

Smart Streetlight Using IR Sensors

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Abstract: Smart Street light is an automated system which automates the street. The main aim of Smart Street light is to reduce the power consumption when there are no vehicle movements on the road. The Smart street light will be turned ON when there are vehicles on the road otherwise the lights will be switched OFF. With advancement of technology, things are becoming simpler and easier for everyone in the world today. Automation is the use of control systems and information technologies to reduce the need for human work in the production of goods and services. In the scope of industrialization, automation is a step beyond mechanization, whereas mechanization provided human operators with machinery to assist the users with the muscular requirements of work, automation greatly decreases the need for human sensory and mental requirements as well. Automation plays an increasingly important role in the world economy and in daily experience. Automatic systems are being preferred over manual system. The research work shows automatic control of streetlights as a result of which power is saved to an extent. The Smart street light provides a solution for energy saving which is achieved by sensing an approaching vehicle using the IR sensors and then switching ON a block of street lights ahead of the vehicle. As the vehicle passes by, the trailing lights switch OFF automatically. Thus, we save a lot of energy. So when there are no vehicles on the highway, then all the lights remain OFF.

Keywords: Arduino Uno R3, HID (High Intensity Discharge Lamps), IR (Infrared) motion sensor, LDR (Light Dependent Resistor), LEDs (Light Emitting Diode), PIR (Passive infrared) motion sensor, Resistor, WSN(Wireless Sensor Network)

I. Introduction

Automation plays an increasingly important role in the world economy and in daily life. Automatic systems are being preferred over manual system. The research work shows automatic control of streetlights as a result of which power is saved to some extent.

In the scope of industrialization, automation is a step beyond mechanization^[1]. Whereas mechanization provided human operators with machinery to assist the users with muscular requirements of work, automation greatly decreases the need for human sensory and mental requirements as well.

Basically, street lighting is one of the important parts. Therefore, the street lamps are relatively simple but with the development of urbanization, the number of streets increases rapidly with high traffic density. There are several factors need to be considered in order to design a good street lighting system such as night-time safety for community members and road users, provide public lighting at cost effective, the reduction of crime and minimizing its effect on the environment. At the beginning, street lamps were controlled by manual control where a control switch is set in each of the street lamps which is called the first generation of the original street light. After that, another method that has been used was optical control method done using high pressure sodium lamp in their system. Nowadays, it is seen that the method is widely used in the country. The method operates by setting up an optical control circuit, change the resistance by using of light sensitive device to control street lamps light up automatically at dusk and turn off automatically after dawn in the morning. Due to the technological development nowadays, road lighting can be categorized according to the installation area and performance, for an example, lighting for traffic routes, lighting for subsidiary roads and lighting for urban center and public amenity areas. The WSN helps in improving the network sensing for street lighting.

Meanwhile, street light system can be classified according to the type of lamps used such as incandescent light, mercury vapor light, metal halide light, high pressure sodium light, low pressure sodium light, fluorescent light, compact fluorescent light, induction light and LED light. Different types of light technology used in lighting design with their luminous efficiency, lamp service life and their considerations.

The LED is considered a promising solution to modern street lighting system due to its behavior and advantages. Apart from that, the advantages of LED are likely to replace the traditional street lamps such as the incandescent lamp, fluorescent lamp and High Pressure Sodium Lamp in future but LED technology is an extremely difficult process that requires a combination of advanced production lines, top quality materials and high-precision manufacturing process. Therefore, the research work highlights the energy efficient system of the street lights system using LED lamps with IR sensor interface for controlling and managing

II. Literature Survey

S.Suganya et al [2] have proposed about Street Light Glow on detecting vehicle movement using sensor isa system that utilizes the latest technology for sources of light as LED lamps. It is also used to control the switching of street light automatically according to the light intensity to develop flow based dynamic control statistics using infrared detection technology and maintain wireless communication among lamppost and control terminal using ZigBee Wireless protocol. It also combines various technologies: a timer, a statistics of traffic flow magnitude, photodiodes, LED, power transistors.

K.Santha et al [3] have surveyed on Street Lighting System Based on Vehicle Movements. The system operates in the automatic mode which regulates the streetlight according to brightness and dimness algorithm and light intensity. The control can be made according to the seasonal variation. It includes a time cut-out function and an automatic control pattern for conserving more electricity. The whole project was implemented using a PIC microcontroller.

Srikanth et al [4] proposed a ZigBee based Remote Control Automatic Street Light System. The system is designed with the help of ZigBee modules that helps in detecting the faulty lights and control the light. It also discusses about an intelligent system that takes automatic decisions for ON/OFF/DIMMING considering the vehicle movement or pedestrian and also the surrounding environment. PIR motion sensor is used to detect movement of both living and non-living things.

M.Abhishek et al [5] have implemented design of traffic flow based street light control system with effective utilization of solar energy in the year 2015. They used the renewable source of energy i.e. the solar power for street lighting. They have also used 8052 series microcontroller and is developed by replacing the normal bulbs with the LEDs due to which the power consumption is reduced by 3 times. Sensors are placed on either side of the road which senses the vehicle movement and sends the commands to the microcontroller to switch ON and OFF the lights. Here all the street lights remain switched off and it glows only when it senses the vehicle movement. Hence, because of the microcontroller, even when its night the lights are switched off.

C.Bhuvaneshwari et al [6] have analyzed the street light with auto tracking system by which one can increase the conversion efficiency of the solar power generation. Here, the sun tracking sensor is the sensing device which senses the position of the sun time to time and gives the output to the amplifier based on light density of the sun. Sun tracking sensor is LDR, amplifier unit is used to amplify the LDR signals which converts low level signals to high level signals and the output is given to comparator. The LM324 IC is used as an amplifier. Comparator compares the signals and gives the command to AT89C51 microcontroller.

Steve Chadwick [7] reports on the two installation case studied in Scotland and Wales and explains the details and benefits of the technology. The system was called as MINOS that had a track record of over 100,000 units installed and working successfully.

SomchaiHiranvarodom [8] describes a comparative analysis of photovoltaic (PV) street lighting system in three different lamps. Namely, a low pressure sodium lamp, a high pressure sodium lamp and a fluorescent lamp have been used for installation in each mast to determine the suitable system to install in a typical rural area of Thailand. All three systems have been mounted with the same module type and wattage in different places within the Rajamangala Institute of Technology, Thanyaburi district, Pathumthani province of Thailand. An operation of solar street lighting system can be divided into 2 period of time, namely, at 18.00-22.00 hours and 05.00-06.00 hours. The design of a control circuit was experimentally done in this work. The aim of this work is to determine the appropriate system to install in a typical rural area or a typical rural village of Thailand.

RadhiPriyasree [9] explains a system to reduce the power consumption of street lights by avoiding inefficient lighting which wastes significant financial resources each year. This is done by dimming the lights during less traffic hours. For this purpose PIR sensor is used which detects any movement. This work also aims at reducing the fatal crashes and road accidents caused due to alcohol consumption. This is done using skin sensors placed in vehicle doors and also using breadth sensors inside the vehicle. By implementing this death rates due to drunk driving can be reduced to a great extent. The prototype has been implemented and works as expected and will prove to be very useful and will fulfill all the present constraints if implemented on a large scale. It also aims at detecting consumption of alcohol by the driver and if it exceeds certain level it impairs the driver from entering into the Vehicle. This prevents occurrence of accidents or any fatal crashes. This initiative will help the government to save this energy and meet the domestic and industrial needs.

From this literature survey, the methods each one has implemented and used is simple and easy to understand. These papers and journals has given many ideas to further implement a much efficient system and make things automated. The presentations are simple and clean with all the necessary information needed for a basic learner or reader.

III. Methodology

The Smart street light control system adopts a dynamic control methodology. According to the proposed plan, initially when it becomes dark, all the street lights automatically glow for a few seconds and switches off. But throughout the night, only one streetlights remains switched on for security concerns. When a vehicle passes by, a block of street lights glows and as the vehicle moves forward, the next block of lights starts glowing where the previous block switches off.

3.1 Existing System

Industry of street lighting systems are growing rapidly and going to complex with rapid growth of industry and cities. Automation, Power consumption and Cost Effectiveness are the important considerations in the present field of electronics and electrical related technologies. To control and maintain complex street lighting system more economically, various street light control systems are developed. These systems are developed to control and reduce energy consumption of a town's public lighting system using different technologies. The existing work is done using HID lamps. Currently, the HID is used for urban street light based on principle of gas discharge, thus the intensity is not controlled by any voltage reduction method as the discharge path is broken.

HID lamps^[10] are a type of electrical gas discharge lamp which produces light by means of an electric arc between tungsten electrodes housed inside a translucent or transparent fused quartz or fused alumina arc tube. This tube is filled with both gas and metal salts. The gas facilitates the arc's initial strike. Once the arc is started, it heats and evaporates the metal salts forming plasma, which greatly increases the intensity of light produced by the arc and reduces its power consumption. High-intensity discharge lamps are a type of arc lamp.

Disadvantages of Existing System:

- HID lamps consume more power.
- The life time of the HID lamps is very less.
- It cannot be used in all outdoor applications.
- Brightness of the lights in the rear view mirrors which causes a problem for drivers in front of your vehicle.

3.2 Proposed System

Since the HID lamps are not cost effective and not reliable, smart street light system has overcome by replacing the HID lamps with LED. Due to automation, power consumption and cost effectiveness in the present field of electronics and electrical related technologies, industry of street lighting systems are growing rapidly and going to complex with rapid growth of industry and cities.

To control and maintain complex street lighting system more economically, various street light control systems are developed. These systems are developed to control and reduce energy consumption of a town's public lighting system using different technologies which uses IR motion sensors to detect the vehicle movement after which the street light begins to glow. As the vehicle moves, the street light that was glowing switches off and the following lights begins to glow.

a) Arduino Uno R3

Arduino Uno R3^[11] specifications are ATmega328 microcontroller, operating voltage at 5v, input voltage 7 to 12v, input voltage limit up to 20v, digital I/O pins 14, analog pins 6, DC current 40mA, flash memory 32KB including 0.5KB used by boot loader. SRAM of 2KB, EEPROM of 1KB and clock speed of 16 MHz some of the Features of Arduino UNO are power: can be USB connection or external power supply, with 7 to 12 volts recommended. The Arduino UNO provides power pins for other devices, the variants are 5v 3.3v and vin IOREF pin for optional power.

Arduino Uno is a 2KB of SRAM and 1KB of EEPROM (Electrically Erasable Programmable Read Only Memory). There are various input and output pins where 14 of them are digital pins with serial transfer and external interrupts and PWM (Pulse Width Modulation) pins and 6 analog pins. Arduino differs from all the preceding boards which does not use the FTDI USB-to-serial driver chip.

b) Infrared sensor

An infrared sensor^[12] 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 that can be detected by an infrared sensor. The emitter is simply an IR LED 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.

IV. Working Procedure

The working procedure of the Smart street light using IR sensors is explained below. The following are the different steps included in building a Smart street light.

1. LDR pin 1 is connected to A0 (analog) port of Arduino Uno board.
2. Connect all the IR sensors to port numbers 2, 3, 4, 5 and 6 respectively (digital) which is the input signal to the Arduino board.
3. Connect the ground of all the sensors to GND port.
4. The LED's which are the output signals, are connected to port number 8, 9, 10, 11 and 12 respectively.
5. Again connect the ground of all the sensors to GND port.
6. Power is passed to the Arduino (7-12V)

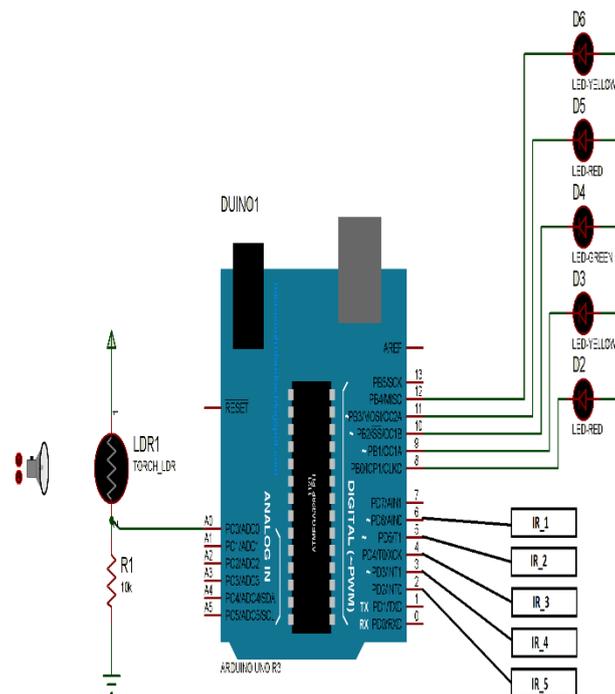


Fig. 4.1. Block diagram for Smart street light using IR sensors

The Fig.4.1 is the block diagram of the Smart streetlight. It works in accordance with the varying sunlight. Whenever there is sufficient sunlight in surroundings, LDR exhibits high resistance and acts as an insulator, while in darkness this LDR behaves as low resistance path and allows the flows of electricity, this LDR's operates with the help of IR sensors, these sensors are activated under low illumination conditions and these are controlled by an AT89C51 micro controller, every basic electronic circuit will operate under regulated 5v DC, so need to step down the 230v AC into 12v AC by means of an step down transformer, this 12v AC is to converted into 5v DC by using an bridge rectifier, and the controlled output from the voltage regulator is sent to the operational kit.

The heart of Arduino circuit is the low power, high performance Arduino micro controller is programmed by embedded assembly programming language for implementing these tasks; this program is stored and operated by means of storage device EPROM, while coming to the functional block i.e. LDR, these LDR's are in expensive, smaller in size, less complexity, highly reliable, low power applications, minimum risk with greater accuracy. The project is successfully implemented in many areas based on the experimental verification proving that it can save the electrical power to greater extent removing the manual work completely; the system became the origin for upcoming advanced intelligent systems in saving both human and electrical power.

V. Results And Discussion

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:

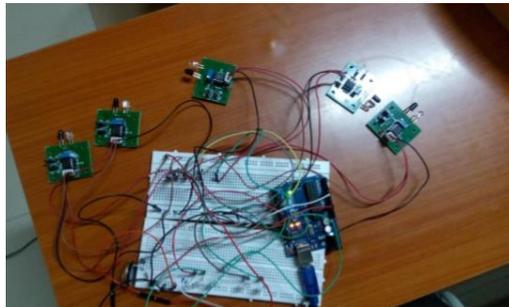


Fig. 5.1 Initial Setup Phase 1

The Fig 5.1 depicts the initial setup of the hardware. All the components are in accordance to every other component. The five IR sensors are placed next to each other. The Arduino board is connected to the external power supply for the flow of current. All the five IR sensors are connected to the Arduino board. The resistor is placed on the bread board to control the flow of current.

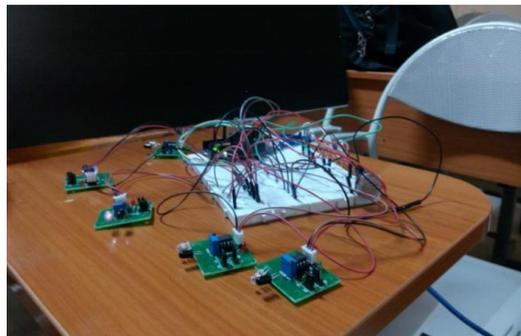


Fig. 5.2 Initial Setup Phase 2

The Fig 5.2 depicts the second phase where all the LED's glow immediately for few seconds and then switches off. It glows on as soon as it becomes dark. Except the first LED, all the other LEDs are switched off. The first streetlight is always switched on for security purposes.

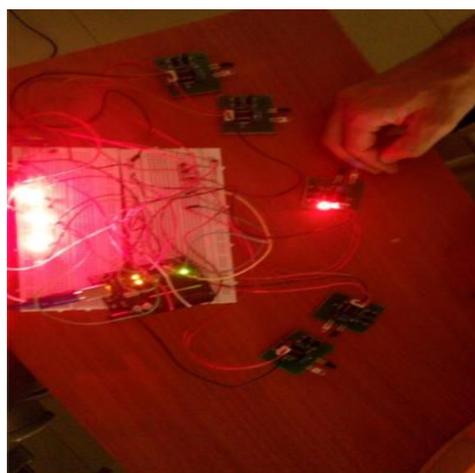


Fig. 5.3 Object detection

The Fig 5.3 depicts the vehicle movement or object movement. As shown in the fig, the third streetlight is switched on as it detected the object. Immediately, as the vehicle passes by, these lights are switched off and the next block of lights are switched on.

VI. Conclusion

By using Smart Street light, one can save surplus amount of energy which is done by replacing sodium vapor lamps by LED and adding an additional feature for security purposes. It prevents unnecessary wastage of electricity, caused due to manual switching of streetlights when it's not required. It provides an efficient and smart automatic streetlight control system with the help of IR sensors. It can reduce the energy consumption and maintains the cost. The system is versatile, extendable and totally adjustable to user needs.

- The system is now used only for one way traffic in highways.
- Continuous use of LDR and IR sensors even in day time.
- Not switched on before the sunset

The Smart light system can be further extended to make the current system in two-way traffic, making the system more flexible in case of rainy days and introduction of ways to control the lights through GSM based service.

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