ARDUINO BASED INTELLIGENT STREET LIGHT SYSTEM

A minor project report,

submitted in partial fulfillment of the requirement for the award of
B.Tech. degree in Computer Science and Engineering

by

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CANDIDATES DECLARATION

We hereby certify that the work, which is being presented in the report, entitled **ARDUINO BASED INTELLIGENT STREET LIGHT SYSTEM**, in partial fulfillment of the requirement for the award of the Degree of **Bachelor of Technology** and submitted to the institution is an authentic record of our own work carried out during the period *May 2019* to *July 2019* under the supervision of **Dr. Anuraj Singh** and **Dr. Saumya Bhadauria**. We have also cited the references about the table(s)/figure(s)/text(s) from where they have been taken.

Date: Signatures of the Candidates

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Dr. Anuraj Singh **Dr. Saumya Bhadauria**

Date: Signatures of the Research Supervisors

ABSTRACT

Arduino based intelligent street light is a system whose purpose is to automate the street lights. Our approach is based on detection of brightness of light in environment and detection of obstacle in proximity. The lights remain off when there is sufficient sunlight in the environment. When it is dark, the lights turn on only when there is someone present on the street. If no one is present on the street, the street lights remain off, by default. The proposed system uses IR(infrared) Proximity sensors to detect presence of objects and LDR(Light Dependent Resistor) to detect intensity of light in environment. Arduino controls the automatic switching of street lights depending upon various scenarios. The goal of the proposed system is to reduce the amount of electricity consumed. This is accomplished by switching on the lights only when the need arises. The proposed system works in 3 different modes: counter mode, timer mode and hybrid mode. In counter mode, the street lights are controlled by counting the number of vehicles detected by the sensors. In timer mode, the street lights are controlled based on a predetermined time period. The lights glow during this time period. Hybrid mode combines the features of counter mode and timer mode.

Keywords: Arduino Uno, Obstacle Detection, Light Intensity Detection and Energy Saving

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(Sandarbh Yadav) (Vaibhav Garg)

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ABBREVIATIONS

CdS	Cadmium Sulphide
DC	Direct Current
EPROM	Erasable Programmable ROM(Read Only Memory)
GND	Ground
IDE	Integrated Development Environment
IR	Infrared
I/O	Input/Output
LDR	Light Dependent Resistor
LED	Light Emitting Diode
MHz	Megahertz
PIR	Passive Infrared
PWM	Pulse Width Modulation
SRAM	Static RAM(Random Access Memory)
USB	Universal Serial Bus
VCC	Voltage at the Common Collector

CHAPTER 1

Introduction

Automation is playing a very important role nowadays as humans are getting busier than ever. Automation is one step ahead of mechanization, which requires manual operators and muscular effort. Automated systems are being preferred over manual systems everywhere. From ceiling fans to washing machines, everything is gradually becoming automated. Oditis et al [1] discusses the automated process control. Street lights are present on every major roadways and on small streets also.The proposed system aims to automate the street lights.

In currently existing street light systems , the lights are switched on when there is darkness and are switched off when there is brightness. In some places, this turning off and on of street lights is done manually. A human operator turns on the lights when it becomes dark and then turns off the lights when there is suuficient amount of sunlight in environment. Manual street lights have many disadvantages : high power consumption, less reliability and hectic operation, especially in case of midnight or season/weather change. An improvement over manual systems are street lights that are operated automatically. They use optical methods based on light detection sensors.

In above systems, the lights glow whole night even though there is no one nearby. An enormous amount of electricity is wasted in cities and towns all around the world. Arduino based intelligent street light provides a solution to this situation. These intelligent street lights, by default, remain off in the night and turn on as soon an object is detected in nearby area. Consequently, this system not only removes the need of hectic manual operation but also saves a lot of energy as well as money.

1.1 Motivation

The motivation for the proposed system came by observing the situation of lights in our campus and outside campus. In our campus, the lights remain on whole night even if there is no one nearby. Also outside campus, the street lights glow all night even though there is very minimal traffic density during specific time periods in night. Not only outside our campus but in most areas, there is very minimal traffic density in night. Figure 1.1 depicts this situation. It leads to wastage of a lot of electrical energy in an era where everyone is focusing on conserving energy. So, we thought of saving electricity by automating the street lights using obstacle detection methodology.

Figure 1.1: Lights keep glowing whole night even though there is no one nearby.

1.2 Problem Statement Formulation

There are many limitations associated with classical street light systems. Some street light systems require manual switching operation. Even in optically controlled street lights, the lights remain on even when there is no one present on street. There is significant amount of power consumption and wastage of electricity. Reliability of these systems is quite less. These systems are vulnerable to seasonal and climatic change. In order to overcome above mentioned limitations, there is ardent need of automatic street lights.

1.3 Objectives

The major objectives of this project are:

1. Automate the street lights : The current street light systems are either manually operated or are optically controlled but they have a lot of disadvantages. Using light intensity detection ensures doing away with hectic manual operation. By integrating obstacle detection, a lot of unnecessary power consumption is minimized.

2. Developing a cost effective eco-friendly system : The proposed system saves an enormous amount of electricity. It also limits the unnecessary monetary expenditure on electricity bills. Also lifetime of street lights is enhanced as they are used in an efficient manner.

1.4 Report Layout

The report is broadly divided into 7 chapters. Chapter 1 provides introduction to the project. It also discusses motivation for project, problem statement formulation and objectives of the project. Chapter 2 discusses the literature survey done for the project. Requirement analysis and specification is the content of chapter 3. System design, project description and methodology form the content of chapter 4. It also includes circuit diagram and working of the project. Chapter 5 comprises of results along with appropriate bar graphs. Chapter 6 includes snapshots of the project along with descriptions. Conclusion and future work is discussed in Chapter 7. References are given in the end.

CHAPTER 2

Literature Survey

The currently existing street light systems either use manual operation or optical methods to control the switching of lights. However, a lot of electricity is wasted in these classical street light systems. A good approach would be to integrate object detection methodology to reduce the unnecessary wastage of power. Kumaar et al [2] , Tan et al [3] , Akinyemi et al [4] and Mainardi et al [5] provide details on implementation of smart lightning systems in houses. These research papers deal with the integration of presence detection mehodology to control lights in houses. Popa et al [6] discusses various energy saving solutions for street light systems. Sheela et al [7] and Jalan [8] provide surveys on various lightning systems. Escolar et al [9] estimated the energy savings in smart street light systems and the results are provided. Cho et al [10] , Saad et al [11] and Wu et al [12] provide basic details on currently existing intelligent street lights. All these research papers provide great insight into the classic street light systems and emphasize on the ardent need of an intelligent street light system which minimizes the wastage of electricity.

CHAPTER 3

Requirement Analysis and Specification

In order to achieve the objectives of the project, the following hardware components are used :

3.1 Arduino Uno

It is a ATmega328 based micro-controller board. It consists of 6 analog inputs. It also contains fourteen digital pins which might serve as output or input. 6 out of these 14 digital pins serve as PWM (Pulse Width Modulation) outputs. A resonator of 16 MHz, reset button, USB connection and power jack is also provided. The Uno is connected with computer through a USB cable. Luois [13] discusses the working of Arduino. Arduino Uno (with its USB cable) is depicted in Figure 3.1.

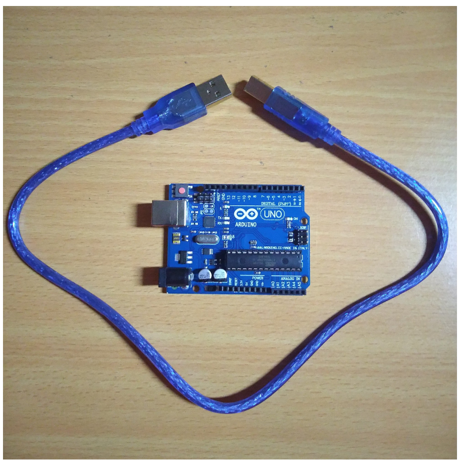

Figure 3.1: Arduino Uno

EEPROM	1 Kilo Byte
Flash Memory	32 Kilo Byte
SRAM	2 Kilo Byte
Direct Current per 3.3 V pin	50 mA
Direct Current per I/O pin	40 mA
Input Voltage	7 to 12 V
Operating Voltage	5 V

3.2 Infrared(IR) Proximity Sensor

IR Proximity Sensors detect objects in front of it. It transmits infrared radiation and whenever an object comes in its proximity, it is detected. For detection of objects in front, the reflected light coming from the object is monitored. Figure 3.2 shows typical IR proximity sensors.

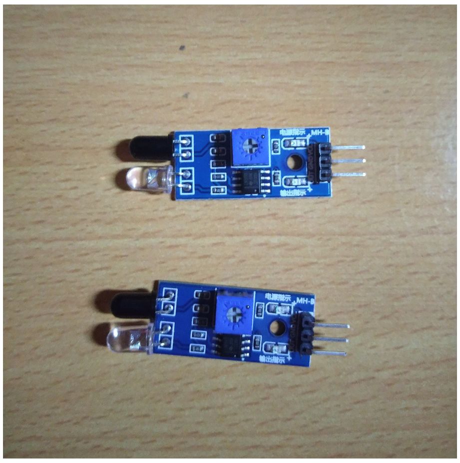

Figure 3.2: IR Proximity Sensor

Passive Infrared (PIR) sensors could also have been used so as to reduce power consumption even more but they suffer from many disadvantages. Fresnel Lens (a focusing device) is needed in front of crystal material. Also, the PIR sensors cannot sense bodies which do not emit IR radiations. Moreover, the IR radiation coming from the object should pass through sensor horizontally.

IR proximity sensors are best for detecting vehicular movements and pedestrian movements. Hence, we have used them.

3.3 Light Dependent Resistor(LDR)

LDR has a variable resistance. Resistance is higher in darkness while it is low in case of bright light. For this reason they are used in light sensing circuits. Figure 3.3 shows LDRs.

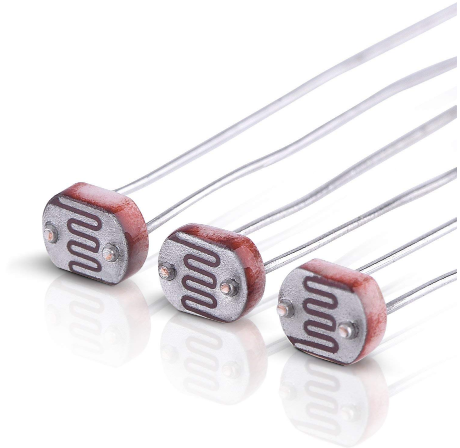

Figure 3.3: Light Dependent Resistor

3.4 Light Emitting Diode(LED)

LEDs are devices that convert electrical energy into light. They are p-n junction diode. On applying a suitable voltage, the electrons are recombined with the holes and photons are released. This leads to emission of light. Figure 3.4 shows LEDs.

Figure 3.4: Light Emitting Diode

3.5 Breadboard

This device is used for making temporary prototypes of electronic circuits. It doesn't require soldering. Appropriate connections are made by using jumper wires. Figure 3.5 shows a typical Breadboard.

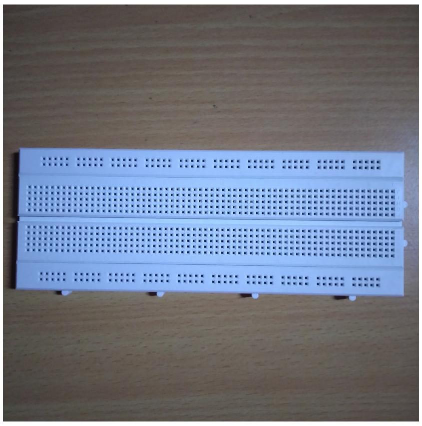

Figure 3.5: Breadboard

3.6 Jumper Wires

Jumper wires are electrical wires which have either connector or pins on their ends. They connect 2 points to each other. The need of soldering is eliminated. They are generally used along with breadboards so that it becomes easy to change a circuit according to needs. Figure 3.6 shows Jumper Wires.

Figure 3.6: Jumper Wires

CHAPTER 4

System Design, Project Description and Methodology

This chapter discusses the system design, circuit diagram, project description, methodology and working of the proposed system.

4.1 System Design

LDR provides output on the basis of amount of sunlight present in the environment. The IR proximity sensors provide output on the basis of IR radiation reflected from the obstacle. The outputs of LDR and IR proximity sensors serve as input to the Arduino Uno. Power supply is provided using power jack. Programming is done on Arduino IDE(Integrated Development Environment) using the embedded programming language. The program is stored in EPROM(Erasable Programmable Read Only Memory) of Arduino and is operated from there. Figure 4.1 gives a basic overview of system design of proposed system.

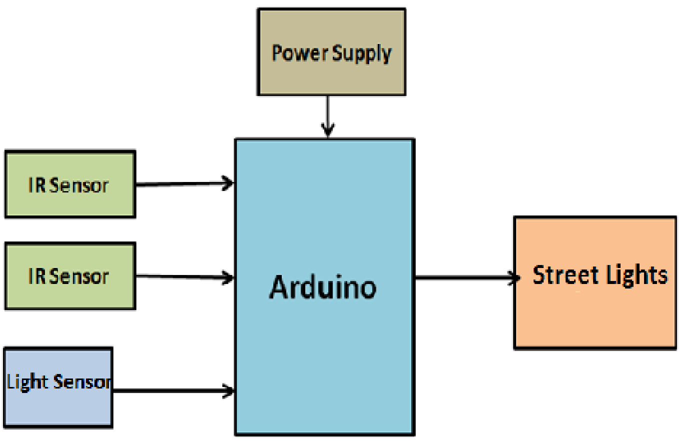

Figure 4.1: System Design

4.2 Circuit Diagram

The proposed system consists of Arduino Uno, 1 LDR sensor, 5 IR proximity sensors, 4 LEDs and power supply.

One LDR output pin is linked to 5 V port of the Arduino Uno. Other output pin is linked to A0 port. The negative terminals of LEDs are connected to GND port and positive terminals are inserted into ports numbered 5, 6, 9, and 10. The output of proximity sensors is linked to ports labeled A1, A2, A3, A4 and A5. GND port of Arduino takes in the ground of IR sensors. VCC port of proximity sensors is linked to 5 V port of Arduino.

All the connections are made using jumper wires and breadboard. Program is loaded using USB connection. Finally, power is passed through power jack. The circuit diagram is given in Figure 4.2

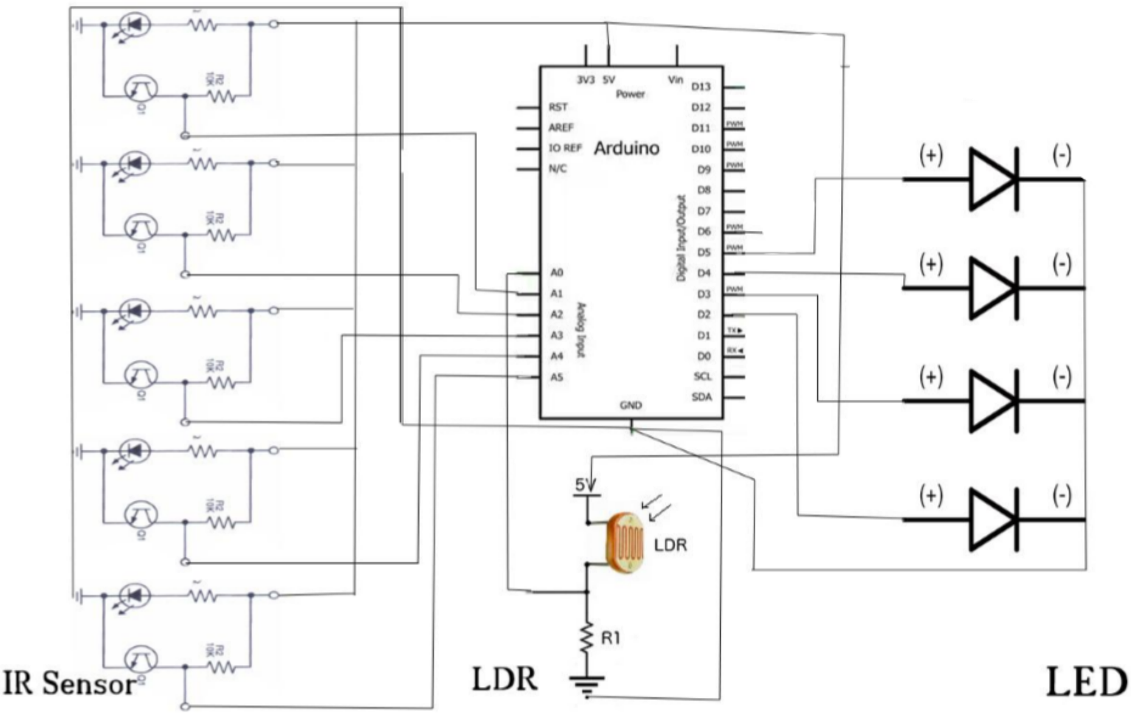

Figure 4.2: Circuit Diagram

4.3 Project Description

The intelligent street light system is implemented using 5 IR proximity sensors and 4 LED lights (2 more for other purposes). The proposed system works in 3 different modes : counter mode, timer mode and hybrid mode.

4.3.1 Counter Mode

In counter mode, the street lights are controlled by counting the number of vehicles detected by the sensors. In the program, appropriate counter variables are maintained which are incremented when an object arrives and are decremented when an object departs. Depending upon the values of the counter variables, the associated street lights are turned on and off. This mode is helpful in low traffic areas.

4.3.2 Timer Mode

In timer mode, the street lights are controlled based on a predetermined time period. The minimum speed of a vehicle is estimated and using the length of path a maximum limit of time period is determined. Whenever an obstacle is detected by a proximity sensor, the associated light is turned on for the predetermined time period. This mode is very helpful in case of highways and expressways where the vehicles generally maintain high velocity.

4.3.3 Hybrid Mode

Hybrid mode combines the features of counter mode and timer mode. A predetermined time period and counter variables are used to control the switching of street lights. This mode can be implemented on normal streets.

4.4 Methodology

The proposed system is based on the following major principles :

4.4.1 Light Intensity Detection

LDR serves the purpose of light intensity detection. Cadmium Sulphide (CdS) is a light sensing material and it is used for making LDR. LDR is basically a CdS photo-resistor. The resistance rises to about 1 mega-ohm in absence of sunlight and drops to about 5 kilo-ohm in presence of sunlight. In darkness, conduction of electricity is very poor because of high resistance. When there is sufficient amount of light, resistance is low and hence conductivity is high.

4.4.2 Obstacle Detection

IR Proximity Sensors have been used to detect obstacles. Initially, the IR sensors are in LOW position. The sensors keep on emitting IR radiation. For detection of obstacles, the reflected light coming from the object is monitored. When an obstacle comes in their proximity, it is detected via reflection of IR radiation and IR sensors switch to HIGH position. Figure 4.3 shows how the IR proximity sensors work.

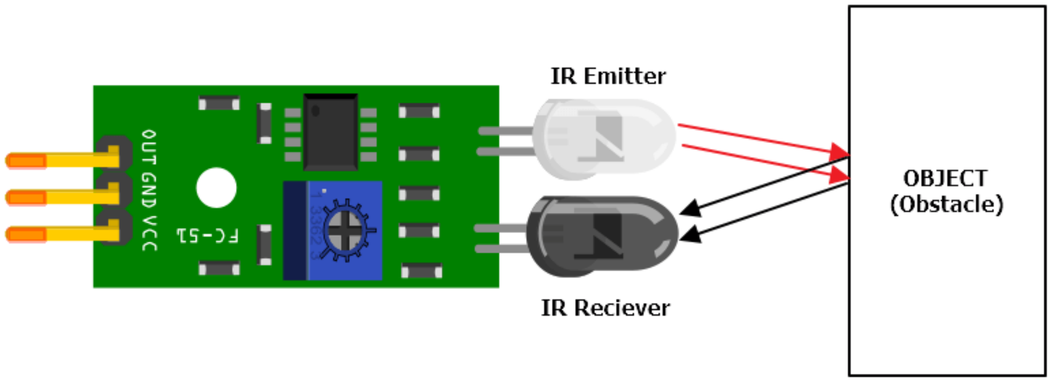

Figure 4.3: Obstacle Detection using IR proximity sensor

4.5 Working

Intelligent street lights work according to the intensity of sunlight in environment. When it is dark, the LDR's resistance is HIGH and it behaves as insulator. When the amount of sunlight in environment is sufficient, the resistance of LDR is LOW and allows flow of electricity. The LDR works in coordination with the IR proximity sensors. In low illumination scenarios, these proximity sensors are activated. Initially the IR sensors are in LOW position. When an object comes within the range of proximity sensors, it is detected through reflection of IR radiation. Whenever an obstacle comes in proximity of IR sensors, they switch to HIGH position. The output of IR sensors is passed to Arduino Uno.

The Arduino microcontroller is programmed through Arduino IDE using embedded programming language. The program is stored in EPROM of Arduino and is operated from there itself. This program uses the inputs from LDR and IR sensors to automatically turn on and off the street lights(here LEDs) according to suitable scenarios.

CHAPTER 5

Results

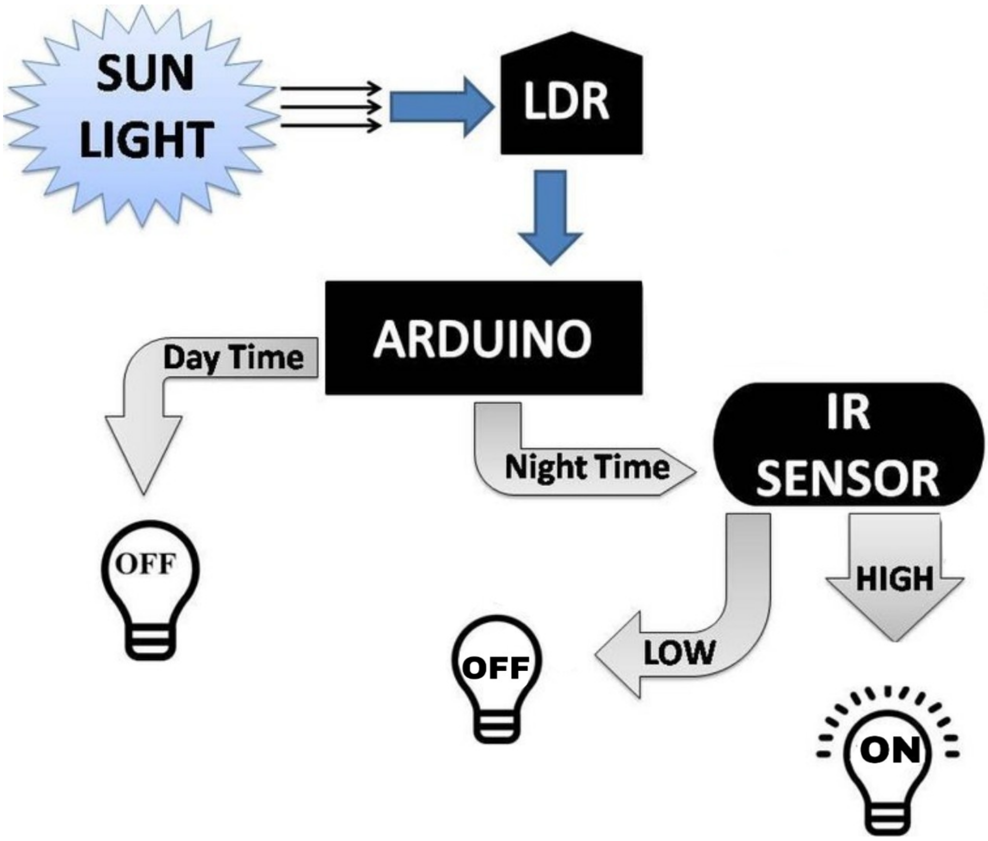

Figure 5.1: Arduino based intelligent street light system

During daytime, the lights remain OFF. During night time, output of IR sensors is taken into consideration. If IR sensors are in LOW position (when there is no object present in the vicinity), the street lights remain in OFF position. However, as soon as some object is detected in proximity of IR sensors, they switch to HIGH position and consequently lights turn on. Figure 5.1 shows the Arduino based intelligent street light system.

5.1 Observations and Outcomes

We need to have some assumptions for a comparative study. The length of street is assumed to be 10 km. It contains 500 street lights at a spacing of 20 metre. We assume that the conventional lights glow from 6 pm to 6 am. The energy consumed by a single street light is assumed to be 1000 units for a period of 1 hour. The speed of all the vehicles is taken to be 40 km/h. The comparison is done for counter mode.

5.1.1 Case 1

Timing : 1 am to 5 am
Vehicle count : 1

At the speed of 40 km/h , it takes 1.8 seconds to cover 20 metre. So, a street light is crossed in 1.8 seconds. Hence, a single street light glows for 1.8 seconds and remains closed for 3598.2 seconds in every hour. Energy consumed by 1 intelligent street light in 1 hour will be 0.5 units. A conventional street light will consume 1000 units in 1 hour. Figure 5.2 summarizes the results of this case.

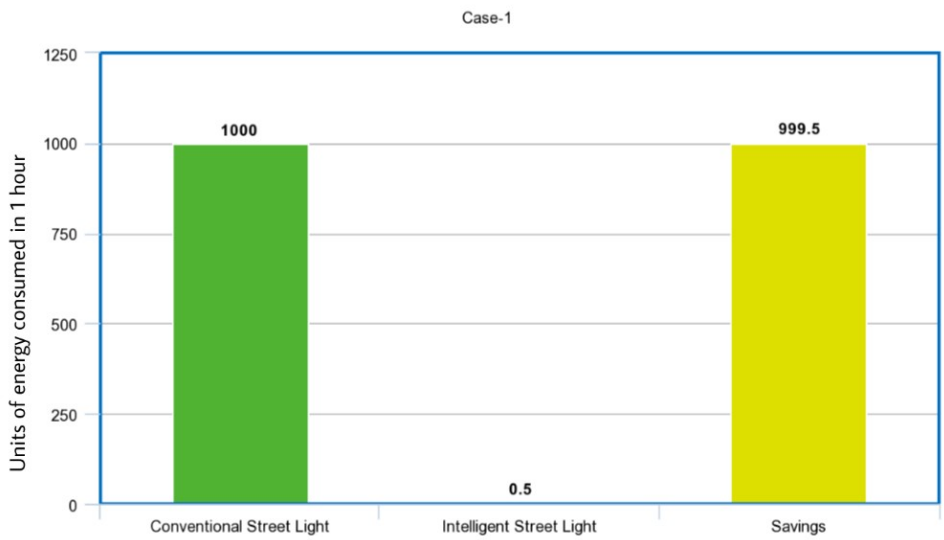

Figure 5.2: Bar Graph associated with Case 1

5.1.2 Case 2

Timing : 5 am to 6 am and 12 am to 1 am
Vehicle count : 10

In worst case, the 10 vehicles will go one by one. Hence, a single street light glows for 18 seconds and remains closed for 3582 seconds in every hour. Energy consumed by 1 intelligent street light in 1 hour will be 5 units. A conventional street light will consume 1000 units in 1 hour. Figure 5.3 summarizes the results of this case.

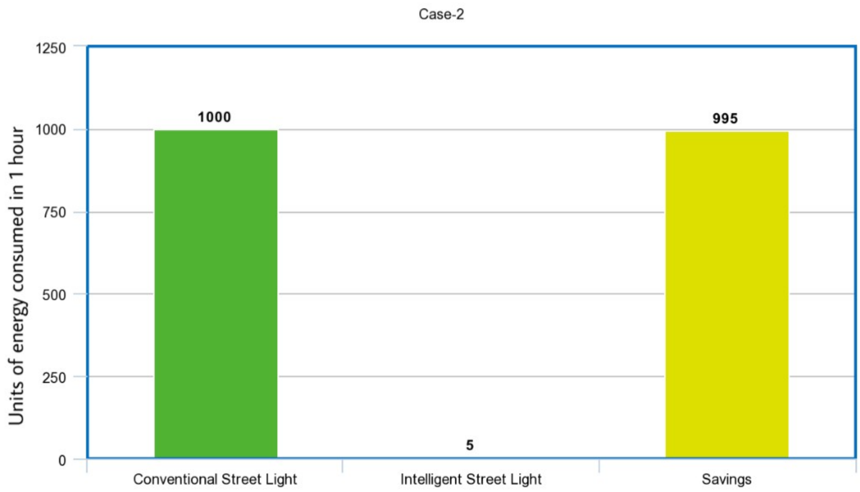

Figure 5.3: Bar Graph associated with Case 2

5.1.3 Case 3

Timing : 10 pm to 12 am
Vehicle count : 100

In worst case, the 100 vehicles will go one by one. Hence, a single street light glows for 180 seconds and remains closed for 3420 seconds in every hour. Energy consumed by 1 intelligent street light in 1 hour will be 50 units. A conventional street light will consume 1000 units in 1 hour. Figure 5.4 summarizes the results of this case.

5.1.4 Case 4

Timing : 6 pm to 10 pm
Vehicle count : 1000

In worst case, the 1000 vehicles will go one by one. Hence, a single street light glows for 1800 seconds and remains closed for 1800 seconds in every hour. Energy

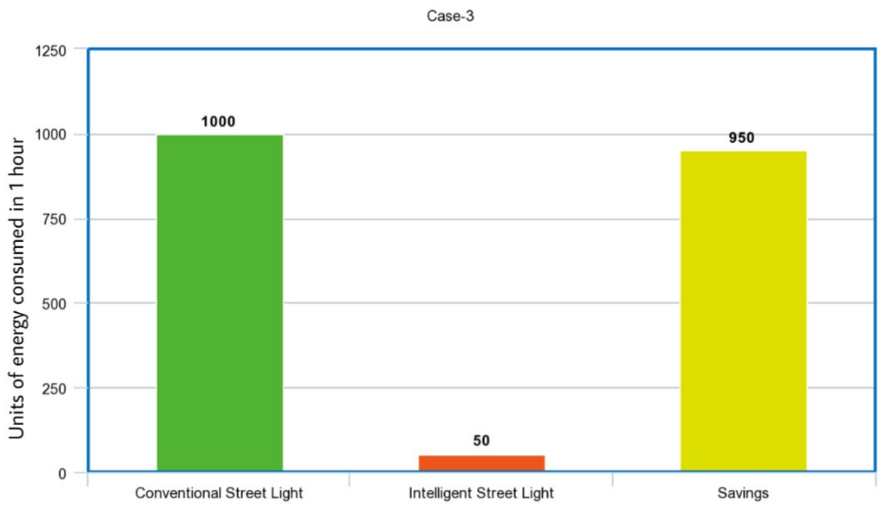

Figure 5.4: Bar Graph associated with Case 3

consumed by 1 intelligent street light in 1 hour will be 500 units. A conventional street light will consume 1000 units in 1 hour. Figure 5.5 summarizes the results of this case.

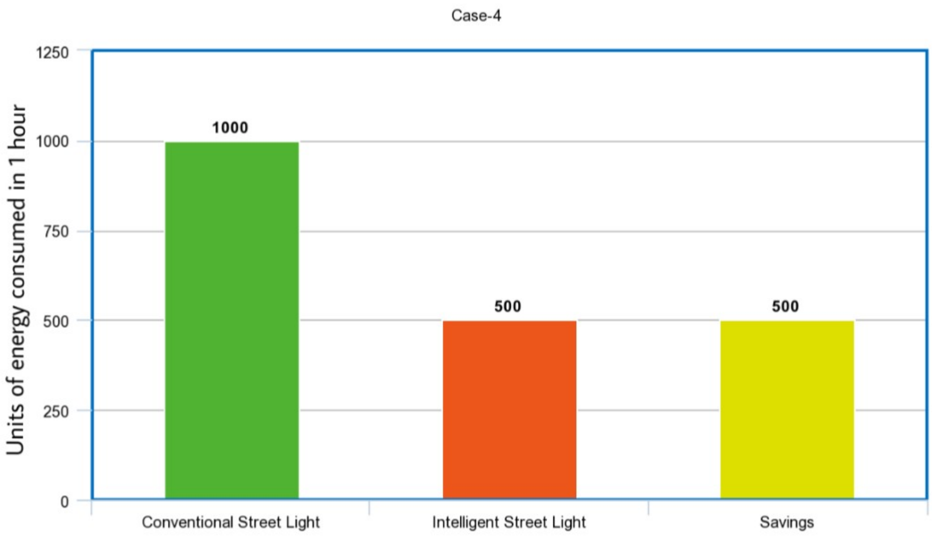

Figure 5.5: Bar Graph associated with Case 4

CHAPTER 6

Snapshots of Project

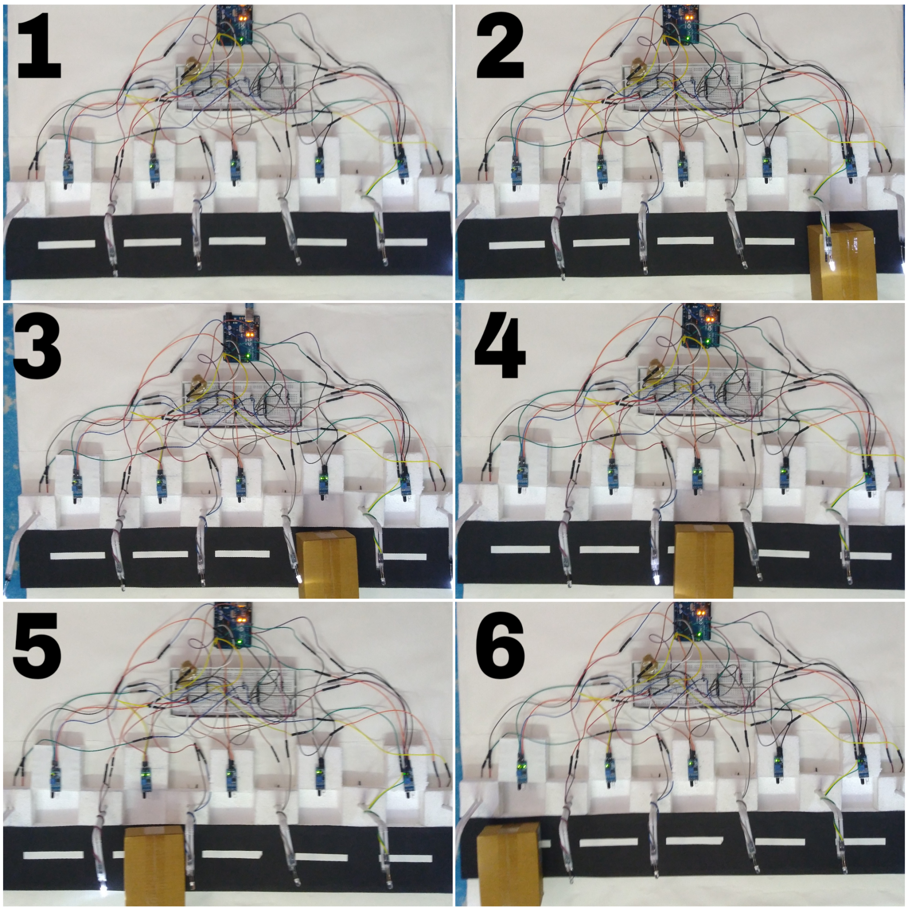

Figure 6.1: Snapshot 1 (Counter mode)

Figure 6.1 depicts the working of intelligent street light in counter mode. The LDR has been enclosed within a covering so as to ensure night environment. Initially, all the street lights are off as there is no object on the street. This is shown in picture labeled 1. In the picture labeled 2, an object arrives on the street. It is detected by first proximity sensor and the first LED is turned on. The object moves forward and is now detected by second proximity sensor. Consequently, second LED is turned on and first LED is turned off. This is depicted in picture labeled 3. In a similar fashion, when the object reaches in front of third sensor, third LED is turned on and second one goes off. This is depicted in picture labeled 4. The object moves further until it reaches within the proximity of fourth sensor. This results in turning on of fourth LED and turning off of third LED. Picture labeled 5 depicts this. Finally, the object reaches the end of the street and is detected by fifth sensor. This results in turning off of fourth LED. This is shown in pictures labeled 6.

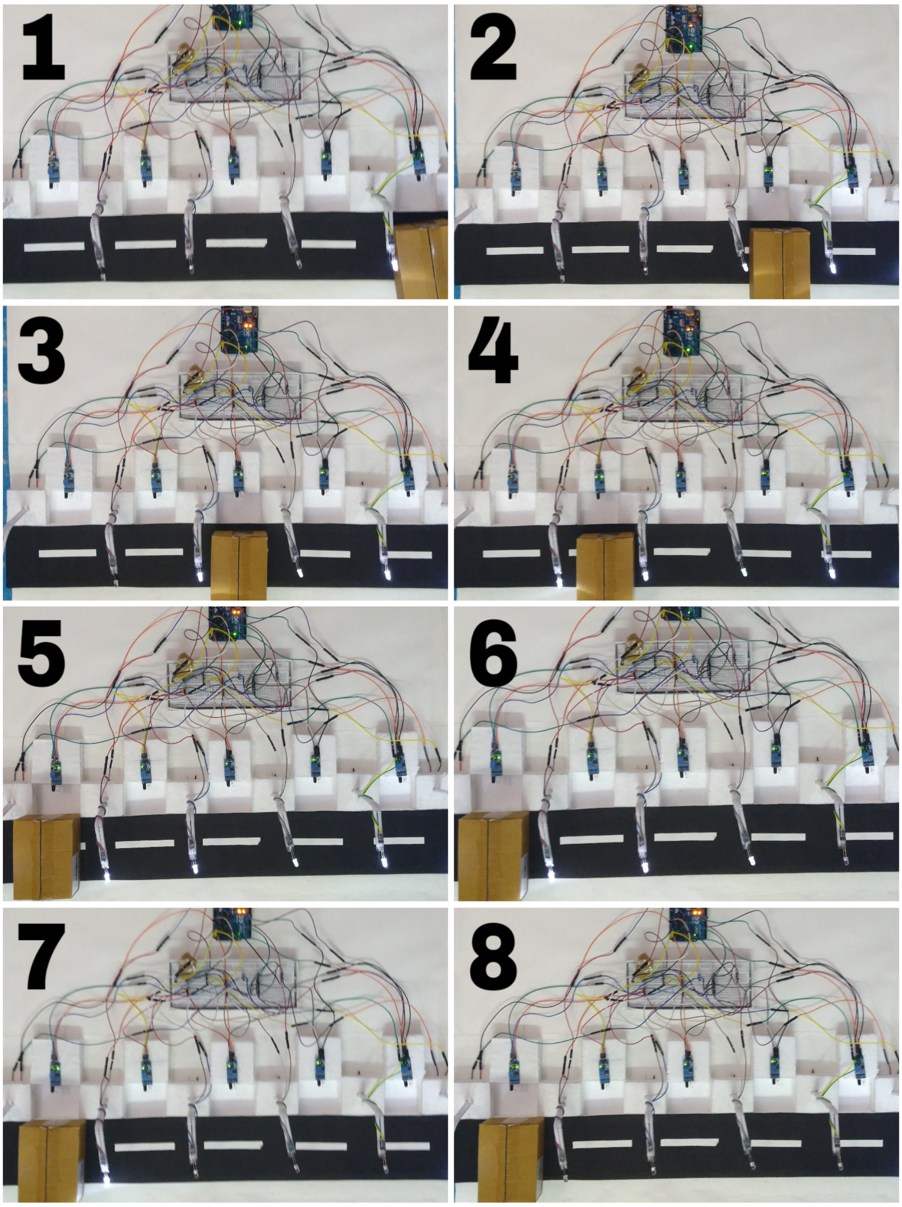

Figure 6.2: Snapshot 2 (Timer mode)

Figure 6.2 shows the working of intelligent street light in timer mode. Here, the predetermined time period is assumed to be 10 seconds (it may vary significantly depending upon the length of street and specified speed limits). In the picture labeled 1, an object arrives on the street and is detected by the first proximity sensor and the first LED is turned on for 10 seconds. The object moves forward and is now detected by second proximity sensor. Consequently, second LED is turned on for 10 seconds. This is depicted in picture labeled 2. In a similar fashion, when the object reaches in front of third sensor, third LED is turned on for 10 seconds. This is depicted in picture labeled 3. The object moves further until it reaches within the proximity of fourth sensor. This results in turning on of fourth LED for 10 seconds. Picture labeled 4 depicts this. Finally, the object reaches the end of the street and is detected by fifth sensor. No light is turned on now. This is shown in picture labeled 5. As the 10 seconds time period gets over for the LEDs, they start turning off one by one. This is shown in pictures labeled 6-8.

CHAPTER 7

Conclusion and Future Scope

In this project, an intelligent street light system has been implemented using light intensity detection and obstacle detection. We have tried to develop a system that is not only environment friendly but also cost effective. The contributions made by our thesis are as follows : The proposed system saves a lot of electricity when compared to currently existing systems. The proposed system is comparatively much cost effective. The proposed system significantly reduces human effort. Also, the lifetime of lights is improved.
The proposed system turns out to be exceptionally valuable and will help in overcoming the limitations of classical street lights if implemented on a vast scale.

7.1 Features

The important features of the proposed system are mentioned below :

1. Whenever there is sufficient amount of sunlight in environment, the street lights remain turned off. Hence, street lights generally remain off during daytime provided there are no clouds or dust-storms which might lead to darkness in environment.

2. During night, lights turn on only when there is someone present nearby. If no one is present in vicinity of the street lights, they remain off by default.

3. A lot of unnecessary power consumption is saved, in some cases up to 70 percent. As the lights do not unnecessarily glow whole night, a lot of wastage of electricity is eliminated.

4. The system is environment friendly. In modern world, saving resources is not only a requirement but a necessity. The proposed system saves a lot of electricity which in turn saves a lot of coal being used in thermal power plants. Also the emission of greenhouse gases and heat is significantly reduced.

5. The system is cost effective. As the requirement of electricity is drastically reduced, the electricity bills are less.
6. Lifetime of lights is improved, sometimes up to 50 percent. The street lights have a limited lifetime depending upon the amount of usage. As unnecessary usage is avoided, the lifetime is enhanced.

7.2 Applications

The project can be used in a wide variety of applications. It can be used on regular roads, express-ways, highways, local streets etc. It can also be used in parking areas of hospitals, hotels, malls, industries etc. The proposed system can be extended to corridors of houses, hostels, hotels etc.

7.3 Limitations and Future Scope

The proposed system is implemented for one way traffic. It can be implemented on two way streets via dual installation (installation on both side of the road). Also, the system can be extended to work on solar energy by using solar panels.

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