Solar Energy Optimization for Street Light Using Arduino

Vaghasiya Surbhi D¹ Trivedi Priya V² J.B.Zala³

¹²³PG Student ³Assistant Professor
³Department of electrical Engineering

Dr.Subhash Technical Campus (Junagadh), Gujarat, India

Abstract— The main aim of this project (solar energy optimization for street light using arduino) is to utilize the application of the Arduino board to control the intensity of street light. As the sun radiation decreases slowly during late-night hours, the intensity of street light gets increased progressively to save energy and so, the street lights switch on at the dusk and then switch off at the dawn, automatically. The process repeats every day. White Light Emitting Diodes (LED) replaces conventional light in street lighting system to include dimming feature. The intensity is not possible to be controlled by the conventional street light which is generally used in urban street lights. LED lights are the future of lighting, because of their low energy consumption and long life. LED lights are fast replacing conventional lights because intensity control is possible by the PWM. This proposed system uses an Arduino board and a rectified-power supply. String of LED are interfaced to the Arduino board with a MOSFET device. The intensity control of the LED light is possible by varying duty cycle from a DC source. A programmed Arduino board is engaged to provide different intensities at different times of the night using PWM technique. This project is also enhanced by integrating the LDR to follow the switching operation precisely.

Key words: Street light automation, Arduino uno, LDR, energy efficient

I. INTRODUCTION

The Street lights are the major requirements in today’s life for safety purposes and avoiding accidents during night. Providing street lighting is one of the most important and expensive responsibilities of a city. Due to busy lifestyle of humans, switching operations on streetlights are not carried out on time, and a huge amount of electricity is being wasted. In the present system it is observed that streetlights are not turned OFF even when there is ample amount of light after sun rise and are turned ON even before sunset. Lighting can account for 30-45% of the total energy bill in typical cities worldwide.

The main considerations in the field of technologies are Automation, Power consumption and cost effectiveness. Automation is intended to reduce man power with the help of intelligent systems. Power saving is the main consideration forever as the source of the power are getting diminished due to various reasons. The main objective of the project is to save electrical energy automatically used in street light by the application of power saving elements such as LDR. We want to save power automatically instead of doing manual, so it’s easy to make cost effectiveness. This saved power can be used in some other applications, such as in villages, towns and many other fields.

We can design intelligent systems by using Arduino to control intensity of street lights. The idea of designing a new system for the streetlight by using LED that do not consume huge amount of electricity and illuminate large areas with the highest intensity of light whenever required. Providing street lighting is one of the most important and expensive expenditure of electricity in a city. Street lighting is a particularly critical concern for public authorities in developing countries because of its strategic importance for economic and social stability. Inefficient lighting wastes significant financial resources every year, and poor lighting can cause accidents. Use of Energy efficient technologies can reduce cost of the street lighting drastically and also provide excellent efficiency.

By using this system manual works are removed. The street lights are automatically switched ON when the sunlight goes below the visible region of our eyes. It automatically switches OFF the street lights under illumination by sunlight.

It is a simple and powerful concept, to switch ON/OFF the street light system automatically. It automatically switches ON the streetlight when the sunlight goes below the visible region of our eyes and switches OFF the streetlight when ample amount of sunlight is available. The component used for light sensing is a Light Dependent Resistor. By using the LDR we can operate the streetlight automatically, when ample amount of light is available the streetlight will be in the OFF state and when it is dark the light will be in ON state, it means LDR resistance is inversely proportional to light falling on it.

When the light falls on the LDR it sends the commands to the control circuit that it should be in the OFF state and the streetlight turns OFF. This project exploits the working of a transistor in saturation region and cut-off region to switch ON and switch OFF. This project exploits the working of a transistor in saturation region and cut-off region to switch ON and switch OFF the lights at appropriate time with the help of an electromagnetically operated switch.

II. OBJECTIVES

The main objective is to save the electricity used in solar street light which is wastage during darkness.

Another objective of this project is to implement an auto-intensity control of LED-based on LDR which is interfaced to an Arduino board. As the surrounding light decreases slowly from evening to night, the light intensity gradually increases and then gets gradually decreased from night to early dawn hence saves energy. Thus, the lights switch on at the dusk and light intensity increases till midnight and regressively decrease till dawn and then finally switch off automatically.

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III. NEED OF THE SYSTEM

The traditional implementation and organization of street lighting system there are no possibilities for improving and development. The dynamic changes in economy, energy supplies and ecology on national, Indian and world like scale require an automatic, adequate modernization of street lighting.

However, this would be possible only with some new functional conception which means flexibility, automation, adaptability of street lighting. Simultaneous ensuring of the conditions of safe traffic and decreasing the energy consumption and operational costs could be realized in conformity with the constantly changing parameters of the environment. In conformity with the 24 hours change of daylight, the highly change in traffic, the variable weather conditions and some extreme situations on the highways, the intensity of street lighting should change in a dynamic manner.

IV. COMPONENT DESCRIPTION

A. Arduino UNO

Arduino is an open-source platform. It is used for building projects. Arduino consists of both a physical programmable circuit board and a piece of Software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

The Arduino platform has become quite popular with people just starting out with electronics and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board we can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the microcontroller into a more accessible package. The arduino UNO is latest in a series of USB arduino boards and the reference model for arduino platform.

Arduino UNO is a microcontroller board based on ATMEGA 328. It has 14 digital I/O pins of which 6 can be used as PWM outputs, 6 analog inputs, a 16 MHZ ceramic resonator, a USB connection, a power jack, ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-DC adapter or battery to get started.

B. LDR (light dependent resistor)

The LDR is a resistor, and its resistance varies according to the amount of light falling on its surface. Light dependent resistor is used to detect change in light intensity or as a light sensor. LDR is basically a variable resistor. LDR resistance changes with the change in intensity of light. If intensity of light falling on LDR is high, LDR will have low resistance. LDR are made by depositing a film of cadmium sulphide or cadmium solenoid on a substrate of ceramic containing no or very few free electrons when not illuminated. If the strip is longer the value of resistance is more. When light falls on the strip of LDR, the resistance decreases. During a day the resistance of light is in between 10K ohm to 15K ohm and is called the dark resistance.

Depending on the exposure of light the resistance can fall down to value of 500 ohms. The power ratings are usually smaller and are in the range 50mW to 0.5W. Though very sensitive to light, the switching time is very high and hence cannot be used for high frequency applications.

1) ATmega 328 microcontroller

The Atmega328 is a very popular microcontroller chip. This is produced by Atmel. It is an 8-bit microcontroller combines 32kB flash memory with read-while-write capabilities, 1kB EEPROM. 23 general purpose I/O lines, 32 general purpose working resistor, three flexible timer/counter with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6 channel 10 bit A/D converter.

The Atmega328 is microcontroller chips that are used with the popular Arduino Duemilanove boards. This Arduino board comes with either 1 of 2 microcontroller chips, the Atmega168 or the Atmega328. The Atmega328 is the upgraded and more advanced chip compare to ATmega 168. The Atmega168 which has 16K of flash program memory and 512 bytes of internal SRAM, the Atmega328 has 32K of flash program memory and 2K of Internal SRAM.
The basic construction and symbol for LDR are shown in above figures respectively. The device consists of a pair of metal film contacts separated by a snakelike track of cadmium sulphide film, designed to provide the maximum possible contact area with the two metal films. The structure is housed in a clear plastic or resin case, to provide free access to external light. Practical LDRs are available in variety of sizes and packages styles, the most popular size having a face diameter of roughly 10mm.

C. Others
We are used many components for our project such as, MOSFET, resistor, capacitor, diode, battery etc.

V. BLOCK DIAGRAM OF ARDUINO BASED SOLAR STREET LIGHT

![Block Diagram](image)

Fig. 6: block diagram

Solar panels collect solar energy from sun and convert into electricity. This energy stored in battery. Arduino receives two inputs. First is LDR and other is power supply. Arduino board fed from battery through power supply LDR gives signal to arduino board that is either a dusk or dawn. Arduino is open source hardware and it’s used for light intensity control. They give command to MOSFET according to the weather condition. MOSFET is a transistor switch is used to ON/OFF LED lights.

VI. WORKING PRINCIPLE OF HARDWARE

![Working Principle](image)

Fig. 7:

The working of our model is very simple. The supply is given through the power jack. From the Arduino we take 5v supply and connect it to one of the terminal of LDR and other end is connected to a resistor of 10k which acts as a voltage divider and then final connected to ground. The output is given by output pin 9 of the Arduino which is connected to the led through a 100 ohm resistor. The other end of LED is perfectly grounded. As this is a working porotype here, we haven’t shown the usage of relays but if required they can be connected just before the lights (LEDS) for isolation purposes.

The LDR senses the amount of light in the atmosphere at that moment of time and accordingly sends the data to is to Arduino .The Arduino converts the data received into various PWM now depending upon the PWM output waveform we adjust the output voltage accordingly from 0 to 5v. So, when complete darkness (night time) that is PWM duty cycle 100% (analog write 255) than the output is 5v as a result LED is brightest or when duty cycle 50% (analog write 127) then the output is half as a result brightness decreases. When duty cycle 0% (analog write 0) then the output is off. The usage of such kind of application in the headlights of cars, park lights, street lights is very useful.

VII. CONCLUSION

This paper elaborates the design and construction of solar energy optimization for street light using Arduino circuit. This circuit works properly to turns street light LED on/off. After design this circuit which, control the intensity of street light. LDR sensor and Arduino board are two main components working in the circuit. If the two conditions have been satisfied the circuit will do the desired work according to specific programme. The intensity of street lights has been successfully controlled by Arduino Board. Street lights are a large consumer of energy for cities using up to 30-50% of energy budget. If the installs proposed system then a lot of power can be saved. Proposed system is power saving mechanism for LED street lights by using Arduino boards. It turns out most reliable and time efficient way to switch ON/OFF street lights.

REFERENCES


