem, we can use a sensor and a communication network for detection of proper functioning of street lights and for sending information to the municipalities.

PROPOSED SYSTEM

Following are the components, with which our smart street light system is realised.

a) **LDR:** It is said that "On the Flintstones, a small bird sits inside the light and turns it on every night before he goes to bed". But in 21st century that small bird's duty is done by a small photo sensitive resister. Light Dependent Resister (LDR) is made up of light sensing material called Cadmium Sulphide i.e. Cds.

An LDR or light dependent resistor is also known as photo resistor, photocell and photoconductor.It is a one type of resistor whose resistance varies depending on the amount of light falling on its surface.This resistor works on the principle of photo conductivity. It is nothing but, when the light falls on its surface, then the material conductivity reduces and also the electrons in the valence band of the device are excited to the conduction band. These photons in the incident light must have energy greater than the band gap of the semiconductor material.This makes the electrons to jump from the valence band to conduction.

These devices depend on the light, when light falls on the LDR then the resistance decreases, and increases in the dark.When a LDR is kept in the dark place, its resistance is high and, when the LDR is kept in the light its resistance will decrease.

So according to problem with the classical street lights

- Are remains switched on in the presence of sunlight
- Need manual switching
- Less reliable
- Waste of huge amount of energy unnecessarily

To overcome this problem, we can connect a relay in series with all the street lights which will receive the signals from LDR where to switch the street lights on or off. By using this concept we can develop an automatic street light.

b) **MOTION DETECTOR:** all the classical street lights are remain switched on from 6pm to 6 amwhether there is a pedestrian or vehicle is present or not present of any activity. The most probable peak time of movement is from 6 pm to 10 pm in a smart city; so, after 10pm all the street lights are glowing at its full intensity which leads to loss of enormous amount of energy. So, to overcome this problemwe can install a small motion detection device with street light which will control the street light to glow at its 100% only in the presence of any movement on the street. The motion detectors that we can use are passive infrared motion sensor (PIR) or proximity sensor or photoelectric beam detector**.**

An infraredsensor is an electronic device that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion.These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. These types of radiations are invisible to our eyes but they can be detected by an infrared sensor.The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, the resistances and these output voltages, change in proportion to the magnitude of the IR light received.

An infrared sensor circuit is one of the basic and popular sensor modules in an electronic device. This sensor is analogous to human's visionary senses, which can be used to detect obstacles and it is one of the common applications in real time.

This circuit comprises of the following components

- LM358 IC 2 IR transmitter and receiver pair.
- Resistors of the range of kilo ohms.
- Variable resistors.
- LED (Light Emitting Diode).

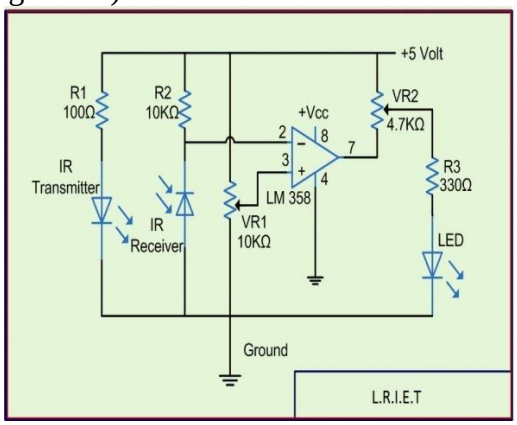

Fig.1 IR Sensor Circuit

Disadvantages of PIR

- A focusing device like Fresnel lens is required in front of its crystal material.
- Radiation from the body should pass through sensor in a horizontal fashion.
- It is unable to sense object that doesn't emits infrared radiations.

The **proximity sensor** detects the objects without any physical contact within the nominal range of its electromagnetic radiations. It senses the change in the electromagnetic field and corresponding return signal from the object. These types of sensor are of capacitive proximity sensor and inductive proximity sensor. Capacitive proximity sensors are effective for plastic and polymeric target whereas inductive proximity sensors are effective for metal targets. These types of sensors are reliable as it doesn't have mechanical physical parts. Proximity sensors are good for either vehicle movement recognition or pedestrian movements.

Photoelectric beam detector uses infrared rays that travel from source to receiver. When anobject passes through the path of that infrared radiation, the infrared radiation is covered by the object and presence of any pedestrian or vehicle is detected.

A disadvantage of this type of sensor is that it needs maintenance and calibration on a regular basis. It needs an alignment of source and receiver otherwise it doesn't work properly.

c) **ARDUINO UNO:** The Arduino UNO is ATmega328 datasheet-based microcontroller that has 6 analog inputs, 8 digital outputs and 6 PWM outputs. It has a reset button and 16 MHz ceramic resonator with an usb connection facility along with a power jack.
"Uno" implies one in Italian and is named to stamp the forthcoming arrival of Arduino 1.0. T Uno and version 1.0 will be the reference renditions of Arduino, making headway. The Uno is the most recent in a progression of USB Arduino sheets and the reference model for the Arduino stage.

Specifications:

1) Microcontroller-ATmega328
2) Operating Voltage-5V
3) Input Voltage(recommended)-7V to 12V
4) Input Voltage (limits)-6V to 20V
5) Digital I/O Pins-14 (of which 6 provide PWM output)
6) Analog Input Pins-6
7) DC Current per I/O Pin-40 mA
8) DC Current for 3.3V Pin-50 mA
9) Flash Memory-2 KB (ATmega328) of which 0.5 KB used by boot loader
10) SRAM-2 KB (ATmega328)
11) EEPROM-1 KB (ATmega328)
12) Clock Speed-16 MHz
13) Length-68.6 mm
14) Width-53.4 mm
15) Weight-25 g

Pin Diagram of Arduino UNO:

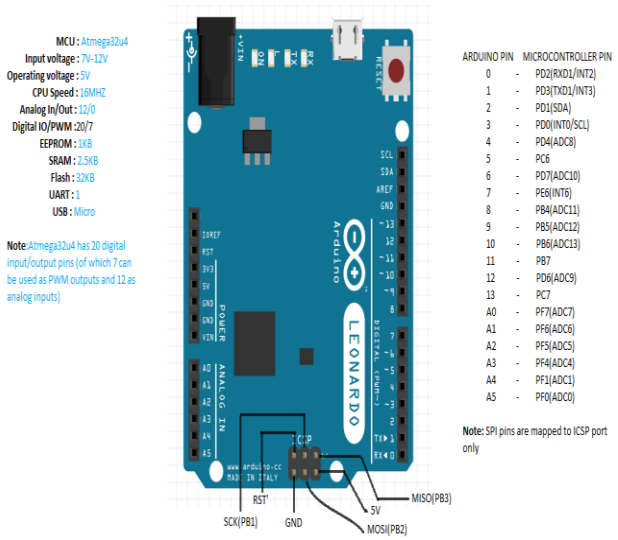

Fig.2 Pin Diagram of Arduino Uno

Physical Characteristics: The greatest length and width of the Uno PCB are 2.7 and 2.1 inches individually, with the USB connector and force jack augmenting past the previous measurement. Four screw gaps permit the board to be connected to a surface or case. Note that the separation between advanced pins 7 and 8 is 160 mil (0.16"), not an even numerous of the 100-mil dispersing of alternate pins.

USB Over current Protection: The Arduino Uno has a resettable poly-fuse that shields your PC's USB ports from shorts and over current. Albeit most PCs give their own particular inner insurance, the fuse gives an additional layer of security. In the event that more than 500 mA is connected to the USB port, the circuit will consequently break the association until the short or over-burden is uprooted.

Power: It can only work on 7-12 volts which can be possible via USB connection from the system. We can give supply to it by using a battery between Vin and GND. It also provides an IOREF pin to decide whether it should work on 5v or 3.3v.

Input and Output

- Serial: 0 (RX) pin to receive serial data.
- Serial: 1 (TX) pin to transmit serial data.
- External Interrupts: Pin 2 and 3 are used to activate interrupt command.
- PWM: 8-bit PWM outputs are provided in ~3, ~5,~6,~9,~10,~11
- LED: 13. The built-in-led shows whether Arduino is on or off. It has 6 analog input named A0,A1,A2,A3,A4,A5

d) GSM SIM 900A MODEM: GSM/GPRS Modem-RS232 is built with Dual Band GSM/GPRS engine- SIM900A, works on frequencies 900/ 1800 MHz. The Modem is

coming with RS232 interface, which allows you connect PC as well as microcontroller with RS232 Chip (MAX232). The baud rate is configurable from 9600-115200 through AT command. The GSM/GPRS Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS. It is suitable for SMS, Voice as well as DATA transfer application in M2M interface. The onboard Regulated Power supply allows you to connect wide range unregulated power supply. Using this modem,you can make audio calls, SMS, Read SMS, attend the incoming calls and internet ect through simple AT commands.

This modem can be used as a communication network. This establishes a communication between street light and controlling device. If there is a fault in street lights then this modem delivers SMS to the respective department regarding its problem.

DESIGN AND IMPLEMENTATION:

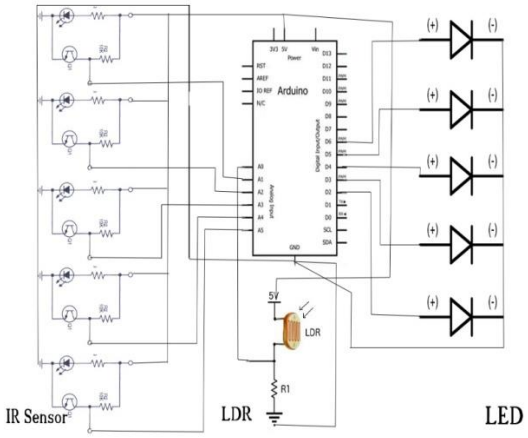

Fig.3 Circuit Diagram

Coding:

```
int led = 3;
int led1 = 10;
int led2 = 5;
int led3 = 6;
int led4 = 9;

int ldr = A0;

int ir = A1;
int ir1 = A2;
int ir2 = A3;
int ir3 = A4;
int ir4 = A5;

void setup()
```

```
{
 Serial.begin (9600);
 pinMode (led,OUTPUT);
 pinMode (led1,OUTPUT);
 pinMode (led2,OUTPUT);
 pinMode (led3,OUTPUT);
 pinMode (led4,OUTPUT);

 pinMode (ldr,INPUT);

 pinMode (ir,INPUT);
 pinMode (ir1,INPUT);
 pinMode (ir2,INPUT);
 pinMode (ir3,INPUT);
 pinMode (ir4,INPUT);

}
void loop()
{
 Serial.println(analogRead(A0));
 int ldrStatus = analogRead (ldr);
 if (ldrStatus <=300)
  {
digitalWrite(led, HIGH);
   analogWrite(led,255/5);

digitalWrite(led1, HIGH);
   analogWrite(led1,255/5);

digitalWrite(led2, HIGH);
   analogWrite(led2,255/5);

digitalWrite(led3, HIGH);
   analogWrite(led3,255/5);

digitalWrite(led4, HIGH);
   analogWrite(led4,255/5);


    if (analogRead(A1)<500)  // IR 1 CODE
     {
 digitalWrite(led,HIGH);
 analogWrite(led,255/5);
}
else
 {
```

```
      digitalWrite(led,HIGH);
delay(1000);// micro second
     }

    if (analogRead(A2)<500)  // IR 2 CODE
     {
      digitalWrite(led1,HIGH);
      analogWrite(led1,255/5);
     }
    else
     {
      digitalWrite(led1,HIGH);
delay(1000);// micro second
     }

    if (analogRead(A3)<500)  // IR 3 CODE
     {
      digitalWrite(led2,HIGH);
      analogWrite(led2,255/5);
     }
    else
     {
      digitalWrite(led2,HIGH);
delay(1000);// micro second
     }

    if (analogRead(A4)<500)  // IR 4 CODE
     {
      digitalWrite(led3,HIGH);
      analogWrite(led3,255/5);
     }
    else
     {
      digitalWrite(led3,HIGH);
delay(1000);// micro second
     }

    if (analogRead(A5)<500)  // IR 5 CODE
     {
      digitalWrite(led4,HIGH);
      analogWrite(led4,255/5);
     }
    else
     {
      digitalWrite(led4,HIGH);
delay(1000);// micro second
```

```
    }
  }
 else
  {
digitalWrite(led, LOW);
digitalWrite(led1, LOW);
digitalWrite(led2, LOW);
digitalWrite(led3, LOW);
digitalWrite(led4, LOW);
  }
}
```

CONCLUSION

This paper expounds the idea of Smart Street Light System. This elaborates that for energy efficiency, the classical street light system can be replaced by a microcontroller, motion detector and a communication network. Microcontroller is used for automatic controlling of street lights, motion detector is used for detection of movement of pedestrians and vehicles and the communication network is used for communication between the system and street light. The road lights have been effectively controlled by Arduino UNO. As the IR Sensor or detects the movement of pedestrians and vehicles, the lights turn ON in the spots of the movements.

We used LED instead of fluorescent, CFL, high pressure sodium lamps or metal halide bulb. The advantages that a smart street lighting system offers in terms of maintenance are often underestimated. For example, the ability to identify a faulty street light from a central location and to send a crew only to repair that particular street light offers huge savings in time and money over the current approach of having to dispatch maintenance crew to check all the street lights one by one over a period of time as a routine activity. This gives an operator the ability to individually control and monitor street lights in an entire locality.

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