Grenze International Journal of Engineering and Technology, June Issue

Design a Smart Street Lighting Controller using Arduino UNO, LDR, and IR Sensors

Dipak Kumar Ghosh[1], Saikat Maliick[2], Shreya Ghosh[3], Samiran Jana[4] and Subhankar Dey[5]
[1]Galgotias University/Department of Electrical, Electronics and Communication Engineering, Greater Noida, India
Email: dipakkumar05.ghosh@gmail.com
[2-5]Adamas University/ Department of Mechatronics Engineering, Barasat, India

***Abstract*— Lighting up the streets consumes a significant amount of the electrical power produced in many nations. However, during some times of the day, the vehicles present on the road are quite low, and over time certain areas of the streets remain empty of vehicles. This work proposes a framework that automatically turns OFF and ON the lights when there are no vehicles and vehicles are available respectively in the streets. This approach may save a significant amount of electricity. Furthermore, it might enhance the lamp's lifespan. In general street lighting systems, unnecessary the lights are ON most of the night in the areas with a low rate of vehicles and meaninglessly wastes a large amount of power. The objective of this work is to develop a new framework for fulfills the demand of flexible lighting systems by designing a Smart Street Lighting Controller (SSLC). In the proposed system, the street lights will be automatically ON before the sun sets at the evening, and when sufficient illumination on the roads the street lights are OFF at morning time. In addition, these lights can only glow with a maximum intensity when the rate of vehicles in the region is high otherwise it should glow at a minimum intensity. In this work to control the street light system, Arduino Uno is used as the brain, whereas Infrared (IR) sensors are utilized to detect the vehicle movement and the day/night time light intensity is detected using Light Dependent Resistor (LDR) sensors.**

***Index Terms*— Smart Street Lighting Controller (SSLC), Arduino UNO, Light Dependent Resistor (LDR), Infrared (IR) sensor.**

I. INTRODUCTION

Designing an efficient and cost-effective street lighting system is an important concern for the public authorities of developing countries as it plays a pivotal role in social and economic stability. Inefficient and outdated lighting systems can waste financial resources whereas poor lighting create unsafe conditions. To address these issues, energy-efficient technologies and design mechanisms should be adopted to reduce the cost of street lighting. The manual control can be disposed to human error and may not be practical for dynamically adjusting lighting levels, especially during the night. To address these issues and make street lighting more efficient, automation and technology-driven solutions are crucial. It is possible to design a street lighting system that minimizes energy wastage, reduces errors, and provides the appropriate level of illumination in a responsive and energy-efficient manner. This not only saves on energy costs but also enhances safety and sustainability.
The conventional street lighting control system, faces several significant problems [1] such as lights are remain on

Grenze ID: 01.GIJET.10.2.532_4

at full intensity even during daylight or when sufficient natural light is available; manual switching operation and dependency on manpower; waste of energy; lack of reliability; requirement of manual adjustments during the seasonal and weather variations etc. Therefore, development of a smart street lighting control system which is well equipped with recent inventions and technology is needed. This work proposes a framework of smart street lighting control system using Arduino UNO, LDR, and IR sensors where automatically ON and OFF the street lights when it is really essential and introduces a controller circuits so that when the rate of vehicles in the region all the street lights can glow with its maximum intensity otherwise it should glow with a minimum intensity. This smart street lighting control system can save a huge amount of power.

II. Related Work

In 2017, Cynthia et al. [1] introduced an Arduino based automatic street light control utilizing vehicle detection algorithm where the vehicle moments has been sensed using Photo diodes and IR sensors and for street arrangement, LED lights are used as power saving applications. The 8051 microcontroller based control logic is developed to switch OFF lights during absence of vehicles and the vehicles rate is used to identify bright and dim mode of operation.
In 2016, Kovacs and Batai [2] explored the solar energy application for positive yearly energy balance in public lighting using realization of a street lighting sub grid. The overall system adaptive behavior is ensured by central controller and web based user interface provides smart city services to the end user. The special interest of the controller is the optimization of the system's energy management.
In 2016, Jagadeesh et al. [3] highlighted that in today's world, the continuous operation of lighting at the night time the street lights consume a large amount of electricity. The authors developed a newly concept to reduce wastage of energy in term of the electricity consumption by enabling automatic the street lights system with considering the traffic conditions in real time and naturalistic condition (full moon).
In 2016, Maluddina and Nur [4] described the storage performance of stand-alone photovoltaic system using Lithium Iron Phosphate (LiFePO4) batteries during charging and discharging. Authors were used LabVIEW Interface to monitoring Arduino (LIFA) and observed in every cycle of operation the battery undergo energy deficit approximately 10%.
In 2016, Kumara and Singhb [5] introduced a study where the demand of fossil fuel energy has replaced by solar energy for lighting the depressing and streets dark of Nigeria's Fugar city. The aim of this study was determining the best options among grid electricity, diesel generators, off- site solar photovoltaic and onsite solar photovoltaic.
In 2011, Thatsanavipasa and Ponganunchoke [6] have developed a new system wireless remote control based traffic light controller for effectively control a road junction by a traffic policeman. The Manual as well as Automatic mode are used to operate the system. In manual mode, the button corresponding to direction of the street is pressed by traffic policeman for making a green light signal. After checking the pressed button on the remote, corresponding the position and direction signals are generated by Hall effects sensor and send it to the traffic light controller board. Finally, the light sequence the traffic light is changed in automatic mode by the controller board according to the preset patterns and time delay; where using the remote the patter can be changed at any time by the traffic policeman. The system is helpful to control traffic flow dynamically in the junction for a traffic policeman.

III. Proposed System

The framework of proposed system comprises power supply, an Arduino Uno, LDR and IR sensors. The functional diagram of the proposed framework is shown in Figure 1.

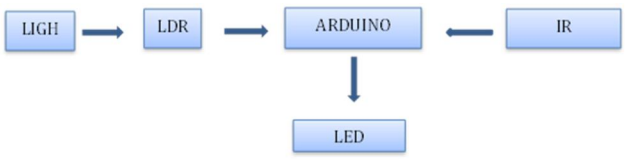

Figure 1. The functional diagram of the proposed framework

A. Light Dependent Resistor (LDR)

Light Dependent Resistors (LDRs) [9] are light-sensitive devices that exhibit a change in resistance in response to the incident light's intensity and also known as photo resistors. The LDR resistance decreases as the intensity of

light falling on them increases. In other words, they become more conductive as light levels rise. These helps to regulate the lighting of street light system according to light intensity at that instant of time.

B. Arduino UNO

Arduino [7, 8] is an ATmega32 series microcontroller board which facilitated an open-source physical platform and also provides an Integrated Development Environment for coding and uploading it to the microcontroller. The boards use USB for loading programs from personal computers. The input and output pins of Arduino are connected with sensors, switches, motors and so on for interaction with external world and acts as the processing module of the system. To be precise it has 6 analog inputs, a power jack, a 16 MHz quartz crystal, a USB connection, an ICSP header, 14 digital input/output pins (of which 6 can be used as PWM outputs), and a reset button. The operating voltage of the Arduino is 5v and input voltage range is 7 to 12v (limit up to 20v). It can take power supply with an AC-to-DC adapter or a battery or through USB also. In this work, the Arduino processes the data received from the LDR and gives the output to LEDS.

C. Software development

Any programming language with suitable compiler can be used to write the Arduino programs [8]. A development environment for their microcontrollers has provided by Atmel. The newer Atmel Studio and AVR Studio can also be used for programming Arduino. The Arduino integrated development environment (IDE) is provided by Arduino project which includes a code editor also provide the additional features like searching/replacing text, cutting/pasting text, brace matching, syntax highlighting, and automatic indentation. To compile and upload programs at an Arduino board, it also provides simple one-click mechanism which contains a text console, a series of menus, a toolbar with buttons for common functions, and a message area. A program written within the IDE for Arduino is called a "sketch" [8] which used to save the program as files with the file extension .ino at the development computer. The software library supplied by Arduino IDE provides many common input and output procedures. The Arduino IDE supports the languages C and C++ using special rules to organize code. User-written code only requires the sketch for starting and the main programs loop.

D. IR obstacle detector sensor

An obstacle detector sensor [1] having an infrared-receiver, an infrared-transmitter, and a distance adjustable potentiometer and used for object motion detection. As shown in Figure 2, the surface of an object hit by the emitted rays when it passes in front of a sensor and reflect to the receiver of the for detecting the object motion.

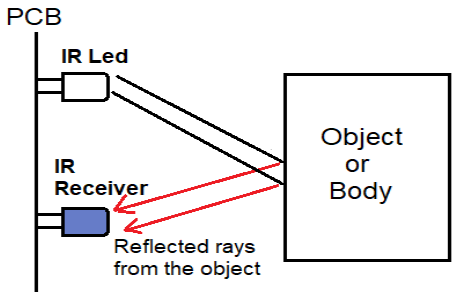

Figure 2. IR obstacle detector sensor

E. Light Emitting Diode (LED)

Light-emitting diode (LED) [9] is a semiconductor device which emits light when voltage is applied to it. They are used in many applications such as indicator lights, displays to general illumination and automotive lighting.

F. Resistors

Resistor [9] is a fundamental component in electronics, and plays a crucial role in circuit design and functionality. They are commonly used to prevent for current limiting (LEDs and sensors), voltage division, setting bias points, and various other applications where controlling the flow of current or voltage is necessary.

IV. WORKING PRINCIPLE

The overall working mechanism of the proposed framework is presented in Figure 3. First, the intensity value of sunlight will sense using LDR and send it to Arduino. The received value is judged by Arduino and assume it as

a night-time (LEDs become ON) and day-time (when LEDs keeping at OFF condition) if the received signal is lower than the threshold value and above the threshold value, respectively. Additionally in the night-time, if no object is detected by the IR obstacle detector sensor (i.e. signal is LOW) the DIM LEDs (half of its peak voltage) will glow; however HIGH LEDs (full of its peak voltage) will glow if any object is detected by IR obstacle detector sensor (i.e. signal is HIGH). The Arduino also counts the total number of vehicles with the help of IR obstacle detection sensor to the serial monitor in the night time.

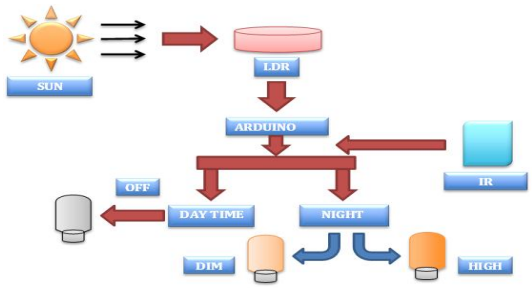

Figure 3. The working architecture of the proposed framework.

IV. Designing Methodology

The circuit design of proposed system based on Arduino Uno which comprises the vehicle detection and Dim light capability features is shown in Figure 4. In this work, 01 Arduino UNO, 03 IR obstacle detector sensors, 01 LDR sensor, 06 resistors and 06 LEDs are used. The LDR sensor is connected A0 an analog pin of Arduino and VCC pin. To identify whether it is day or night using LDR sensor, threshold value of the sensor is adjusted. After that, the pin 3, 5, 7, 8, 9 and 11 of Arduino are connected with the positive terminals of the LEDs through resistors. As shown in Figure 4, the Ground port is connected with negative terminal of the LED's. The IR sensors are connected to pin number 2, 4 and 10, respectively of the Arduino port and deliver the input signal, and whereas Arduino 5V pin is attached to all VCC of IR sensors and all IR sensors ground terminal connected to GND port. Initially, if there is no motion, the IR sensors set to HIGH at the starting time. After completing all connecting of the devices to the corresponding pins in Arduino as shown in Figure 4, the Arduino Software is downloaded and installed from the official website www.arduino.cc. Finally, with the help of the USB cable Arduino Uno is connected to the computer and the driver software is installed on the computer for writing, compiling and run the code in the platform of Arduino software.

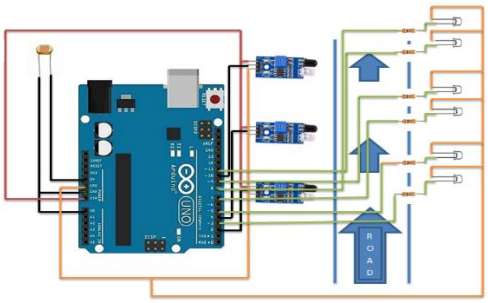

Figure 4. The circuit design of proposed system.

The specifications of electronic components which are used for system designed are given in Table 1.

Table 1: The Specification Of Electronic Components.

Components	Specifications
1. Arduino Uno	22 pins, 6-20V (operating voltage).
2. IR obstacle detector sensor	Voltage: DC 3-5V, Angle 35, Range 2-30cm.
3. LDR	Voltage: DC 3-5V, 1.8 gm, 5mm.
4. Resistors	100 ohm-220 ohm.
5. LEDs	5 mm, operating voltage 5V.

V. CONCLUSIONS

The work proposes a Smart Street Lighting Controller (SSLC) for automatic controlling the street light where Arduino Uno is used as brain, whereas Infrared (IR) sensors are used to detect the vehicles movement and light intensity of day/night time senses using Light Dependent Resistor (LDR) sensors. In the proposed framework, automatically the streets lights will be ON before the sun sets at evening and when sufficient illumination on the roads the streets lights are OFF at morning time. In addition these lights glow with maximum intensity when there having a high vehicles rate in the region otherwise it can be glow at a low intensity. The system can be helping to get free from problems of manual switching; deduce primary cost and maintenance and wastage of energy. The solar-based LED modules can be used to replace conventional LED modules for upgrading the system. This system can be applied in monitoring agriculture field, hospitals parking lights, airport, malls, universities and industries etc.

REFERENCES

[1] Cynthia P. C., Raj V. A., George S. T. 2017 Automatic street light control based on vehicle detection using Arduino for power saving applications. Int. J. Electron. Electr. Comput. Syst., 6(9): 297-295.

[2] Kovacs A., Batai R., Csaji B. C., Dudas P., Hay B., Pedona G., Revesz T., Vancza O. 2016 Intelligent control for energy-positive street lighting. Energy,114: 40-51.

[3] Jagadeesh YM, Akilesh S, Karthik S, Prasanth 2015 Intelligence street lights. Procedia Technology, 21: 547-551.

[4] Jamaluddina A, Ainia AN, Adhitamaa E, Purwantob A 2017 Assessment of LiFePO4 Battery Performance in Stand Alone Photovoltaic Street Light System. Procedia Engineering, 170: 503-508.

[5] Kumara NM, Singhb AK, Reddyc KVK 2016 Fossil Fuel to Solar Power: A Sustainable Technical Design for Street Lighting in Fugar City, Nigeria. Procedia Computer Science, 93: 956-966.

[6] Thatsanavipasa K., Ponganunchokea N., Mitathab S., Vongchumyenb C. 2011 Wireless Traffic Light Controller. Procedia Engineering, 8:190-194.

[7] Rao A., Konnur A. 2017 Street light automation system using arduino uno. Int. J. Innovative Res. Comput. Commun. Eng. 5(11):16499-16507.

[8] http://arduino.cc/en/Guide/Libraries

[9] www.electronicshub.org