DESIGN AND DEVELOPMENT OF AUTOMATIC STREET LIGHT USING IOT

A thesis submitted in fulfilment of the requirements for the degree of Master of Engineering in

ILLUMINATION ENGINEERING

Submitted by

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CERTIFICATE OF RECOMMENDATION

This is certify that the thesis entitled "**DESIGN AND DEVELOPMENT OF AUTOMATIC STREET LIGHT USING IOT"**, is a work carried out by **JOY SARKAR** (exam roll no: M4ILN22006) under my supervision and guidance for partial fulfilment of the requirement for the award of degree of **MASTER OF ENGINEERING IN ILLUMINATION ENGINEERING,** department of electrical engineering, during the academic session 2020-2022.

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This foregoing thesis is hereby approved as a credible study of an engineering subject carried out and presented by **JOY SARKAR (**Exam roll no.- **M4ILN220006**) in a manner satisfactorily to warranty its acceptance as a pre-requisite to the degree for which it has been submitted. It is understood that by this approval the undersigned do not endorse or approve any statement made or opinion expressed or conclusion drawn there in but approve the thesis only for purpose for which it has been submitted.

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DECLARATION OF ORIGINALITY AND OF ACADEMIC ETHICS

I hereby declare that this thesis contains literature survey and original research work by the undersigned candidate, as part of the thesis for the degree of **Master of Engineering in Illumination Engineering** studies during academic session 2020-22.

All information in this document have obtained and presented in accordance with academic rules and ethical conduct.

I also declare that, as required by this rules and conduct, I have cited and referred all materials and results that are not original to this work

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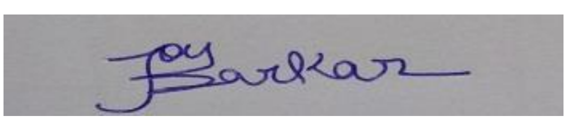

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ABSTRACT

A huge amount of electrical power is consumed in lighting the streets. A system that automatically adjusts the illuminance to 25% of the light for the parts of the streets having no vehicles and adjust the illuminance to 100% when vehicles that are going to come. Logically, the system may save a large amount of the electrical power. In addition, it will increase the lifetime of the lamps. This system automatically controls and monitors the lamp on the streets. It can light only the parts that have vehicles and help on the maintenance of the lighting equipments and gives the best solution for electrical power wastage. Also the manual operation of the lighting system is completely eliminated. Here in this thesis sensors used are, Light Dependent Resistor (LDR) to indicate a day/night time and the photoelectric sensors to detect the movement on the street. The Arduino Uno is used as brain to control the street light system. This thesis also show that the saved energy may reach up to 65% and an increase of the lifetime of the lamps of 53%.

List of Contents

CHAPTER 1

INTRODUCTION

1. INTRODUCTION

1.1. GENERAL INTRODUCTION

The idea of designing a new system for the street-light that do not consume huge amount of electricity and illuminate large areas with the highest intensity of light is concerning each engineer working in this field. Providing street lighting is one of the most important and expensive responsibilities of a city. Debu C [1] published an article that street lighting is one of the major component of power consumption in India also. He also stated that 18 to 38% of total energy bill goes towards street lighting.

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 creates unsafe conditions. Energy efficient technologies and design mechanism can reduce cost of the street lighting drastically. Manual control is prone to errors and leads to energy wastages and manually dimming during mid-night is impracticable.

Also, dynamically tracking the light level is manually impracticable. The current trend is the introduction of automation and remote management solutions to control streetlighting. In this work Light Dependent Resistor (LDR) is used as sensor.

The main objective is to provide an efficient & energy saving lighting system by evaluating the outside lighting condition and then adjusting the lights accordingly. The circuit mainly consists of a sensing element known as LDR, which is followed by processing unit Arduino which takes input for sensing element and gives its output to the LEDS.Though other units like relays, transistors are also be used for higher voltage supply. The system basically consists of a LDR, power supply, relays and Arduino Uno. The pictorial representation of system is given below **fig.1.1.**

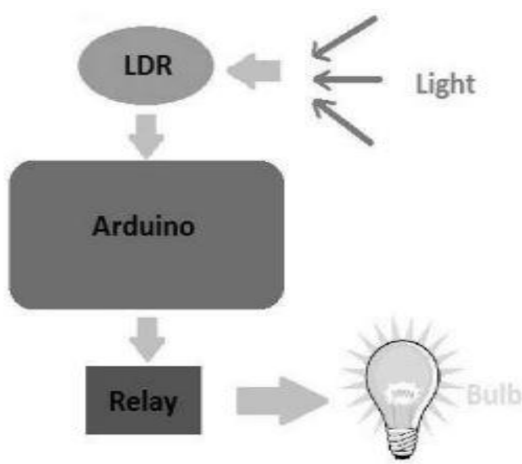

Fig.1.1

Pictorial representation of system

The LDR senses the light and sends the data to Arduino. The Arduino analyze the data and gives its response to the LEDs through the relay mechanism. The Arduino is programmed in such a way it automatically adjusts the lights to give most accurate result possible.

1.2. LITERATURE SURVEY

Literature survey is an assignment of previous task done by some authors and collection of information or data from research papers published in journals to progress the task. It is a way through which new ideas, concept can be found. There are lot of literatures published before on the same task some papers are taken into consideration from which idea of the thesis is taken.

Study Paper 1: ***B. K. Subramanyam*** [2] ***"Design and Development of Intelligent Wireless Street Light Control and Monitoring System Along With GUI", Volume. 3, Issue 4, Jul-Aug 2013.***

Worked on intelligent wireless street light control and monitoring system, which integrates new technologies, offering ease of maintenance and energy savings. Using solar panel at the lamp post by using LDR(Light Dependent Resistor) it is possible to save some more power and energy, and also can monitored and controlled the street lights using GUI(Graphical User Interface) application, which shows the status of the lights in street or highway lighting systems.

Study Paper 2*: P. Nithya [3] *"Design of Wireless Framework for Energy Efficient Street Light Automation", Volume 2, Special Issue 1, March 2014.

Work on Design of Wireless Framework for Energy Efficient Street Light Automation suggested an intelligent management of the lamp posts by sending data to a central station by ZigBee wireless communication. With the suggested system, maintenance can be easily and efficiently planned from the central station, allowing additional savings.

Study Paper 3*: Srikanth M [4] *"ZigBee Based Remote Control Automatic Street Light System", June 2014.

Proposed an automatic lighting system based on remote control that uses ZigBee. The implemented system is completely automatic and the functions of turning the lights on and off or simply dim the light were done efficiently depending on the movements taking place on roads. Using PIR sensors the motion of all the objects were detected.

Study Paper 4*: Anila Devi Y [5] *"GSM Based Remote Control System of High Efficiency Intelligent Street Lighting System Using a Zigbee Network of Devices and Sensor", Volume 3 Issue 7, July 2014 P.P 2319-7064.

Implemented a street lamp which was completely based on a GSM module along with a zig-bee module implemented with some additional sensors. The system was implemented on the concept of wireless technology for further monitoring and repairing of lamps. Led lamps were installed which are more reliable and cost effective and requires much less maintenance.

Study Paper 5: Shagun Malhotra [6] "Smart Street Lighting System: An Energy Efficient Approach", Volume 5 Issue 2, February 2016.

Worked on a smart street lighting system that suggested an intelligent use of street lights that is energy efficient and offered effective way for the maintenance of street light by using a Global System for Mobile (GSM) module that sends the relevant information to the centrally located control station. But using a GSM module is not much reliable because of connectivity complexity, so instead an ESP8266 Wi-Fi module can be used to send the required data to the control station.

Study Paper 6*: Sindhu A. M [7] *"Smart Street Light Using IR Sensors", Volume 3, Issue 2, Mar. - Apr. 2016, PP 39-44.

Worked on smart street lights using infrared sensors (IR) and by introducing Light Emitting Diode (LED) lamps instead of High Intensity Diode (HID) lamps since HID lamps are not cost effective and reliable. The system was implemented using IR sensors, using which the movement of vehicles and pedestrians was monitored and the system was programmed to get activated once there was an input to the sensor. But the range of IR sensors is less. IR sensors make lamps light up on detection of movement which will lessen lamp life in the long run due to being on/off again and again if the vehicular traffic is discontinuous. So LDR can be used instead to vary the intensity of light than shutting it down completely.

Study Paper 7: K. Y. Rajput [8] "Intelligent Street Lighting System Using GSM", Volume 2 Issue 3, March. 2013.

Work on intelligent street light using GSM, also suggested the concept of smart lamp posts in which there will be a 24-hour monitoring of street lamps where necessary actions will be taken and maintenance will be done to check the condition of lamps using GSM module. But surveillance system of lamps requires frequent maintenance increasing human dependency.

STUDY PAPER 8:

International Journal of Innovative Research in Science, Engineering and Technology Amul Shravankumar Jalan U.G. Student, Department of Instrumentation Engineering

Summary: The system used here is a closed loop on-off system. Controlling lighting system by means of LDR and Arduino together on Indian streets is relatively a new concept. Still today research has been done only on street light system based on Passive Infrared receiver and few are LDR based but they are controlled by means of timers and analog circuits. Some were controlled by wireless GSM/GUI networks which are too costly and not affordable. The disadvantages of current system used are

1. Need a manual operator to operate the lights on the street.

2. Switching time is same in all climates.

3. There are many streets on India where lights are kept 'ON' even during the day. Energy is wasted due to this carelessness. Hence by using arduino and LDR system considerable amount of energy can be saved.

In this comparison different papers which were published by various authors have been studied and compared in tabular form considering techniques used, merits and demerits

PAPER	TECHNIQUE	MERITS	DEMERITS
Solar Lighting System	Solar Panel, Passive Solar Technology	1.Operation cost is minimum 2.Less maintenance 3.Non polluting source	1.Initial investment is higher 2.Cost of equipment is high 3.Climatic condition may be affected

GSM Based Street Light System	GSM modem, circuitry system, client server mechanism	1.Low cost 2. Easy deployment 3.Highly scalable	1. No appropriate Communication Protocol 2.Not defined in Semantic point of view
Street Light System Control With Single Chip Microcomputer	Photo resistor & Fixed resistor. Photo sensitive Technique	1.Compact in structure 2.Low cost	Maintains must be done regularly
Wireless self Localizing System	Wireless retrofitting lamps	1.Installation flexibility 2.lower cost	Limited coverage
Zigbee Based System	Zigbee communication Protocol	1.Reduced the manual work 2.Save more energy	Complexity in design

1.3. PROBLEM IDENTIFICATION

When users get up at morning and have noticed that street lights are still ON when it's not necessary & when users travel to rural areas either there is no street lamp or there are not so many vehicles to fully utilize that facility. Simply it means the wastage of electricity. At the beginning, street lamps were controlled manually in which the control switch was set in each of the street lamps. That was called as the first generation of the original street light. In sunny and rainy days, ON and OFF time differ discernibly which is one of the significant hindrances of the present street lights systems. Conventional street lighting systems are online most of the day without purpose. The consequence is that a large amount of power is wasted meaninglessly. With the wide accessibility of adaptable lighting innovation like Light emitting diode (LED) lights and all over accessible remote web association, quick responding, dependable working, and power moderating street lighting frameworks get to be reality. The reason for this work is to portray the Smart Street Lighting framework, a first way to deal with perform the interest for adaptable smart lighting frameworks. The goal of this undertaking is to plan an automated lighting framework which focuses on the saving of power; to construct a vitally energy efficient smart lighting framework with integrated sensors and controllers; to outline a smart lighting framework with particular methodology plan, which makes the framework adaptability and expandability and configuration a smart lighting framework which similarity and versatility with other commercial products and mechanized automated system, which may incorporate more than lighting frameworks.

1.4. PROBLEM STATEMENT

The main purpose of this project "**to develop and design automatic street light control with different light intensity**" is to minimize the cost & loss of electricity and also man power to manually on- off the street light.

Statement [1]: Street lights are on in the presence of sun light.

Statement [2]: Street lights are on in the absence of any vehicle and pedestrian.

Disadvantages of Classical Street Light:

- Street lights are remain on when there is a visible spectrum of light.
- These street lights need a manual switching operation.
- It also needs man power.
- These street lights are unnecessarily glowing with its full intensity in the absence of any activities in the street.
- High power consumption and waste of energy.
- Less reliable.
- Manual hectic operation due to change in season and climate.

To face the various problem mentioned above in the conventional lighting system we need a lighting system that is well equipped with recent inventions and technology. As it is well known to everyone is that the natural source to generate power is limited and we are wasting so much of energy meaninglessly. So if we can use automation in this particular case so that all the street lights can be switch on and off automatically when it is really necessary. And if we can use controller circuits to implement a model so that all the street lights can only glow with its maximum intensity when there is activity in its region otherwise it should glow at a minimum given intensity. So that user can save a huge amount of power. With the inventions of light emitting diodes which have a small amount of power consumptions and high efficiency. With the help of all these sensor available in the market, to control 100% over the street for the safety and security of lives in the streets along with a flexible transportation system.

1.5. OBJECTIVE

The objective is to provide a fully automated street light controller which will definitely affect mankind. It will provide a public lighting system which is cost effective; it will help in reduction of crime, & it has less effect on environment

1.6. METHODOLOGY

A proper schematic diagram is drawn at first to find the best way of implementing the thesis. Later the hardware implementation and control operation define the actual process of this project. During the research of design prototype of automatic street light system, several pieces of literature based on this criterion are properly analyzed and utilized to develop and design the system .The following research is based on the embedded language C.

1.7. OUTLINE

- **CHAPTER 1- This chapter gives the reader gist of the topic "Design and Development of Automatic street light using IOT" ,describing the basic idea behind the Comprehensive study.**

- **CHAPTER 2 - This chapter gives the basic understanding of Automatic Street light and concept to develop a lighting system.**

- **CHAPTER 3 – In this chapter the development of actual circuit is described and the working prototype of automatic street light is also described.**

- **CHAPTER 4- This chapter has list of components that can be used and to understand the working procedure as per user's point of view.**

- **CHAPTER 5- This chapter is the result analysis, here the outcome of thesis work is been described in few words along with practical implementation pictures, which helps to understand visually the theme of the thesis.**

- **CHAPTER 6 – Here the future scope for this long thesis work has been discussed. What holds next in this world of automation and smart lighting and how this can be the used in future by the lighting industry.**

CHAPTER 2

STREET LIGHTING

2.1 STREET LIGHTING

Street lighting design is the design of street lighting such that people can safely continue their travels on the road. Street lighting on daytime is different from night because of the natural light in daytime which provide sufficient light for people, but to provide sufficient light on night to see people important objects required Street lighting design. Street lighting plays an important role in:

- Reducing the risk of night-time accidents
- Assisting in the protection of buildings/property (discouraging vandalism)
- Discouraging crime
- Creating a secure environment for habitation

2.2. BASIC FEATURES OF STREET LIGHT LUMINAIRIES

The basic features of street lighting luminaries are:

- Roadway luminaries are mounted horizontally and thus have fixed vertical aiming.
- Roadway lighting luminaries have particular intensity distributions which are desired to light long arrow horizontal stripes on one side of the luminaries, while

minimizing the intensities on the other side of the luminaries.

- The intensity distributions up and down the narrow strip are generally the same.

- Any fixed aimed luminaire which does not have this type of intensity distribution is called an area luminaire.

2.3. MAIN FACTORS IN LIGHTING DESIGN

The main objectives of street lighting design scheme are given below:

1. Perfect visual sensation for safety
2. Illuminated environment for quick movement of the vehicles
3. Clear view of objects for comfortable movement of the road user

Various types of lamps are used in street lighting luminaires. They are

1. High pressure sodium lamp
2. Metal Halide Lamps
3. Low pressure sodium lamps
4. Incandescent Lamp
5. Light emitting diode(LED)
6. Compact fluorescent lamps(CFL)

2.4 MAIN FACTORS IN THE STREET LIGHTING DESIGN SCHEME

1. **Luminance Level** should be proper
Luminance always influences the contrast sensitivity of the obstructions with respect to the back ground. If the street is brighter, then darker surroundings makes the car driver adapted, unless the driver will be unable to perceive the objects in the surroundings. As per CIE, 5m away from the road on both sides will be lit by Illuminance level at least 50% of that on the road.

2. **Luminance Uniformity** must be achieved
to provide visual comfort to the viewer's eyes, enough luminous uniformity is needed. Luminous uniformity means the ratio between minimum luminance level to average luminance level, i.e.

$$U_0 = \frac{L_{min}}{L_{max}}$$

It is termed as longitudinal uniformity ratio as it is measured along the line passing through the viewers' position in the middle of the traffic facing the traffic flow.

3. **Degree of Glare** limitation is always taken into design scheme
Glare means visual discomfort due to high luminance. There are two types of glare created by the street light luminaires, first type is disability glare and second type is discomfort glare.

Disability glare is not a strong factor , rather discomfort glare is a common factor due to unplanned street lighting scheme.

4. Lamp Spectra for Visual Sharpness depends on the Proper Luminaries It is very much essential to make an object as per size and the dimension

5. Effectiveness of Visual Guidance is also an important factor it helps a viewer to guess how far another object is from his position.

2.5. TYPES OF ROAD TO IMPLEMENT VARIOUS STREET LIGHTING DESING

As per CIE 12 roads are broadly classified into five types.

Type A of Street Lighting Design

- Heavy and high speed traffic.
- The roads are separated with the separators.
- No crossing is allowed.
- Controlled access
- As the example: express ways

Type B of Street Lighting Design

- Heavy and high speed traffic.
- Separate road for slow traffic movement or pedestrians.
- As the example: Trunk road.

Type C of Street Lighting Design

- Heavy mixed traffic with moderate speed.
- Rural and urban roads.
- As the examples: Ring Road or Radial Road.

Type D of Street Lighting Design

- Slow traffic and pedestrians' purpose.
- Road in the city or shopping center.
- As the example: Shopping streets.

Type E of Street Lighting Design

- Mixed Traffic with limited speed.
- Connector road between residential areas.
- As the example: Local street.

2.6. STREET LIGHT LUMINAIRE

Intensity distribution of the street light luminarie is measured with mirror Goniophotometer. And it is graphically represented by polar intensity diagram.

But Intensity distribution of the road light is measured following C-ɣ photometric convention. In C-ɣ photometry, C is the angle on the road surface plane and ɣ is the angle created between vertical axis of the luminaries and lumen throwing direction, or in other word, ɣ is the angle of incidence.

Initially on the surface of the road, point specific Illuminance values are collected.
Then intensity I is calculated from the equation of the Illuminance,

$$E_P = \frac{Icos^{2\prime}\Upsilon}{h}$$

Where, E_P is the Illuminance at point P on the road and h is the vertical height from the point P to the luminaire. After calculation of the intensity, we put all the intensity values making a C-ɣ table as per their angular position.**fig2.**

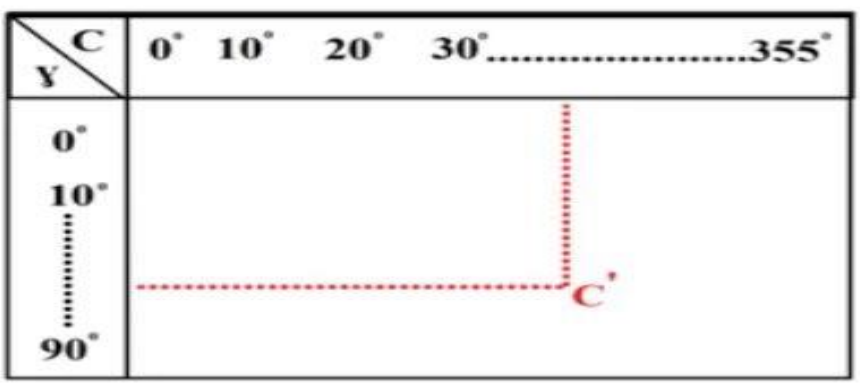

Fig2.

The format of C-ɣ table is shown above. In this above chart C' is the position of maximum intensity on the table.

Three basic planes of intensity are considered on the road surface with respect to one luminaire:

1. Plane 1: C-0^o to C-180^o along the road.
2. Plane 2: C-90^o to C-270^o across the road.
3. Plane 3: Principle Plane, through the point of maximum intensity of the light, i.e. C' to C' + 180^o

To obtain C' we have to prepare intensity distribution chart of the road light luminaire on the road. Where intensity will meet at maximum value this is the degree value of C'. To draw the principle plane axis we have to add 180^o with C'.

Spread and Throw Angle of Street Light Luminaire

The two main terms related to the street light luminaire are:

1. Spread angle: it is the angle of the luminaire to direct the luminous flux across the road.

2. Throw angle: it is the angle of the luminaire to direct the luminous flux along the road.

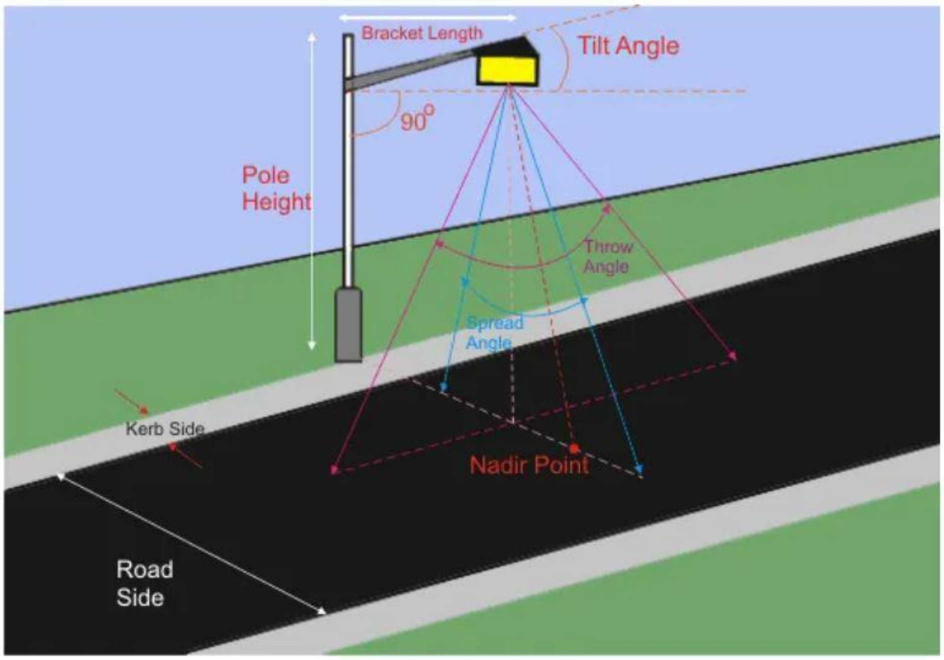

Fig3.

Road light design

2.7. STREET LIGHT DESIGN PARAMETER

1. Average maintained luminance level in Lux
2. Over all uniformity (U_0) of Illuminance

$$U_0 = \frac{E_{min}}{E_{max}}$$

For entire area (span × width) of the road

3. Longitudinal Uniformity

$$U_L = \frac{E_{min}}{E_{max}}$$

Is measured along the length of the road (centre length by default)

4.Transverse uniformity

$$U_t = \frac{E_{min}}{E_{max}}$$

is measured across the road along a line passing through the nadir point.

5. Disability glare is expressed in threshold Increment.
6. Discomfort Glare is expressed in glare control mark.
7. Unit Power Density(UPD) is measured for unit length. Where,

$$UPD = \frac{\frac{Watt}{Lumen} \times no.of\ luminaire}{s \times w}$$

Where no. of the luminaire (n) = 1 for single sided pole arrangement
= 2 for double sided pole arrangement
= 2 for staggered sides pole arrangement.

Average Illuminance is calculated by Lumen method, where maintenance factor (MF) and coefficient of utilization (COU) are taken into account.

$$E_{avg} = \frac{n \times N \times COU \times MF \times \emptyset}{A_{eff}}$$

Where,

Φ_L = Lumen of the Luminaire,

A_{EfF} = effective road surface area under Illumination = Span × Width = S × W

N = Number of luminaire

Again,

N = 1 for single sided street lighting design and

N = 2 for double and staggered sided street lighting design,

n = number of lamps used in single luminaire = 1 for street lighting.

Coefficient of Utilization (COU) is the ratio of utilized lumen to the installed lumen. And it is obtained from the COU graph recommended by CIE.

2.8. GLARE IN STREET LIGHTING

Glare is the visual dis- comfortability of human eyes due to improper level of luminance distribution of the luminaire to view an object. Glare can be classified into two types**,**

1. Disability Glare
2. Discomfort Glare

Disability Glare

Disability glare makes human eyes disable to see any object for a little while. For an example, when we look at any bright source for a few seconds and then we look at any object with low brightness, we become unable to see this object properly, rather we see black spot for some times. This is one type of momentarily blindness. Disability glare is measured at threshold increment value. With the aid of the luminous distribution of a luminaire and using the nomogram the threshold increment of a luminaire installation can be determined. The nomogram is a graphical representation of the formula for the equivalent veiling luminance; threshold increment value is represented by T_I and calculated in percentage.
It is defined as

$$T_I = 65 \frac{L_v}{L_{avg}^{0.8}}$$

Where, L_V is veiling luminance and L_{avg} is the average luminance of the object or road surface. Where, L_V is veiling luminance and L_{avg} is the average luminance of the object or road surface.

Discomfort Glare

Discomfort glare is not the cause of momentarily blindness like disability glare, but it is responsible to affect the visibility of the human eyes to an extent for long time. This kind of glare depends on the luminaire installation. If the luminance is in higher value, the human eyes cannot observe the object with lower luminance properly beyond this higher luminance. Discomfort glare is calculated in logarithmic term. If we have the specific luminaire index (SLI) of a luminaire, we can easily calculate this discomfort glare of that luminaire. SLI is the luminaire light distribution characteristics. It is denoted by glare control mark (G). For street lighting, the discomfort glare control mark is given by:

$$G = SLI + 0.97\log L_{avg} + 4.41\log h' - 1.46 log\ p$$

Where,
SLI = Specific Luminaire Index,
L_{avg} = average road surface luminance (cd/m^2)
h' = reduced mounting height (m).
p = number of luminaires per kilometer.
SLI is calculated in terms of logarithmic value.

$$SLI = 13.84 - 3.31 log_{10}^{I_{80}} + 1.3\sqrt{log_{10}^{\frac{I_{80}}{I_{80}}}} - 0.08 log_{I_{80}}^{I_{80}} + 1.29 log_{10}^{F} + C$$

Where,

I_{80} and I_{88} are the luminous intensity (cd) along the downward vertical directions in the vertical parallel to the road axis correspond to angle 80 degree and 88 degree respectively.

F is the apparent light emitting area (m^2) of the luminaire as seen at an angle ɣ = 76 degree to the downward vertical.

C is the color factor according to the SPD of the electric lamp used. For low pressure sodium lamp C = 0.4 and C = 0 for all other white lamps.

When SLI < 2, glare control is limited. When 2 ≤ SLI ≤ 4, glare control is moderate. When SLI > 4, glare control is high. Higher value of SLI means lower chance to create discomfort glare.

CHAPTER 3

CIRCUIT DESIGN, FLOW CHART AND BLOCK DIAGRAM

3.1. CIRCUIT DESIGN

Fig.4 shows the circuit design of an automatic street light control system based on object detection using Arduino Uno, with DIM light capability. In this scenario, the lights will turn to HIGH only with the detection of an object; otherwise the lights will remain OFF at day-time, and DIM at night-time.

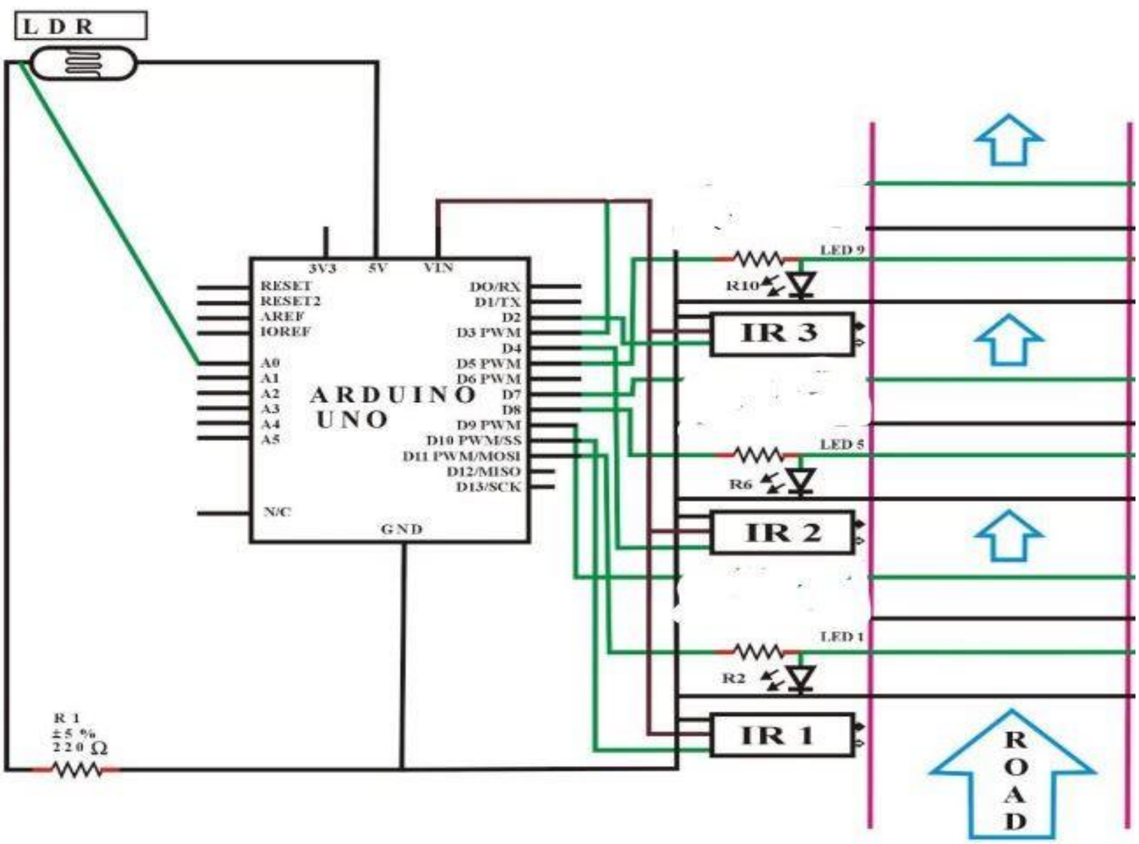

Fig4.

CIRCUIT DESIGN OF AUTOMATIC STREET LIGHT CONTROLLER

In this task, an LDR sensor, 2 LEDs, three IR obstacle avoidance sensors, and a single Arduino Uno were used. One leg of the LDR sensor was connected to Arduino analog pin number A0, and another leg to a 5 V pin, and the same with a resistor to the GND port of the Arduino. Besides, the threshold value for the LDR was adjusted to 10 from the discrete values (0–1023) for understanding whether it is day or night. After that, all the positive terminals of the LED set were connected with resistors to pin numbers D7, D5, and D3 as the outputs of the Arduino signals. Furthermore, the GNDs of all the LEDs were connected to the GND port, as shown in the circuit diagram (**fig.4**).

The OUT terminals (represented by green lines of IR1, IR2, IR3) of the IR obstacle avoidance sensors were connected to the Arduino port from pin number D10, D4, and D2, respectively, which is the input signal to the Arduino board. Similarly, the GND of all the IR obstacle avoidance sensors were connected to the GND port, and all VCC (input voltage) of the IR obstacle avoidance sensors were connected to the Arduino 5 V pin. Initially, the IR obstacle avoidance sensors were set to LOW (by default) at the start, if there was no motion. Meanwhile, the detailed software code for this case is given

3.2. FLOW CHART

This flow chart helps to understand the process or say working in a single go i.e., flow. It initiates a proper understand of the whole process step by step which are sometimes become very difficult to understand.

In the beginning, the LDR sensor will sense the light intensity in the atmosphere at that time, and it will consequently transfer the data to Arduino , as shown in figure 8 **.**After receiving the data, Arduino will convert it into different discrete values from 0 to 255 (in which 0 represents maximum darkness, and 255 represents maximum brightness), and then it will adjust the output voltage accordingly from 0 to 2.5 V/5 V (DIM/HIGH) depending upon the received value (0–255) by comparing it with the threshold value. Whereas, the threshold value is adjusted to 125. So, the output will be 2.5 V in the complete darkness (night time), if the received value is more than the threshold value. As a result, DIM LEDs will glow that is the half of maximum brightness, and when there is completely shine (daytime), the received value will be less than the threshold value, and the output voltage would be 0 V, resulting the LEDs to be completely switched OFF. Initially, the IR obstacle avoidance sensor will be LOW. So, when there is no object in front of the sensor, the IR transmitter does continuously transmit the IR light. Whenever a car or any other object blocks any of the IR obstacle avoidance sensors, then the emitted rays will reflect the IR receiver after hitting the object, then microcontroller will sense it as a motion. In simple words, when an object passed in front of the first IR obstacle avoidance sensor, the corresponding LEDs will be turned from MIN to HIGH BRIGHTNESS (5 V) by the microcontroller. As the object moves forward and blocks the next IR obstacle avoidance sensor, the next three LEDs will be turned to HIGH from and the LEDs from the previous set switched to MIN from HIGH BRIGHTNESS. The process continues this way for the entire IR obstacle avoidance sensors and LEDs.

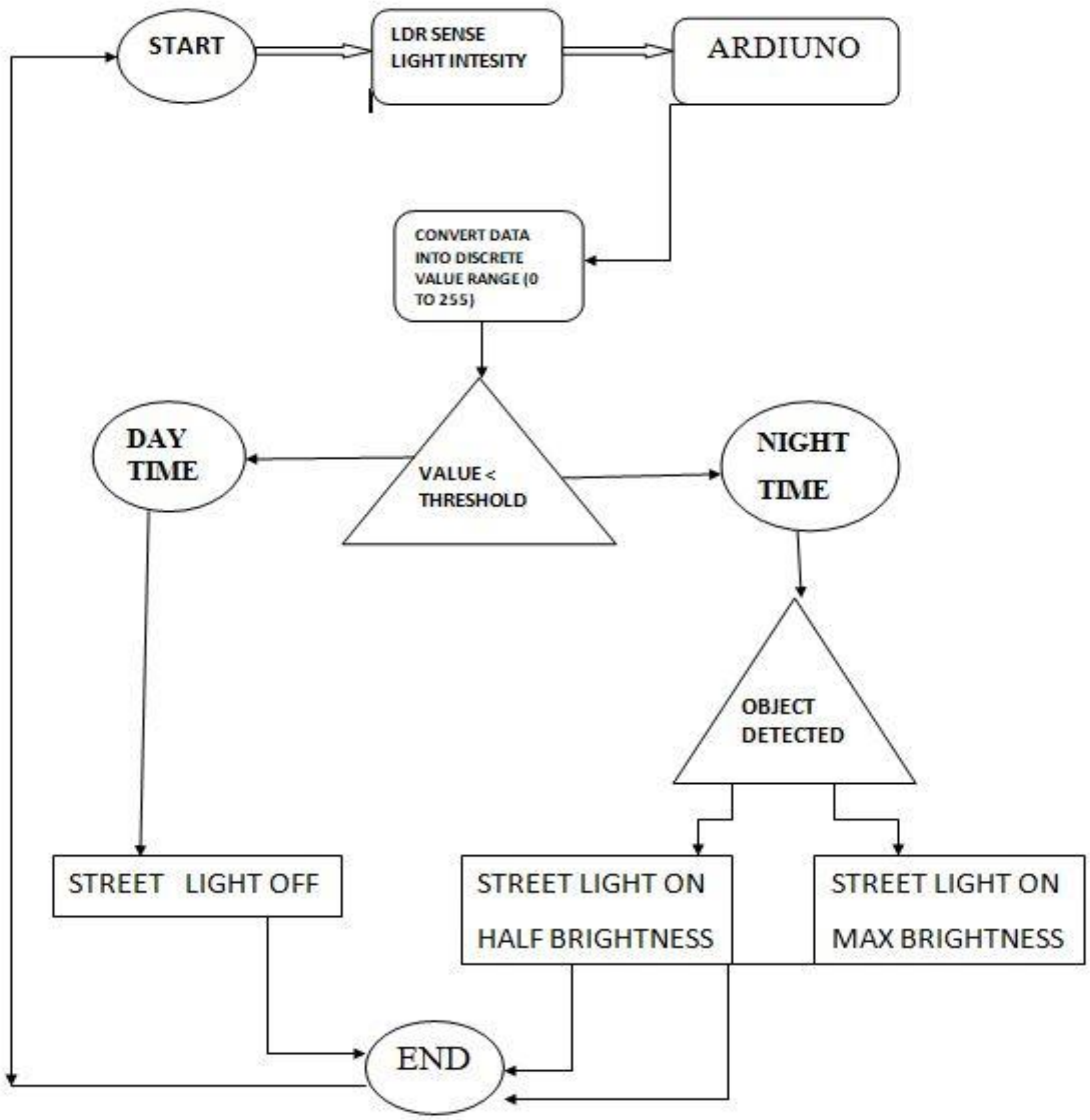

Fig5. DIAGRAM OF AUTOMATIC STREET LIGHT SYSTEM

3.3. BLOCK DIAGRAM

Block diagram as shown in **fig.6** actually helps to better understand what is really happening at the back side. Here the role of arduino uno is been clearing described, which gives the control signal to set the desired lighting condition.

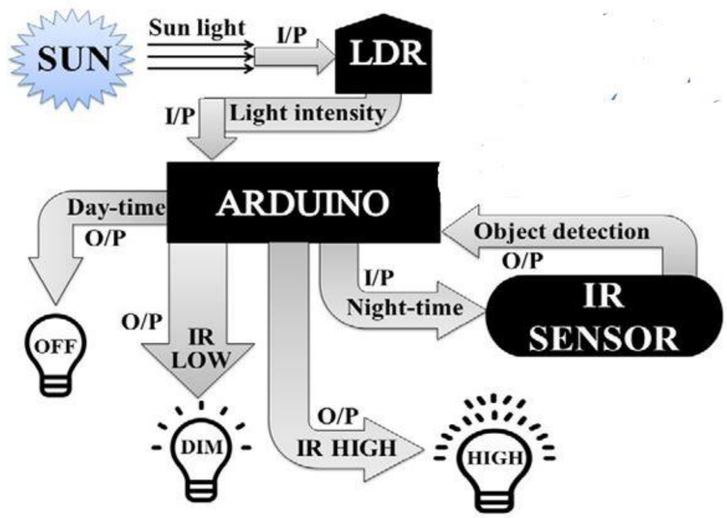

Fig.6

BLOCK DIAGRAM OF AUTOMATIC STREET LIGHT CONTROL

3.4. DESIGN AND WORKING OF PROTOTYPE

The working of the model is very simple. The supply is given through the power jack. From the Arduino we take 5v supply and other end connected to ground. The output is given by output pin 13 of the Arduino which is connected to the led. The other end of LED is perfectly grounded. One LDR circuit to distinguish between the day and night is used LDR with one end is connected across the 5V and other to GND of the Arduino Uno and from the LDR the output of the circuit is feed to A0 of the Arduino which turn on all the street lights which are represented by Led connected to the PWM output (~3, ~5, ~6). LDR is a special type of resistor whose value depends on the brightness of the light which is falling on it. It has resistance of about 1M-ohm when in total darkness but a resistance of only 5 k-ohm when brightness is illuminated. The voltage is directly proportional to the conductance so more voltage we will get when there is sunlight and vice-versa and then we have to set a reference value for the switching actions of the Led. The reference value is set to 500. 3 infrared receiver and sender circuits are made to detect the movements and output from the receiver is fed to the input terminal of A1,A2,A3 which corresponds to the led connected to ~3,~5,~6respectively. All the object sensors are connected between 5V and GND of the Arduino UNO. If the Arduino UNO reads any value from LDR whose value is more than the LDR reference value than it will turn on the street lights. The output from object sensor1 and object sensor 2, object sensor 3are connected to the pin A1,A2,A3 and reference value of all sensor is set to 500. Another 3 integer value for each object sensor are set to zero and if any object sensor detects any presence of objects then Arduino UNO compares the value with reference value. . If the sensed value is less than the reference value it will glow with 100% of its intensity otherwise 10% of its intensity.

WORKING OF PROTOTYPE

As show in **fig.7** .During day-time, the received value was higher than the threshold value, and the output was also 0 V, resulting in the LEDs being entirely switched OFF.

fig.7.

DAY TIME

As shown in **fig.8**. During Complete Darkness the LEDs will glow with 10% of brightness

Fig8.

Complete Darkness

As shown in **fig.9.** Initially, the IR obstacle avoidance sensor was LOW. Thus, when there was no object in front of the sensor, IR transmitter continuously transmitted IR rays. Whenever a car or any other object blocks any of the IR obstacle avoidance sensors, then the emitted rays will reflect the IR receiver after hitting the object, then microcontroller will sense it as a motion. In simple words, when an object passes in front of the first IR obstacle avoidance sensor, the corresponding LEDs will be turned from DIM to HIGH (5 V) by the microcontroller. As the object moves forward and blocks the next IR obstacle avoidance sensor, the next three LEDs will be turned to HIGH from DIM, and the LEDs from the previous set are switched to OFF from HIGH. The process continues this way for the entire set of IR obstacle avoidance sensors and LEDs.

Fig 9. DURING NIGHT

CHAPTER 4

COMPONENTS

COMPONENTS

4.1. Light Dependent Resistor (LDR) SENSOR

Light Dependent Resistor as the name suggests the resistance is dependent upon the light incident on it. The theoretical concept of the light sensor lies behind, which is used in this circuit as darkness detector. The LDR is a resistor as shown in **Fig. 10**.

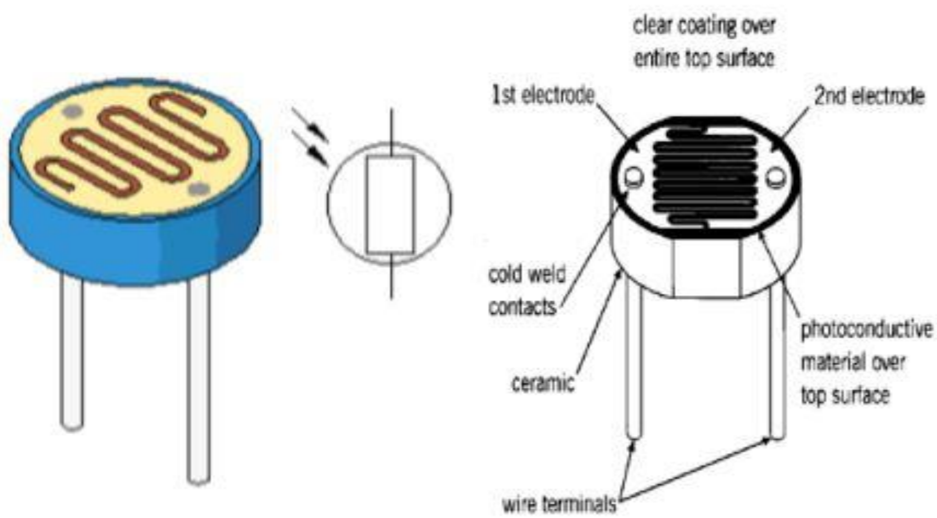

Fig.10.Diagram of Light Dependent Resistor

The LDR resistance changes with intensity of light, with increase in light intensity the resistance offered by the sensor decreases and with decrease in light intensity the resistance offered by the sensor increases. Hence it acts as variable resistor with change in light intensity. These helps in finding the amount of light intensity at that instant of time and thus helping in regulating the lighting system accordingly.

Mathematical representation of LDR can be given as, Resistance α 1/ Intensity of light

4.2 ARDUINO UNO

Arduino is an open-source platform used for building electronics projects as shown in **fig.11**. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on user's 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 – a USB cable can simply be used. 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 micro-controller into a more accessible package.

The Uno is one of the more popular boards in the Arduino family and a great choice for beginners. We'll talk about what's on it and what it can do later in the tutorial.

The Arduino hardware and software was designed for artists, designers, hobbyists, hackers, newbies , and anyone interested in creating interactive objects or environments. Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet, and even the smart-phone or the TV! This flexibility combined with the fact that the Arduino software is free, the hardware boards are pretty cheap, and both the software and hardware are easy to learn has led to a large community of users who have contributed code and released instructions for a huge variety of Arduino-based projects.

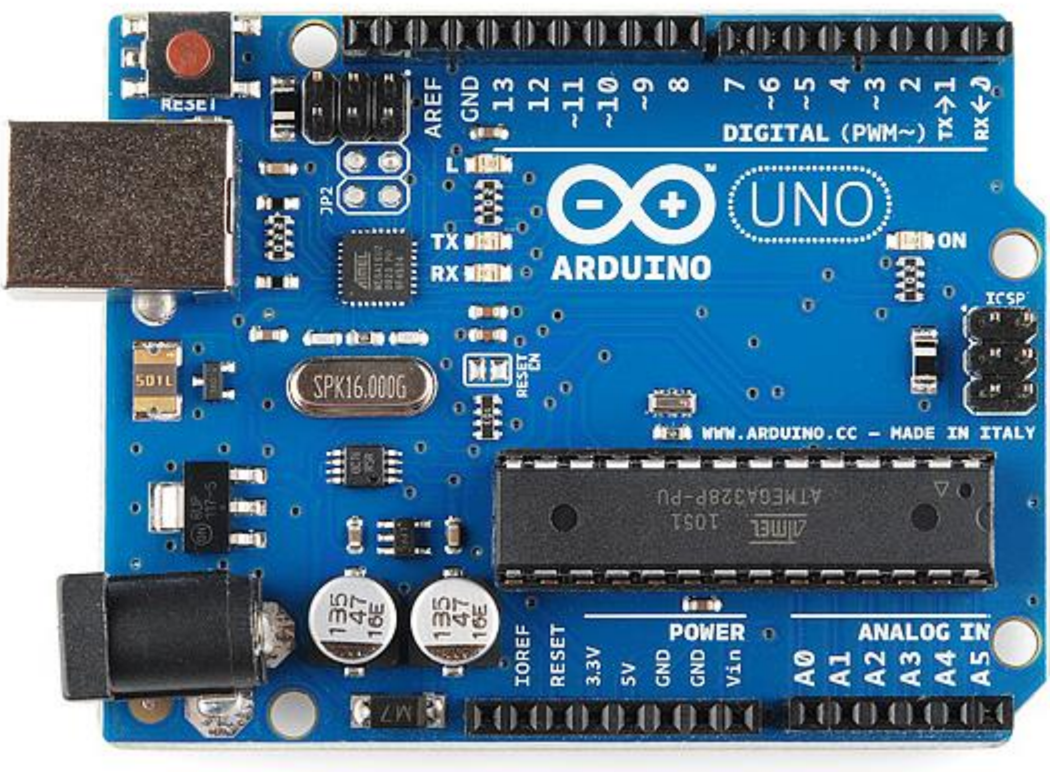

Fig.11. Arduino Uno R3 board

For everything from robots and a heating pad hand warming blanket to honest fortune-telling machines, and even a Dungeons and Dragons dice-throwing gauntlet, the Arduino can be used as the brains behind almost any electronics project.

The Arduino board exposes most of the microcontroller's I/O pins for use by other circuits. The Diecimila , Duemilanove, and current Uno provide 14 digital I/O pins, six of which can produce pulse-width modulated signals, and six analog inputs, which can also be used as six digital I/O pins. These pins are on the top of the board, via female 0.1-inch (2.54 mm) headers. Several plug-in application shields are also commercially available. The Arduino Nano, and Arduino-compatible Bare Bones Board and Boarduino boards may provide male header pins on the underside of the board that can plug into solderless breadboards.

Many Arduino-compatible and Arduino-derived boards exist. Some are functionally equivalent to an Arduino and can be used interchangeably. Many enhance the basic Arduino by adding output drivers, often for use in school-level education, to simplify making buggies and small robots. Others are electrically equivalent, but change the form factor, sometimes retaining compatibility with shields, sometimes not. Some variants use different processors, of varying compatibility.

Drawbacks -

Arduino shields away a lot of complexity which is an advantage to get started, but limits expansion later. It also makes understanding how certain things work more difficult, but that's inevitable.

Users are limited to a small number of MCUs right now: Arduino is only officially supported on the Atmel AVR and Atmel SAM series. There are ports and adaptions to a few other MCUs like the ESP8266 or even the nRF51 series, but they don't seem to be fully supported, so generally it’s been limited to Atmel MCUs.

The Arduino libraries are not very efficient in certain parts and waste RAM and CPU cycles (Example: http://bleaklow.com/2012/02/29/why_im_ditching_the_arduino_software_platform.html).

The Arduino IDE is very limited and a really bad code editor. That however can be fixed, user can use a different editor to write the code. It has been suggested to use PlatformIO as a build tool chain and any editor like (e.g., GitHub's Atom, which as great support for Arduino).

Conclusion –

The Arduino Uno R3 which is the most common version of Arduino is not suitable for Wi-Fi supported devices. It doesn’t allow wireless connectivity or controls, hence fails to make the cut for the minimum requirement.

4.3 LED

A light-emitting diode (LED) is a p-n junction diode, which emits light when activated. When we apply voltage across its leads, electrons are able to recombine with holes within the LED, releasing energy in the form of photons which gives the light. Hence, it is a two-lead semiconductor light source. Light emitting diodes represents our lighting system and the amount of light emitted by it is directly related to the amount of light in the environment that is when outside light is less than the light given by LEDS is more and vice-versa.

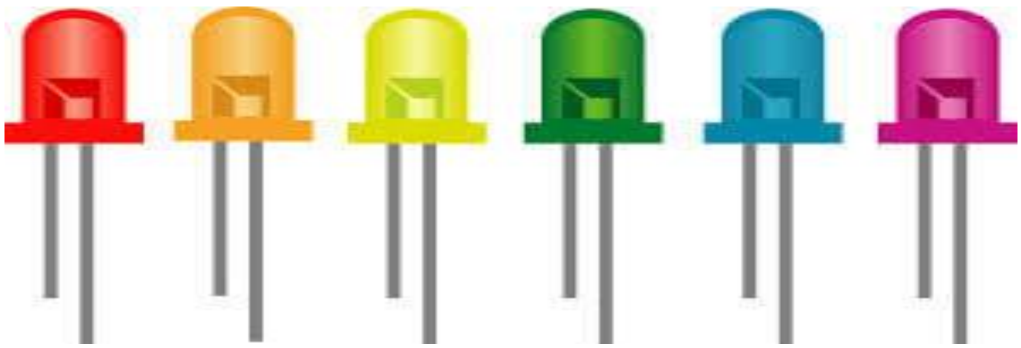

Fig 12.LED

When Light Emitting Diode (LED) is forward biased, free electrons in the conduction band recombines with the holes in the valence band and releases energy in the form of light.

The process of emitting light in response to the strong electric field or flow of electric current is called electroluminescence.

A normal p-n junction diode allows electric current only in one direction. It allows electric current when forward biased and does not allow electric current when reverse biased. Thus, normal p-n junction diode operates only in forward bias condition.

Like the normal p-n junction diodes, LEDs also operates only in forward bias condition. To create an LED, the n-type material should be connected to the negative terminal of the battery and p-type material should be connected to the positive terminal of the battery. In other words, the n-type material should be negatively charged and the p-type material should be positively charged.

The construction of LED is similar to the normal p-n junction diode except that gallium, phosphorus and arsenic materials are used for construction instead of silicon or germanium materials.

In normal p-n junction diodes, silicon is most widely used because it is less sensitive to the temperature. Also, it allows electric current efficiently without any damage. In some cases, germanium is used for constructing diodes.

However, silicon or germanium diodes do not emit energy in the form of light. Instead, they emit energy in the form of heat. Thus, silicon or germanium is not used for constructing LEDs.

STRUCTURE OF LED

LEDs produce more light per watt than incandescent bulbs; this is useful in battery powered or energy-saving devices. LEDs can emit light of an intended color without the use of color filters that traditional lighting methods require. This is more efficient and can lower initial costs. The solid package of the LED can be designed to focus its light. Incandescent and fluorescent sources often require an external reflector to collect light and direct it in a usable manner. When used in applications where dimming is required, LEDs do not change their color tint as the current passing through them is lowered, unlike incandescent lamps, which turn yellow. LEDs are ideal for use in applications that are subject to frequent on-off cycling, unlike fluorescent lamps that burn out more quickly when cycled frequently, or High

Intensity Discharge (HID) lamps that require a long time before restarting.

4.4. IR SENSOR MODULE

IR sensor is an electronic device ,that emits the light in order to sense some object of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, but infrared sensor can detect these radiations. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode. Photodiode is sensitive to IR light of the same wavelength which is emitted by the IR LED. When IR light falls on the photodiode, the resistances and the output voltages will change in proportion to the magnitude of the IR light received. There are five basic elements used in a typical infrared detection system: an infrared source, a transmission medium, optical component, infrared detectors or receivers and signal processing. Infrared lasers and Infrared LED’s of specific wavelength used as infrared sources. The three main types of media used for infrared transmission are vacuum, atmosphere and optical fibers. Optical components are used to focus the infrared

IR Sensor Working Principle

When we turn ON the circuit there is no IR radiation towards photodiode and the output of the comparator is LOW. When we take some object (not black) in front of IR pair, then IR emitted by IR LED is reflected by the object and absorbed by the photodiode. Now when reflected IR Falls on Photodiode, the voltage across photodiode drops, and the voltage across photodiode drops, and the voltage across series resistor R2 increases . When the voltage at Resistor R2 (which is connected to the non inverting end of compartor) gets higher than the voltage at inverting end, then the output becomes HIGH and LED turns ON. Voltage at Inverting end, which also called Threshold Voltage, can be set by rotating the variable resistor's knob. Higher the voltage at inverting end (-), less sensitive the sensor and Lower the voltage at inverting end (-), more sensitive the sensor.

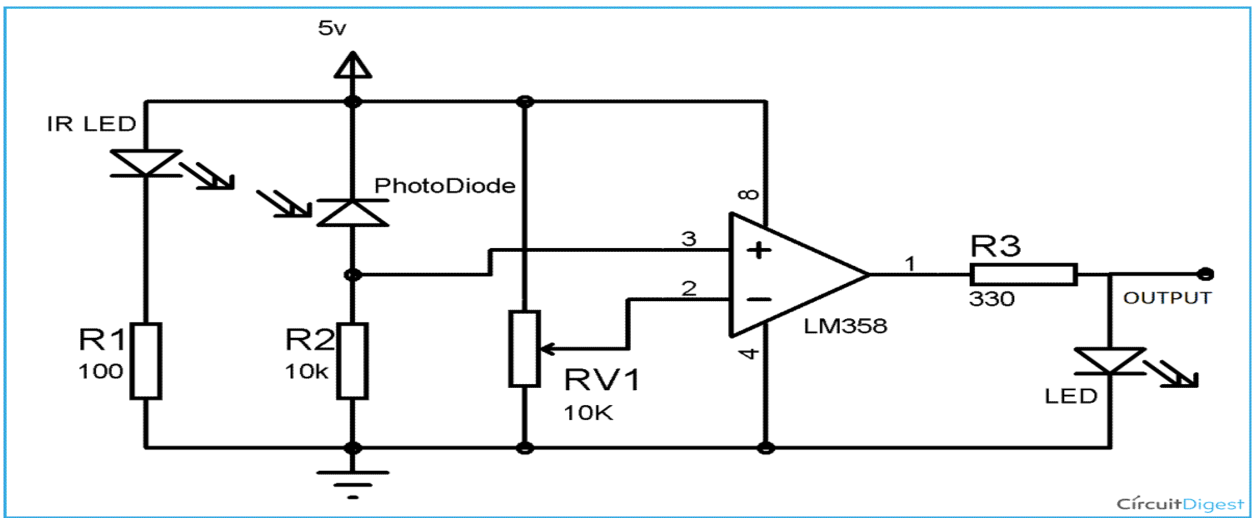

FIG.13. IR SENSOR CIRCUIT DIAGRAM

4.5 BREAD BOARD

A breadboard is an electronic tool which can be used to test electrical circuits. Instead of using soldering to connect wires and components together (like on a perfboard or printed circuit board), they can be stuck into the holes of the breadboard. It has metal strips inside that will connect them, and it lets them be removed easily or moved around when testing a circuit.

The rows and columns of holes on a breadboard are usually labelled with numbers and letters. Everything in a row with the same number will be connected, except if the breadboard has a strip down the center. In that case, the metal is split and the row has two separate connections (one on each side). The center strips is also useful when connecting integrated circuits, because they can be pushed in over the top of it and have legs connecting to both sides without overlapping the connections.22 or 24 gauge wire usually work best to plug into the holes in a breadboard.

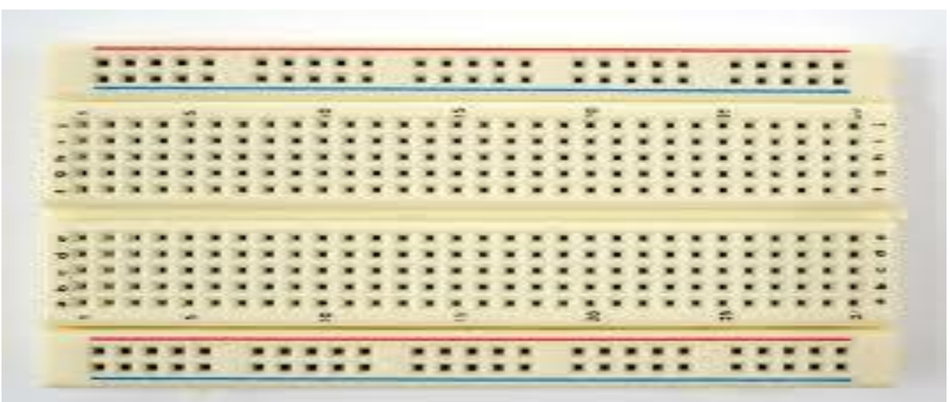

FIG.14 BREAD BOARD

CHAPTER 5

OBSERVATIONS , OUTCOMES AND RESULT

5.1 OBSERVATIONS AND OUTCOME

For a comparative study the following assumptions are taken:

Assumptions:

Suppose a 10 km long one-way street contains 500 street lights and the nominal range of all the street lights are 20 meter.

• All the street lights are supposed to glow for a period of 12 hour from 6 pm to 6 am.

• One street light is supposed to consume 1 kwh power for a period of 1 hour when it glows with its maximum intensity so that one street light consumes maximum 12kwh in a day.

• So 500 street lights consume maximum 12kwh*500=6000kwh power in a day.

• All the vehicles are crossing the street lights at a speed of 40km/hr.

Case-1: (from 1am to 5am; let only one vehicle is in motion)

All the 500 street lights are consuming a power of 500 kwh for a period of one hour and a vehicle is crossing the lane at a constant speed of 40 km/hr.

In conventional street light system all the street lights are supposed to consume 500 kWh. Time required to cross the nominal range of one street light

$$= \frac{\text{Nominal Range of one street light}}{\text{speed of the vehicle}}$$

$$= \frac{20\text{m}}{40 * \frac{1000\text{m}}{3600s}}$$

= 1.8 second or 0.5 x 10^{-4} hour

So every street lights will glow with 100% intensity for only 1.8 second and rest period 3598.2 second it will glow with 10% of the maximum intensity. Now we can see that when a street light glows with its maximum intensity it consumes 1000 watts for 3600 seconds so it consumes 0.278 watts for 1 seconds with 100% intensity and 0.0278 watts with 10% intensity. So one street light will consume 100.02 watt and 0.5 watt and total 100.52 watt power when a vehicle crosses it. So a street having 500 street lights will consume 50.26 kw.

Case-2: (from 5am to 6am and 12 pm to 1 am; let only 10 vehicles are in motion)

If 10 vehicle crosses the street light one by one; so for a period of total 1.8 * 10 = 18 seconds they will be in the nominal range of street lights. So total 5 watts + 99.5 watts = 104.5 watts.

Case-3: (from 10pm to 12am; let only 100 vehicles are in motion)

If 100 vehicle crosses the street light one by one; so for a period of total 1.8 * 100 = 180 seconds they will be in the nominal range of street lights. So total 50 watts + 95watts = 145watts.

Case-4: (from 6pm to 10pm; let only 1000 vehicles are in motion)

If 1000 vehicle crosses the street light one by one; so for a period of total 1.8 * 100 = 1800 seconds they will be in the nominal range of street lights. So total 500 watts + 50watts = 550watts.

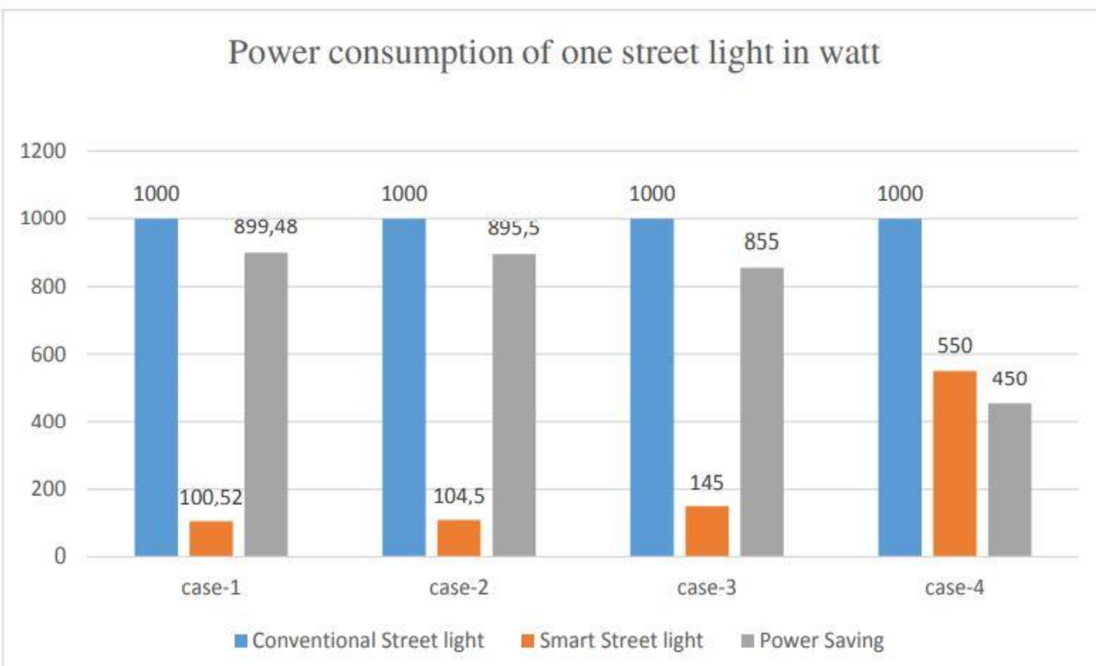

FIG.15. POWER CONSUMPTION CHART

5.2 RESULT

The goal of this thesis was to control the intensity of the street lights during day/night , and to detect the movement on the road and increase the intensity of the lights when there is movement and reduce the intensity after the movement has passed. All these were achieved in our project an innovation with many future applications apart from the fact that it can also be used in many present day tech such as head lights, street light, park lights, industrial lights and many more. The usage of the smart lighting system will undoubtedly change the world that see today.

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION

In this thesis, a design scheme for controlling a streetlight system based on Arduino Uno microcontroller has been demonstrated, which can be programmed to react to events (based on night and object's detection as described above) and to cause corresponding actions. The proposed scheme provided with two operational modes, in which the first automated system is used to control the streetlights based on night (lights turn to DIM state) and object detection (lights turn to HIGH state). The same system is further extended to design a second mode that turns the streetlights ON, based on only object's detection. Meanwhile, it is presented that the proposed automated systems have capabilities to control the status of doors (closed/opened) and monitor objects. The hardware implementations of the proposed systems were carried out at a lab-scale prototype to verify the simplicity, flexibility, reliability, specificity and low cost of the system. As a lesson learned, we found that the proposed systems can be easily tested under real conditions at large-scale in near future, and it can be easily implemented in smart cities, home automation, agriculture field monitoring, timely automated lights, parking lights of hospitals, malls, airport, universities, and industries, etc.

6.2 FUTURE SCOPE

The future work of this project is to use CCTV cameras with real time image processing.The use of CCTV cameras serves an additional purpose of Security surveillance and The above project can develop solar street light system with Automatic street light controller. The system can be powered from a battery, which can be charged during day time by harvesting the solar energy through a solar cell. The solar energy harvested from sunlight can be.

7. References

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6. "Smart Street Lighting System: An Energy Efficient Approach", Volume 5 Issue 2, February 2016.

7. "Smart Street Light Using IR Sensors", Volume 3, Issue 2, Mar. - Apr. 2016, PP 39-44

8. **"**Intelligent Street Lighting System Using GSM", Volume 2 Issue 3, March. 2013

ANNEXURE

CODE

```
int light;
void setup () {
 pinMode (9,OUTPUT );
 pinMode (6,OUTPUT );
 pinMode (5,OUTPUT);
 pinMode(A1,INPUT);
 pinMode(A2,INPUT);
 pinMode(A3,INPUT);
 Serial.begin(9600);
}
void loop()
{
   light = analogRead(A0);
 if(light<400)
  {
    analogWrite(9,66);
```

```
 analogWrite(6,66);
 analogWrite(3,66);
if(digitalRead(A1)==LOW)
 {
  analogWrite(9,255);
 }
else
 {
  analogWrite(9,66);
 }
if(digitalRead(A2)== LOW)
   {
   analogWrite(6,255);
   }
else
   {
  analogWrite(6,66);
   }
```

```
  if(digitalRead(A3)==LOW)
      {
   analogWrite(3,255);

      }

   else
      {
     analogWrite(3,66);

      }
}
else
{
 digitalWrite (9,LOW);
 digitalWrite(6,LOW);
 digitalWrite(3,LOW);
}
```