Automatic Street Lights that Glow on Detecting Night and Object Using Arduino

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Abstract— This paper aims at designing and executing the advanced development in embedded system for energy saving of street lights. Nowadays, human have become too busy and are unable to find time even to switch off the lights wherever not necessary. The present system is like the lights are switched on in the evening and they are switched off next day in the morning. This paper gives the best solution for electrical power wastage. Also the human effort required is minimized. The paper basically uses two sensors namely LDR (Light Dependent Resistor) and the IR (Infrared) sensor; the LDR will be used to detect whether it is the day or night time and IR sensor will help in finding if the object is present or not. The Arduino Uno will act as brain to control this system which uses C programming language.

Key words: LDR, IR Sensor, Arduino Uno, Street Lights, Energy Saving

I. INTRODUCTION

For designing any new system for the streetlight that does not consume huge amount of electricity and provides sufficient light for large area is a big challenge for every engineer. An important component of power consumption worldwide is street lighting. India is no different. [1] 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. Very often, one notices that the street lights stay on well past sunrise. This is because the lights are switched off based on a pre-decided 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.

Manual control is prone to errors and leads to energy wastages and manually dimming during mid- night is impractical. Also dynamically tracking the light level is manually impractical and the current trend is automation for controlling the street lights [2]. There are various controlling methods such as design of CPLD based solar power saving system for street lights and automatic traffic control [1], design and fabrication of automatic street lights [3], automatic street light intensity and road safety module using embedded system [4], automatic street light control system [5], Intelligent street light system using GSM [6], energy consumption and saving solutions based on intelligent street

turning ON/OFF the street lights. The IR sensor will basically help in determining any movement in the area and then in the required condition help in activating the street lights. If the LDR detects it is night and also the IR sensor senses some object at the same time then the street lights become activated else they remain switched off/dim. The IR sensor will be placed along the road side and will be controlled using the Arduino Uno. If any object crosses the IR sensor particular light will be ON automatically. This will form the basic principle for the automation of street lights in any place.

The block diagram of street light system is shown in Fig. 1. The block diagram consists of Arduino, LDR, IR sensor and LEDs. By using LDR we can operate the lights i.e. when light is available the LED will be OFF and when light is not available (dark) LED will be turned ON which means that LDR is directly proportional to light.

When light falls on LDR it sends the signal to the Arduino to turn off the light and this switches of the light even if the IR sensor has high output. The IR sensor will be basically used to turn ON and DIM the lights according to the presence of the objects during the night time. All the commands from the LDR and IR sensor will be sent to Arduino and the normal function will occur depending on the signals received from the sensor.

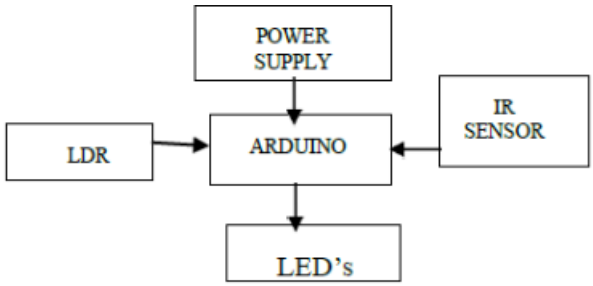

Fig. 1: Block Diagram for automatic street lights

IR sensor draws 5v from Arduino. A single LDR is used as master sensor for a number of street lights in an area eliminating the need for large number of LDR sensors hence it is cost effective.

II. MATERIALS REQUIRED

A. Light Dependent Resistor (LDR)

The LDR is acronymed for Light Decreasing Resistance, or light-dependent resistor, or photo-conductive cell [8]. When the LDR detect light its resistance will get decreased, thus if it detects darkness its resistance will increase. The LDR is a resistor as shown in Fig. 2.

greater than the band gap of the semiconductor material to make the electrons jump from the valence band to the conduction band. Hence when light having enough energy strikes on the device, more and more electrons are excited to the conduction band which results in large number of charge carriers.

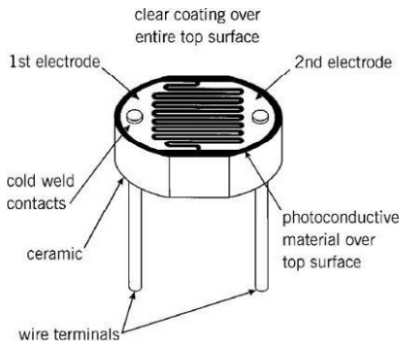

Fig. 2: Construction of LDR

The result of this process is more and more current starts flowing through the device when the circuit is closed and hence it is said that the resistance of the device has been decreased. The circuit diagram is shown in Fig. 3.

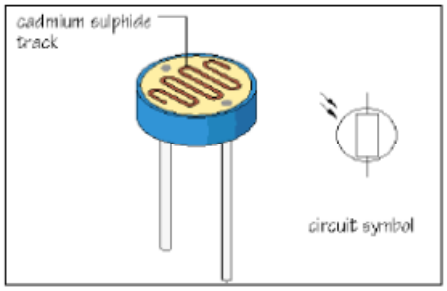

Fig. 3: LDR Circuit Symbol

LDR's are light dependent devices whose resistance is decreased when light falls on them and that is increased in the dark. When a light dependent resistor is kept in dark, its resistance is very high. This resistance is called as dark resistance. Figure below shows resistance vs. illumination curve for a particular LDR. Photocells or LDR's are non-linear devices.

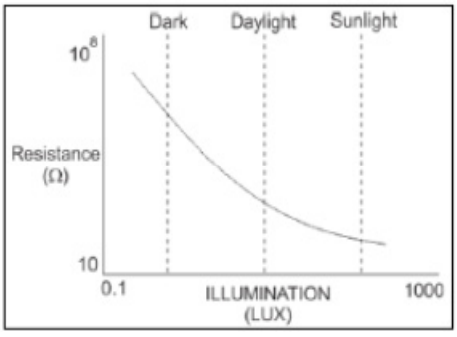

Fig. 4: Graph depicting illumination during various conditions

B. IR (Infrared) Sensor

Infrared technology addresses a wide variety of wireless applications. The main areas are sensing and remote controls. In the electromagnetic spectrum, the infrared portion is divided into three regions: near infrared region, mid infrared region and far infrared region.

The frequency range of infrared is higher than microwave and lesser than visible light. An infrared sensor emits and/or detects infrared radiation to sense its surroundings. The working of any Infrared sensor is governed by three laws: Planck's Radiation law, Stephen – Boltzmann law and Wien's Displacement law.

The basic concept of an Infrared Sensor which is used as Obstacle detector is to transmit an infrared signal, this infrared signal bounces from the surface of an object and the signal is received at the infrared receiver. Infrared sensors can be passive or active. Passive infrared sensors are basically Infrared detectors. Active infrared sensors consist of two elements: infrared source and infrared detector.

When operated at a supply of 5V, the IR transmitter consumes about 3 to 5 mA of current. The most commonly used modulation is OOK (ON – OFF – KEYING) modulation. An IR sensor consists of an IR LED and an IR Photodiode; together they are called as Photo – Coupler or Opto – Coupler. The basic principle working of IR sensor is shown in Fig. 5.

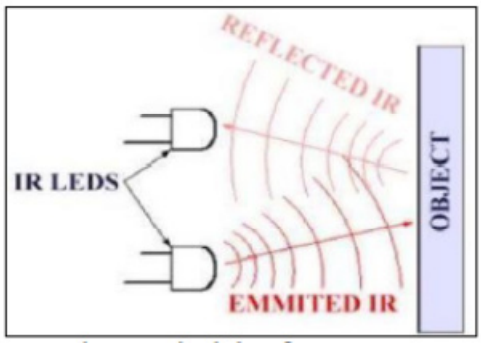

Fig. 5: Principle of IR sensor

C. Arduino Uno

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc [9]. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

Fig.6: Arduino Board

While the Uno communicates using the original STK500 protocol, it differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2

D. Light Emitting Diode (LED)

A light-emitting diode (LED) is a two-lead semiconductor light source. It is p-n junction diode that emits light when activated. The long terminal is positive and the short terminal is negative. When a suitable current is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons.

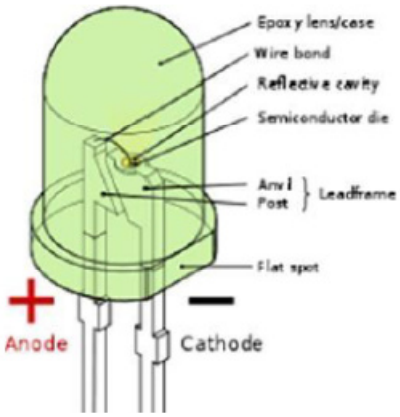

Fig.7: LED Structure

LEDs are typically small (less than 1 mm2) and integrated optical components may be used to shape the radiation pattern.LEDs are versatile semiconductor with a number of attributes which make them perfect for most applications.

III. WORKING PROCEDURE

The inputs in the streets lighting system are LDR and IR sensors, after dusk the light sensor will activate the system, to be ready to detect any object by IR sensors, on the road to turn ON the streetlights.

Whenever, LDR detects it is night time, it sends the signal to Arduino. Simultaneously, IR sensors detect the object and sends the signal to Arduino. The Arduino processes both the signals and gives the output of LEDs accordingly. The following are the possible outputs of the LEDs.

I. When it is day time, the LEDs remain turned off.

II. When it is night time and no vehicle is detected, the LEDs glow dim.

III. When it is night time, and a vehicle is detected by IR sensor, the LEDs glow with full intensity.

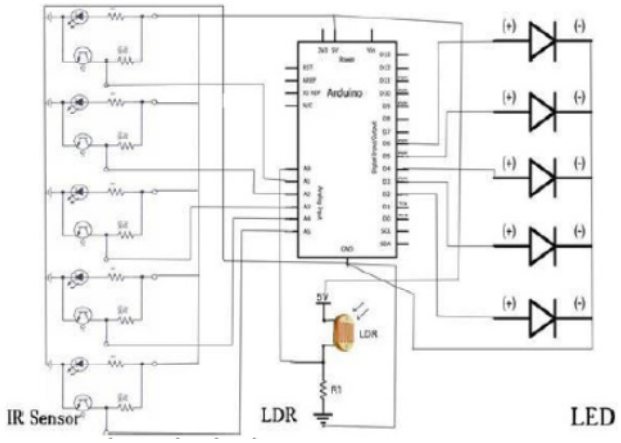

Fig.8: Circuit Diagram

The above diagram represents the circuit of the entire design. IR sensors are given as input to Arduino's analog pins A1-A5. LDR sensor output is given as input to Arduino's analog A0 pin. LEDs are connected to the PWM pins of the Arduino.

IV. RESULTS AND DISCUSSIONS

In this section, the setup of the whole research work is depicted in a step by step manner. Sample screenshots are displayed once the components are fixed and connected to each other. All the components are connected to each other and thus completes the system setup which helps one to understand the steps in a simple and easy way. With these steps, even when a person who is trying to implement the same, it makes it simple, clear and easy. The following are the screenshots in an orderly way.

Fig.9: Operation phase-1

Fig.9 depicts the operation phase-1 where the all the components are connected and it is day time. So LEDs remained turned off and no LEDs will glow.

Fig.10: Operation phase-2

Figure 10 depicts operation phase 2 where LDR detects it is night time and LEDs start to glow. Since there is no vehicle passing by, all the LEDs remain dim. i.e., glow with half intensity.

Fig.11: Operation Phase-3

In figure 11, it is evident that whenever the vehicle passes through first IR sensor, the first and second LEDs glow with full intensity and other LEDs remain dim.

V. CONCLUSION

This paper elaborates the design and construction of automatic street control system circuit. Circuit works properly to turn the street lights ON/OFF/DIM. The paper also has provided an efficient way in saving the energy of the street lights. The entire functioning of the circuit depends upon the LDR (Light Dependent Resistor) and the IR (Infrared) Sensor. If the two conditions are satisfied then the circuit will do the desired work according to specific program. Each sensor controls the ON or OFF or DIM lighting column. The street lights have been successfully controlled using the Arduino Uno. This system also need not have a specific time when the light should turn ON, all happens with the help of the sunlight intensity falling on the LDR. A single LDR signal can help to control more than one street light. With commands from the Arduino the lights will be ON in the places of the movement when it is dark. The system can be used in places such as highways, long roadways between the cities, places where there is not much human or car movement during the night and especially in villages the system can be beneficial.

ACKNOWLEDGEMENT

The experience has enabled us to use many of the theoretical ideas we had acquired into practical use. With a deep sense of credit we sincerely thank our Assistant Professor, Mrs.G.Sindhura Bharavi, Dept. of Electronics and Communication Engineering, Narayana Engineering College, Nellore for facilitating us to work in a flexible manner, giving us all the necessary support throughout the research and project work and supervising us to come up with a meaningful report. Finally, we would like to thank Head Of the Department all the staff members of the Electronics and Communication department, Narayana Engineering College, Nellore.

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