INNOVATIVE ARDUINO STREET LIGHTING WITH IR SENSING

A Industrial Oriented Mini Project report submitted to JNTUH
In partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

in

ELECTRONICS & COMMUNICATION ENGINEERING

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(Affiliated to JNTU HYDERABAD)

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CERTIFICATE

This is to certify that the Industrial Oriented Mini Project report entitled **"INNOVATIVE ARDUINO STREET LIGHTING WITH IR SENSING"** is being submitted by **T. AKHIL (20UK1A0412), K. YUGENDER (20UK1A0414), P. RAKESH (20UK1A0438), E. AKHIL (20UK1A0439)** in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in **Electronics & Communication Engineering** to **Jawaharlal Nehru Technological University Hyderabad** during the academic year **2023-2024**, is a record of bonafide work carried out by them under my guidance and supervision. The results embodied in this Industrial Oriented Mini project report have not been submitted to any other university or the institute for the award of any degree.

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DECLARATION

We declare that the Industrial Oriented Mini Project entitled "**INNOVATIVE ARDUINO STREET LIGHTING WITH IR SENSING**" submitted in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in **Electronics & Communication Engineering** to **Jawaharlal Nehru Technological University Hyderabad** is the work carried out by us.

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ABSTRACT

The main theme of this project is an Arduino microcontroller, which intelligently controls the street lights based on real-time data acquired from IR sensors strategically placed along the streets. These IR sensors detect the presence of vehicles, pedestrians, or any moving objects within their range. When activity is detected, the system instantly adjusts the lighting intensity, providing adequate illumination only where and when needed. As the activity diminishes, the lighting gradually returns to its default low-intensity mode, conserving energy.This adaptive and responsive lighting system not only reduces energy consumption but also enhances road safety by ensuring well-lit areas when required. It also offers cost savings by prolonging the lifespan of the light sources and reducing maintenance efforts.

The Arduino-based system can be easily integrated into existing street lighting infrastructure, making it a practical and sustainable solution for modern urban environments. Preliminary tests and simulations demonstrate its feasibility and effectiveness in optimizing street lighting while prioritizing energy efficiency and safety. This innovation represents a step forward in the quest for smarter and more sustainable urban lighting solutions. As the world is going digital so is the need of the hour that we must opt for new technologies. With a smart street light system using Arduino, we not only can manage electricity usage but also chances of accidents will be minimized. The best thing about these street lights is instead of turning on all night whenever any motion will be detected light will be turned on automatically. In case there will be no motion then these lights will be turned off.

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LIST OF ABBREVIATIONS

IR	:	Infrared Radiation
LDR	:	Light Dependent Resistor
LED	:	Light Emitting Diode
HPS	:	High Pressure Sodium
PIC	:	Peripheral Interface Controller
IDE	:	Integrated Development Environment
CT	:	Current Transformer
AC	:	Alternating Current
DC	:	Direct Current
LAN	:	Local Area Network
PWM	:	Pulse Width Modulation
UART	:	Universal Asynchronous Receiver/Transmitter
IC	:	Integrated Circuit
SRAM	:	Static Random Access Memory
EEPROM	:	Electrically Erasable Programmable Read-Only Memory
PIR	:	Passive Infrared

CHAPTER 1
INTRODUCTION

Night travel has always been troublesome and considered unsafe because of the lingering darkness. To get rid of this issue, the idea of public lightning was proposed by ancient Romans. A civilized and planned system was first used in the 16th century. Since then street lights have undergone many changes and updates to become what it is today.

These traditional lights also have their pros and cons. These lights are switched ON and OFF manually. Hence sometimes mistakes happen. Like light remains ON even during the day. And by mistake sometimes lights remain OFF even during the nights. Street lights also run using the electricity supplied by the respective electric boards. And so when in the night, the supply is cut off due to any reason, the surrounding is completely engulfed in darkness as street lights and also the lights from our homes go OFF. This also leads to confusion and accidents. Several mishaps happen due to the darkness that engulfs our surroundings.

To overcome these shortcomings the idea of smart street lights was proposed. These lights are equipped with sensors, microcontrollers, etc. which makes this system smart. LDRs (Light Dependent Resistors) are the trigger to turn ON and OFF the smart street lights at Twilight. IR (Infrared) sensors sense the presence of vehicles and humans and switch ON and OFF the street lights in the dead of the night. LEDs are used in place of Sodium lights which are both energy and cost-efficient. Overall this system is costly to install but is profitable in the long run.

The conventional street lighting systems are often inefficient and consume excessive energy due to their static operation, leading to unnecessary wastage. In response to these challenges, this research presents an innovative Arduino-based street lighting system that incorporates Infrared (IR) sensing technology. The proposed system aims to optimize energy usage, enhance user safety, and reduce operational costs. This adaptive and responsive lighting system not only reduces energy consumption but also enhances road safety by ensuring welllit areas when required. It also offers cost savings by prolonging the lifespan of the light sources and reducing maintenance efforts.

1.1 HISTORY OF STREET LIGHTS

During the time of night, there is almost negligible natural light present in the surroundings or the environment. This has always been a problem for humans. A lot of basic problems, as well as an inconvenience, have to be faced by the people at the time of night or dark. People can be attacked, mugged, or rubbered in the shadow of the dark during the night.

The history of street lights is much older than we think because this issue has always prevailed in society irrespective of the type and culture. It is also known that gas leaking from the volcano was used as fuel for street lamps with the help of bamboo pipes (early 500 B.C). Oil lamps were filled with vegetable oil and used as street lights by the ancient Romans. They also used a separate slave to take care of these lamps, to light them, extinguish them and keep a check on the level of oil in the lamps.

The very first organized method of public lightning was done in 1417 by Sir Henry Barton, Mayor of London. He brought a law that every house must hang lanterns outside their homes at the time of dawn in the winter season. After this in 1524 streets in Paris were also illuminated for the first time. Order was given that every house must have a light on its window facing the street. There was one other method known as “Link boys”. Wealthy citizens of London use to take some servant boys along them at night. These boys carried torches to accompany the wealthy citizens. These servants accompanied their masters throughout their night travel carrying lamps.

Fig 1.1: Coal Gas Lamp

After few years of this came the invention of electricity. This proved to be the turning point in the history of street lights. Street light became more efficient.

1.2 YABLOCHKOV CANDLE

The first streetlight that was lit using electric power was given the name “Yablochkov candle” in the year 1878 in Paris. Within three years, 4000 more electric lamps came into use in place of gas lanterns. They used arc so they were also called arc lamps.

These arc lamps started becoming famous and in 1890 USA also had more than 120000 arc lamps. The towers on which these were installed were known as moonlight towers. These towers were made tall to cover the move area. But these arc street lights also had some problems and flaws, one was that they produced very harsh light and the second was that they did not last for too long. Thus, after some time these arc lamps were replaced by incandescent lamps. These lamps solved both the problems of the arc lamps. It was cheaper, lighter, and longlasting. This started to prove very useful for the industries.

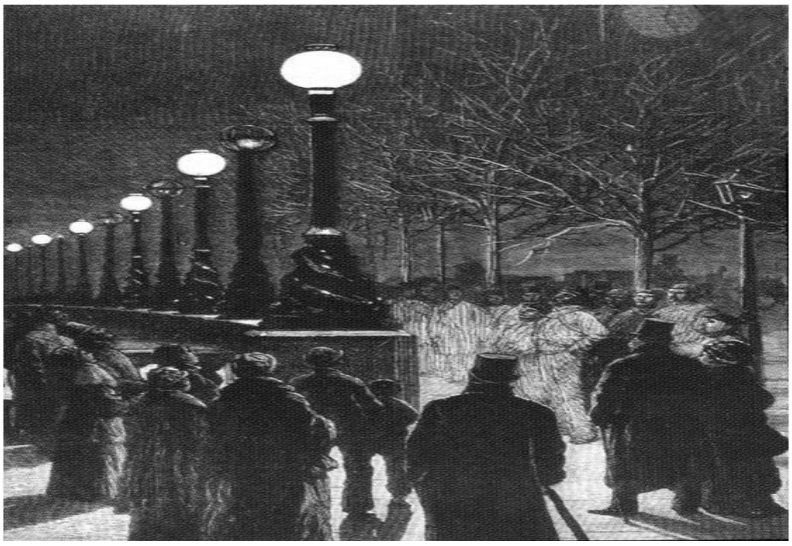

Fig 1.2: Yablochkov candle

1.3 MODERN LIGHTS

After world war 2 efficient lamps like high-intensity discharge lamps, low-pressure sodium lamps came into good use. They gave the advantage of low power consumption and long life.

These lamps are still in use in today's time for street lighting purposes.

As the 20th century proceeded in the late years of this century high-pressure sodium lamps came into preference. These lamps provided greater photopic illumination for the least consumption of electricity.

Fig 1.3: High-pressure Sodium Lamp

Now variation in illuminance standards is allowed for different spectra. HPS performance is decreased to 75% in Australia, and in the UK it is reduced with a much higher value.

In today's time, many new technologies are used in the street lights such as LEDs and induction lights. These lights very efficient and give a white glow on street making the scenery look more beautiful than before.

Fig 1.4: Intelligent street light

Now the time is demanding a more efficient and automatic street light for our roads and street which can work on its intelligence. The only thing we need to do is to monitor the working of these intelligent or automatic street lights. These lights will automatically on and off as per the movements on the road. They will play a major role in moving towards a smart world.

1.4 OBJECTIVES

The main objectives of making a street light automatic and intelligent are

i. To make it more efficient so that a good amount of power can be saved and utilized for other purposes.

ii. To minimize the manual error

iii. To operate the street lights with real-time data.

These objectives are fulfilled by automatic street lights using sensors.

The project works with the help of 3 main units:-

I. Sensing unit

II. Control unit

III. Feedback unit

To develop an intelligent street lighting system equipped with vehicle detection sensors which provide a better solution to reduce electricity wastage.

The objectives for an innovative Arduino street lighting system with IR sensing are:

1. **Energy Efficiency:** Reduce energy consumption by ensuring street lights are only active when necessary, based on the presence of objects or motion detected by IR sensors.

2. **Cost Savings:** Lower operational costs by minimizing the time street lights are illuminated and optimizing energy usage.

3. **Safety**: Improve safety in public spaces by ensuring adequate lighting when needed, especially during nighttime or in areas with low visibility.

4. **Environmental Impact**: Reduce the carbon footprint by using energy-efficient lighting and potentially incorporating solar power sources.

5. **Customization:** Allow for customization of lighting schedules and brightness levels to suit specific environmental conditions and user requirements.

6. **Motion Detection:** Implement reliable motion detection algorithms to accurately detect the presence of pedestrians, cyclists, or vehicles.

7. **Adaptability:** Create a system that can adapt to changing weather conditions, traffic patterns, or special events.

8. **Remote Monitoring and Control:** Enable remote monitoring and control of the lighting system, providing real-time insights and the ability to adjust settings as needed.

9. **Data Collection and Analysis:** Gather data on lighting usage patterns to make informed decisions about optimization and maintenance.

10. **Reliability:** Ensure the system is robust and dependable, minimizing downtime and maintenance requirements.

11. **User-Friendly Interface:** Develop a user interface (if required) that allows users or administrators to easily interact with and configure the system.

12. **Weather Resistance:** Ensure the system is designed to withstand various weather conditions, including rain, snow, and extreme temperatures.

13. **Security:** Implement security features to protect the system from unauthorized access or tampering.

14. **Scalability:** Design the system in a way that allows for easy expansion to cover larger areas or to accommodate future growth.

15. **Compliance:** Ensure the system complies with relevant regulations and safety standards, particularly in public spaces.

CHAPTER 2

LITERATURE SURVEY

Street Light Glow on detecting vehicle movement using sensor is a 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 lamp post and control terminal using ZigBee Wireless protocol. It also combines various technologies: a timer, a statistics of traffic flow magnitude, photodiodes, LED, power transistors.

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. They 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 energy source i.e. the solar power for street lighting. They have also used 8052 series microcontroller and it 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 it is night the lights are switched off.

The main aim of doing this " Innovative Arduino Street Lighting with IR Sensing "is to create a more energy-efficient and responsive street lighting solution. As the world is going digital so is the need of the hour that we must opt for new technologies. With a smart street light system using Arduino, we not only can manage electricity usage but also chances of accidents will be minimized. The best thing about these street lights is instead of turning on all night whenever any motion will be detected light will be turned on automatically. In case there will be no motion then these lights will be turned off.

An innovative Arduino street lighting system with IR sensing can contribute to more sustainable, efficient, and safer urban environments while reducing energy consumption and costs.

2.1 PROBLEM STATEMENT

It is very common to see the street light alight all night, which is a great waste of energy. The power consumption is relatively high day by day. Some streets are not fully occupied like the main city streets; sometimes they are empty for a certain period time.

Based on the problem, the observation of street lighting was done to improve the street lighting control system to make sure the street light can operate properly. By applying this system, it can reduce energy consumption and also can reduce electricity wastage. Therefore it is important to know the ways how to minimize the power consumption of the street light.

2.2 EXISTING METHOD

Creating innovative Arduino-based street lighting with IR sensing involves integrating technology for energy-efficient and smart lighting solutions. Here are some existing methods and components commonly used for this purpose:

- Arduino Micro controller
- IR Sensors
- Light Sensors
- Efficient Power Supply
- Real-time Clock Module
- Machine Learning
- Mobile App interface

In the existing system, the highway lights are operated by hand to turn ON and OFF. So we need manpower to operate these, we have brought a very good system in which we don't need manpower and manually operating the highways road lights when vehicles approach we have set down an LDR and Arduino board which automatically turns ON and OFF the lights depending on the sunlight and vehicles come.

Fig 2.1 : Street Lighting System

2.3 PROPOSED SYSTEM

Creating innovative Arduino-based street lighting with IR sensing involves integrating technology for energy-efficient and smart lighting solutions. Here are some existing methods and components commonly used for this purpose:

- IR Motion Sensing
- Ambient Light Sensing
- Time-Based Scheduling
- Adaptive Brightness Control
- Weather Sensing
- Emergency Mode
- Remote Control

The road lights will be controlled the night. If the sun sets the light will be on and light will be off if the sun is rising. We used Arduino board, 2 IR sensors 5 LED's 1 LDR sensor which plays a key role in the turning ON and OFF of the lamps and dims the light. The Arduino UNO Microcontroller acts as an interface while converting the Analog input into a digital form of output and makes the lamp glow bright and dull. The code is dumped into the Arduino board by using an Arduino IDE software. when the obstacle comes near to the lamplight the dim light show high brightness by following 2 lamp light and the obstacle move far away the light will dim. If nobody or no obstacle is there means the lamp light is in dim mode. If any obstacle

came near to IR sensor means continuously the light will show high intensity and light will be in ‘ON’ State.

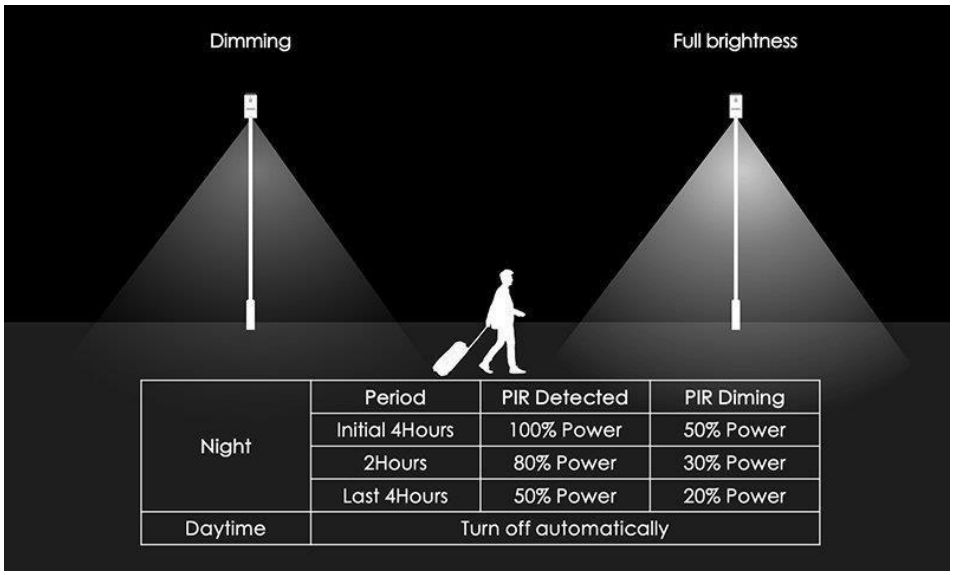

Fig 2.2 : IR Motion Sensing Method

An Arduino street lighting system with IR sensing can contribute to more sustainable, efficient, and safer urban environments while reducing energy consumption and costs.

CHAPTER 3
COMPONENTS

The Arduino-based system can be easily integrated into existing street lighting infrastructure, making it a practical and sustainable solution for modern urban environments. Preliminary tests and simulations demonstrate its feasibility and effectiveness in optimizing street lighting while prioritizing energy efficiency and safety.

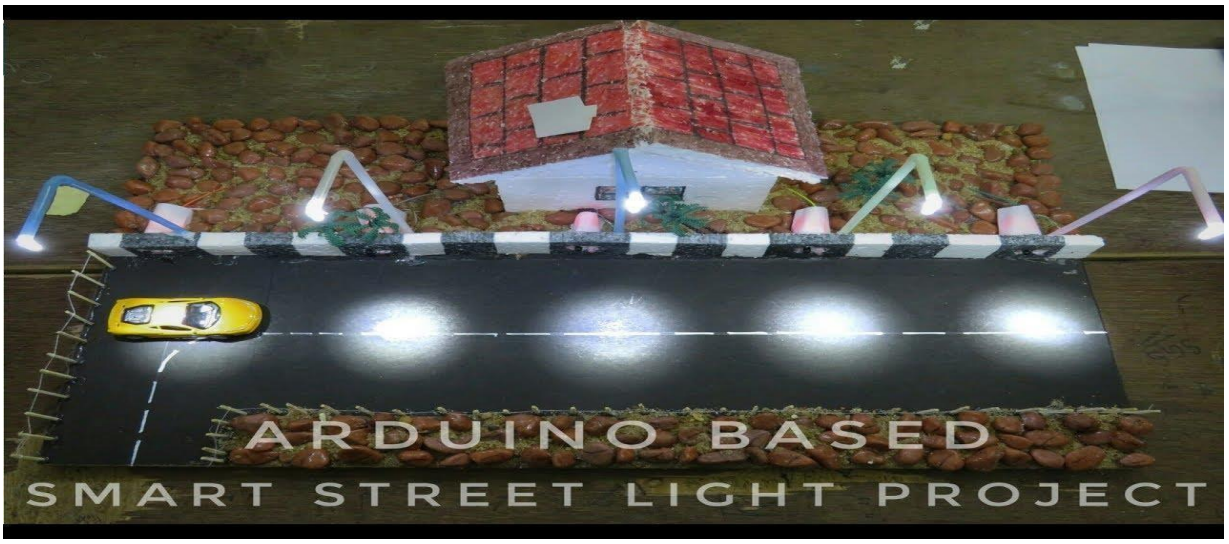

FIG 3.1 : Arduino Based Smart Street Light Project

This project is about Smart Street light, street light will turn on while vehicle is passing through it. Here we are using 2 IR sensors that senses the position of the vehicle, each IR sensor controls 3 LED's. When vehicle passes by a particular IR sensor it senses the position of vehicle and gives its signal to the Arduino board and it will turn on the LED's.

With a street light system using Arduino, we not only can manage electricity usage but also chances of accidents will be minimized. The best thing about these street lights is instead of turning on all night whenever any motion will be detected light will be turned on automatically. In case there will be no motion then these lights will be turned off. It can lead to energy savings, cost reduction, and improved safety.It reduces power consumption and human effort.

The Arduino-based system can be easily integrated into existing street lighting infrastructure, making it a practical and sustainable solution for modern urban environments. Preliminary tests and simulations demonstrate its feasibility and effectiveness in optimizing

street lighting while prioritizing energy efficiency and safety. This innovation represents a step forward in the quest for smarter and more sustainable urban lighting solutions.

3.1. COMPONENTS REQUIRED

In order to complete this project we will require both Hardware and Software components.

The required Hardware components are

- Two IR sensors
- IR sensor module
- Arduino Uno
- 12 LEDs

The required Software components are

- Arduino IDE
- Arduino Code
- Motion Detection Algorithm

3.2. CURRENT SENSOR

Commonly referred to as current transformer or CTs, current sensors are the devices that measure the current passing through wire using a magnetic field and sense current it and generate output proportionally. The current sensor works both for an AC and DC without any interruption. An in-circuit current sensor is capable of measuring current passively and replaces the current sensor around the conductor where we want to measure the output.

There is much essential application of the current transformer-

- For determination of energy uses by separate tenants, these are commonly used in sub-metering.

The current sensor also helps with their facility regulation by providing information on energy usage and then used to calculate when to keep cost high and low and increases efficiency also.

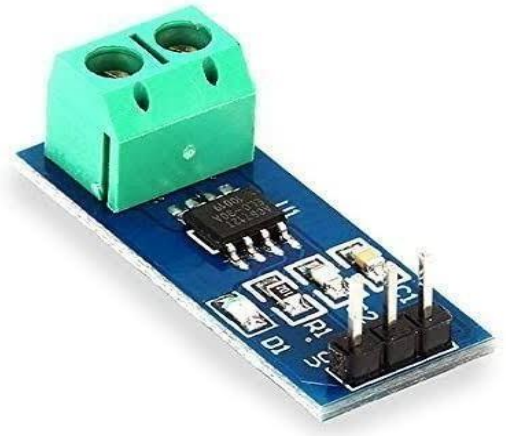

Fig 3.2 : Current Sensor

3.3 TRANSCEIVER

The combination of transmitter and receiver in a single package is termed a transceiver. Irregularly the Transceiver name is used as a reference to transmitter and receiver devices that are used within a cable or in the optical fiber systems. The transceiver is used in various wireless communication devices like cellular telephones, radios cordless telephone sets, and many more. The major function of these devices is to transmit as well as to receive a different signal within the wires and fibers.

This is majorly used in the land to apply signal illustrated to the components over the network wire and it also detects the signal flowing through the wire in several LANs, it is embedded in the network interface card and some kind of network, there is a requirement of an exterior transceiver.

Fig 3.3 : Transceiver

3.4 IR SENSOR MODULE

The infrared (IR) sensor is an electronic device that measures and detects infrared radiation in its surrounding environment. The detection range of the sensor can be adjusted by the potentiometer mounted on the sensor.

1. The effective distance range is 2 ~ 30cm
2. Working voltage is 3.3V-5V.

Fig 3.4 : IR Sensor Module

An infrared sensor is a sort of device that can sense surrounding like measuring the heat of an object or detecting motion. These types of sensors measure only infrared spectrum, all the objects radiate some form of thermal radiation.

Human eyes fail to detect such radiation while IR sensors can. The emitter is an IR LED and the detector is an IR photodiode (sensitive to IR light of the same wavelength of the LED). Resistances and output voltage changes as soon as IR light falls on the photodiode.

3.4 1 Classification of Infrared Sensors

ACTIVE SENSOR

These types of sensors have both the transmitter and the receiver. Usually LED is used as a source. It is used as a non-imaging IR sensor whereas laser diode is used as an imaging IR sensor.

These sensors work all-around energy radiation. They are received and detected through energy radiation. They are used to fetch necessary information by the signal processor. Examples- Reflectance and break beam sensor.

PASSIVE SENSOR

This type of sensor has only a detector but no transmitter. It uses objects like transmitters or IR sources. The energy it emits is detected through an Infrared receiver. A signal processor is used to decipher signals to fetch information. Example- pyroelectric detector, bolometer, thermocouple-thermopile.

Passive sensors are further classified into two subcategories-

• **THERMAL IR SENSORS**

a. They do not depend on wavelength.

b. The energy source is heated

c. Slow response

• **QUANTUM IR SENSORS**

a. Depend on wavelength

b. High response

c. Need regular cooling

3.4.2.IR IMAGING DEVICES

It is used in IR waves because it is not visible. It is used for thermal images, night vision devices. The electronic detector is cooled by liquid helium or liquid nitrogen. These cooling detectors ensure that radiated energy comes from terrain and not from the temperature of the object within scanner or IR imaging devices.

Applications of the infrared sensors include the following.

- Meteorology
- Gas detectors
- Testing of Anesthesiology
- Exploration of Petroleum
- Climatology

- Photo-bio modulation

3.5 LDR (Light Dependent Resistor)

LDR is a light-dependent resistor whose resistance changes with the intensity of light. When the light intensity will change the resistance of the LDR will be changed and according to that, we will make the decision whether to turn on or off the LED.

The light-dependent resistor is an electronic component that is used to detect light and used in the operation of the circuit depending upon the intensity of light. It is used in an electrical circuit where there it is important to detect the presence of light and to measure the intensity of light. There are many terms given to light-dependent resistors that as photo registers or LDRs.

There are various names used for this light-dependent resistor is the light-dependent resistor (LDRs), photoresistor, even photoconductor, or photocell. The same function of LDR is also performed by electronic components like photodiode or phototransistor. a little amount of light level changes the large resistance of the circuit so it is preferred or is being convenient to choose in many electronic circuits design.

LDR is used in a variety of different applications such as there was a time when it is used in photographic light meter and even now there are many places and many devices where it is used where it is necessary to detect light levels or presence of light is important. manufacturing of LDR is easy and it has low maintenance cost and its cost is also low.

Fig 3.5 : Light Dependent Resistor

LDRs are passive devices they do not possess a PN junction even though a semiconductor material is used for manufacturing photo resistors this distinct property makes it different from other devices like photodiode and phototransistor.

The specifications of LDR are as follows :-

- Maximum Voltage: 150V
- Maximum power consumption: 100mW
- Temperature: – 30C – – +70C
- Peak Spectrum: 560
- Bright Resistor: 5-10K_
- Dark resistance: 0.8M_

3.6 LIGHT EMITTING DIODE

Fig 3.6 : Light Emitting Diode

A light-emitting diode (LED) is a two-lead semiconductor device. LED is a p- n junction diode that emits light when we current move on it or turn it on. The big terminal is an anode and the small terminal is a cathode. LEDs are typically small. An LED is a semiconductor light source that produces light when triggered by an electronic current. A semiconductor is a solid substance whose ability to conduct electric current ranges between that of most metals and an insulator.

There are a variety of advantages of LED to lighting professionals and ultimate beneficiaries of LED lighting system-from individual creative to the innovative business to the beautiful cities and amazing countries:

- The brightness and intensity level of LED is high-Generated lumen output is high, during the intensity of light and color light is good by the LED.

- Range- Without any use of gels are filtered the color and tunable of white light by led and have many color temperature ranges and accuracy is very high.

3.7 RESISTORS

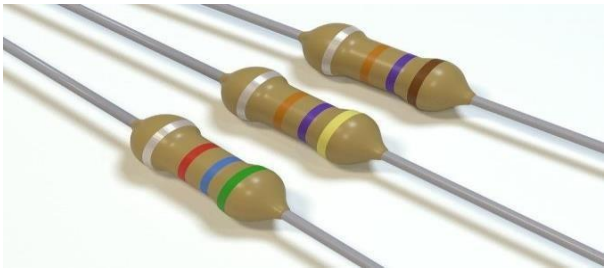

Fig 3.7 : Resistor

The Resistor is a passive device. It opposes the current flow or electron flow in the circuit. The Resistor sent a fixed current through the circuit. It protects the device from any damage. We use a 370 ohms resistor for LED and a 1k ohms resistor for LDR.

3.8 ARDUINO UNO

Arduino UNO is the microcontroller used in this project, it is based on ATmega328. It is open source electronic platform based on easy to use software and hardware. It reads input-light on sensor, finger on a button, etc. it has 14 input/output and 6 analog pins. The software used in this microcontroller is ARDUINO IDE.

The word 'Uno' means 'one' in Italian and it is taken to signify the initial release of Arduino software and its originals and preferred quality are made in Italy. Uno is the latest in this series of USB Arduino boards. The ATmega 328 onboard comes with the preprogrammed bootloader which allows users to upload new code without the use of any external hardware in the Arduino software.

Arduino Uno is an open-source microcontroller board based on the ATmega 328p microcontroller which is developed by the Arduino company. This board consists of digital and analog input/output pins which are further connected to other devices, electronic component, and circuits. This board consists of 14 input and output pins, out of which 6 analog input/output pins and 6 are capable of PWM outputs and these are programmable with Arduino IDE (Integrated Development Environment) with B-type USB cable. It accepts voltage

between 7 and 20 volt and this can be powered by USB cable or external 9-volt battery. It consists of everything that is needed to support the microcontroller and it can be operated by simply connecting to a computer with a USB or a power source with AC or DC adaptor.

Specification:-

Its Operating Voltage: 5 Volts

Its Input Voltage: 7 to 20 Volts

External power source: 9 volts battery

Digital I/O Pins: 14

PWM Output Pins: 6

Analog Input Pins: 6

Per I/O in DC Current: 20 mA

DC Current for 3.3V Pin: 50 mA

Flash Memory: 32 KB (of which 0.5 KB used by bootloader)

UART: 1

SRAM: 2 KB

EEPROM: 1 KB

Clock Speed: 16 MHz

Length: 68.6 mm

Fig 3.8 : Arduino UNO

3.9 ARDUINO IDE

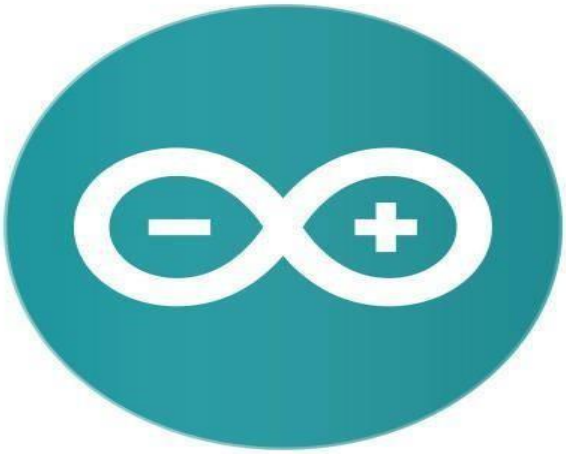

Fig 3.9 : Arduino IDE

The code is done with help of Arduino IDE software. It is free source software.It is easy to code in that software platform. We use the c++ language to code.

- The Arduino Software (IDE) makes it easy to write code and upload it to the board offline. We recommend it for users with poor or no internet connection. This software can be used with any Arduino board. There are currently two versions of the Arduino IDE, one is the IDE 1.x.x and the other is IDE 2.x. The IDE 2.x is new major release that is faster and even more powerful to the IDE 1.x.x. In addition to a more modern editor and a more responsive interface it includes advanced features to help users with their coding and debugging.
- The coding language that Arduino uses is very much like C++ (“see plus plus”), which is a common language in the world of computing. The code you learn to write for Arduino will be very similar to the code you write in any other computer language – all the basic concepts remain the same – it is just a matter of learning a new dialect should you pursue other programming languages.

3.10 LIBRARY INSTALLATION

To install a new library into your Arduino IDE you can use the Library Manager (available from IDE version 1.6.2). Open the IDE and click to the "Sketch" menu and then *Include*

Library > Manage Libraries

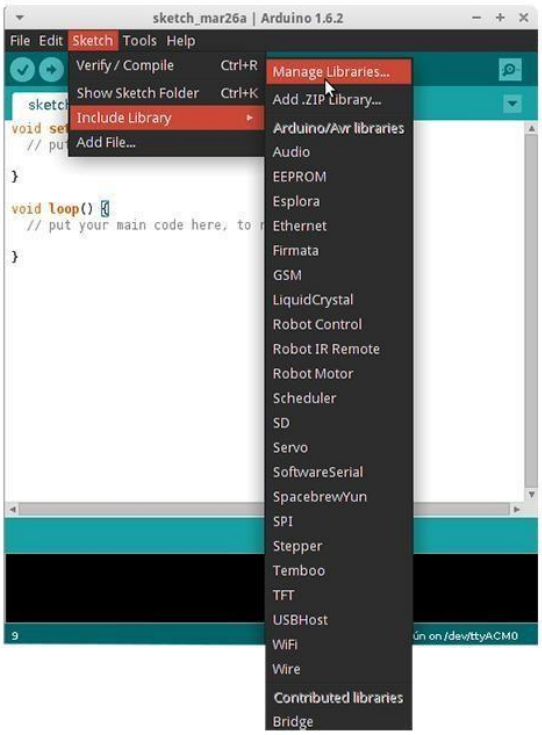

Fig 3.10: Library Installation

Then the Library Manager will open and you will find a list of libraries that are already installed or ready for installation. In this example we will install the Bridge library. Scroll the list to find it, click on it, then select the version of the library you want to install. Sometimes only one version of the library is available. If the version selection menu does not appear, don't worry: it is normal.

Finally click on install and wait for the IDE to install the new library. Downloading may take time depending on your connection speed. Once it has finished, an *Installed* tag should appear next to the Bridge library. You can close the library manager.

CHAPTER 4
METHODOLOGY

4.1 BLOCK DIAGRAM

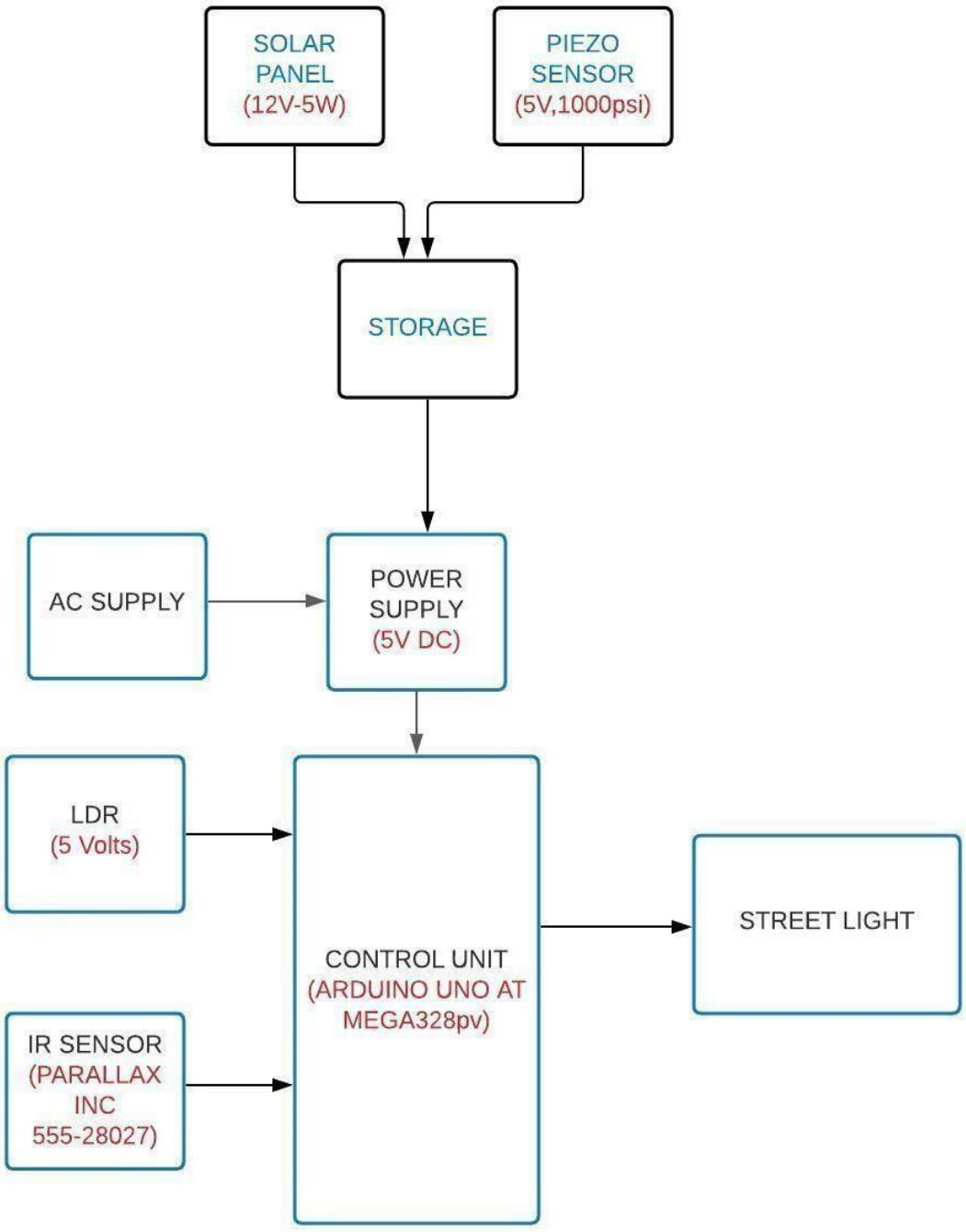

Fig 4.1 : Block Diagram of Automatic Street lights using different sensors

Above shown is the block diagram of Automatic street lights using different sensors. The diagram consists of three main sensors that sense different factors surrounding us.

Information is collected from different sensors attached to each pole send to the control unit which is precoded as per our requirement. Then the resultant signal is sent to the minicomputer (Raspberry pi) where the data is stored and thus a feedback signal is generated which is sent back to the control unit and then to the street light poles. Thus, making the lights ON or OFF or dim as per the feedback given.

The data stored in the mini-computer can also be used for sending notifications on an app or a website as per the requirement with the help of the internet making it a more real-time efficient project.

A separate source unit is also shown in the diagram consisting of a solar panel and a Piezoelectric sensor. This unit together helps in providing extra voltage sources to the street light making it more efficient. This unit has a battery also connected with it for the storage of energy generated by solar panels and a piezoelectric sensor.

Initially we need to make the connections according to the circuit diagram. The code is very important in making the whole equipment work. Recent days, Smart Street Light System is major component of a smart city Infrastructure. The important function is to lighting the city streets using. Sensor's to save the current or power energy. In existing system using normal street lamps, It takes more current and expensive so we must use LED lamps to save the current and low amount of power is required.

The project works with the help of 3 main units:-

I. Sensing unit II. Control unit

III. Feedback unit

4.2 SENSING UNIT

The main function of the elements of this unit is to sense different conditions and parameters of the environment around them. All the types of sensors like Infrared sensors, Lightdependent resistors, and current sensors are part of this sensing unit. They all have different roles for sensing different things in the environment and then send the signal to the control unit. Now let's see what every sensor does individually. First is the IR (infrared) or the

PIR (passive infrared) sensor. It is placed on each pole of the street light. The work of the IR sensor is to sense any movement of an object or human or animal in its vicinity. So as the vehicle passes through the vicinity of a pole, the IR sensor will send the information to the control unit about the vehicle or vehicle passing.

Next is the LDR, it is also placed on each node or pole of the street light. Lightdependent resistor works on the principle of Photoconductivity which is nothing but an optical process or phenomenon. Its work is to detect the presence or absence of light around it. So, as it starts getting dark, LDR sends this information sensed by it to the controller which then switches ON the lights or increases the intensity of the light. Another one is the Current sensor, which is a safety device. As the current flows it produces a voltage drop.

4.3 CONTROL UNIT

Once all the signals are collected from the sensor then the work of the control unit starts. It consists of a microcontroller, it could Arduino Uno or Nodemcu v2 or any other as well. The main purpose of the controller is to analyze the information collected from the sensor and compare it with the preset commands and generate an Error signal, which is then sent to the minicomputer or the feedback unit. Commands are given to the controller before only and thus it operates accordingly. The most easily available microcontroller in today's time is Arduino Uno and Node Mcu v2 ESP8266.

4.4 FEEDBACK UNIT

The error signal generated by the control unit is now sent to the central base station of the project where the data collected and processed is stored as well. This unit consists of a minicomputer. This computer stores the information and then with all the available data collected a feedback signal is generated and given back to the controller (whether to switch ON or OFF the lights). The stored data in the minicomputer can also be used for real-time monitoring. This can be done with the help of the internet which can send a notification about all the actions going on along with the time and place. Another separate unit can also be installed with these 3 main units which consist of a Solar panel and a Piezoelectric sensor. They will make the project self-dependent and also contribute to the demand side management programs going in the country.

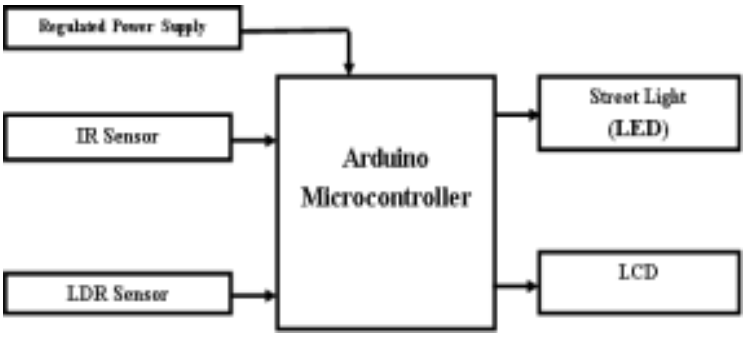

Fig 4.2 : Block diagram of the proposed concept

The above fig.1 represents block diagram of the project carried out . The main aim is to reduce the power consumption by the street lights, the present situation is like the street lights on the national highway will be switched ON in the evening and OFF in the morning. But the actual timing of these street lights to be switched ON is when there is absolute darkness. With this the power will be wasted to some extent. This project gives the best possible solutions for the power wastage. In our project we are using LDR, whose resistance varies according to the amount of light falling on its surface, this gives the indication whether it is day/night time. The IR sensors have been placed on both the sides of the road which are monitored by microcontroller. The IR'S will be activated only during the night times. If any obstacle that is vehicle or a person crosses IR automatically the light gets brighter till the obstacle crosses to certain distance and then the street light gets dimmer (less brightness). So as mentioned 50% of the power consumption is reduced. In this project we use microcontroller(ATMELGA328P) and a regulated voltage supply of 5V to the Arduino.

The road lights will be controlled the night. If the sun sets the light will be on and light off if the sun is rising. We used Arduino board, 5 IR sensors 5 LED's 1 LDR sensor which plays a key role in the turning ON and OFF of the lamps and dims the light. The Arduino UNO Microcontroller acts as an interface while converting the Analog input into a digital form of output and makes the lamp glow bright and dull. The code is dumped into the Arduino board by using an Arduino IDE software. when the obstacle comes near to the lamplight the dim light show high brightness by following 2 lamp light and the obstacle move far away the light will dim. If nobody or no obstacle is there means the lamp light is in dim mode. If any obstacle came near to IR sensor means continuously the light will show high intensity.

CHAPTER 5
IMPLEMENTATION

The Arduino-based system can be easily integrated into existing street lighting infrastructure, making it a practical and sustainable solution for modern urban environments. Preliminary tests and simulations demonstrate its feasibility and effectiveness in optimizing street lighting while prioritizing energy efficiency and safety.

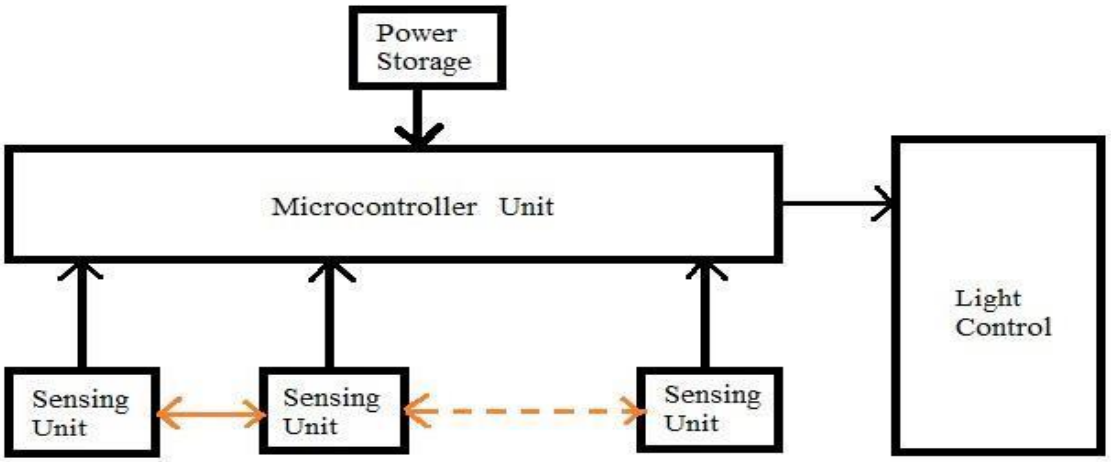

Fig 5.1 : Process of Implementation of Arduino based system

The following are the different steps included in building a Smart street light.

- Output of the LDR pin is connected to A5 (Analog) port of Arduino Uno board.
- Connect all output of the IR sensors to port numbers A0 and A1 respectively (Analog) which is the input signal to the Arduino board.
- Connect the ground of all the IR sensors to GND port.
- The output signals from LED are connected to port number 2 and 3 respectively.
- Again connect all the negative terminals of LED's to GND port.
- Power is passed to the Arduino (7-12V).

These lights were operated manually which sometimes results in misoperations. And a huge amount of energy is wasted on these lights because of these mistakes. Smart street lights provide a solution to this worldwide problem. These lights are not only energy but also costeffective. The system of smart street lights can be installed on existing infrastructure. They help us in saving energy in this era of energy crisis. And also make the lights automatic with less to no human intervention. LDRs (Light Dependent Resistors) act as a trigger to switching

the lights ON and OFF. The lights turn on automatically as soon as the sun sets and turns off when the sun rises, thus preventing any mistake.

5.1 HARDWARE IMPLEMENTATION

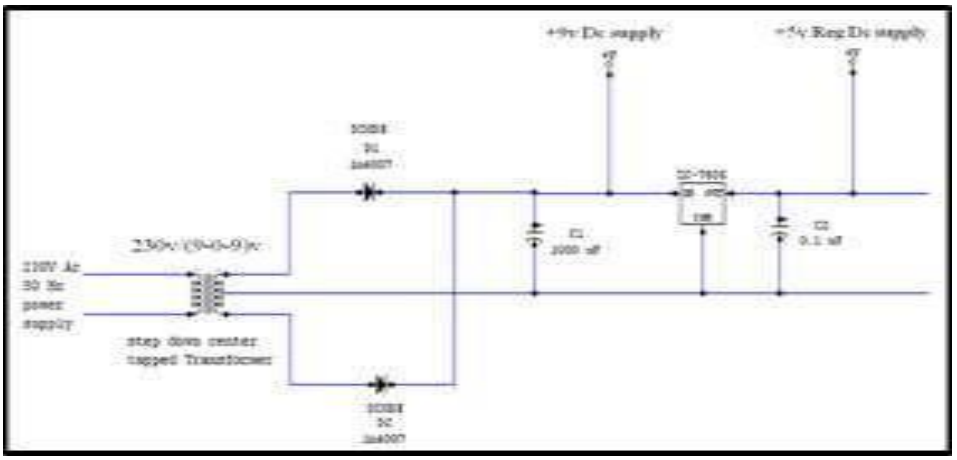

Fig 5.2 : Regulated Power Supply Circuit

The hardware design of the overall system has been implemented in the same form as it was designed. The subsystems implemented are illustrated in a sequence.

The 230V AC 50 Hz supply is given to step down center tapped transformer (9-0-9) V, 500mA. Here the voltage is stepped down from 230V to (9-0-9) V then by using two diode full wave rectification circuit the voltage is rectified and converted into pulsating dc that is fed to capacitive filter to remove the ripple content from the voltage and then it is fed to 7805 regulator IC to get a regulated power supply of 5V DC, 500mA. Appropriate heat sink is included to dissipate the heat developed during the operation.

5.2 LCD Interface to Arduino

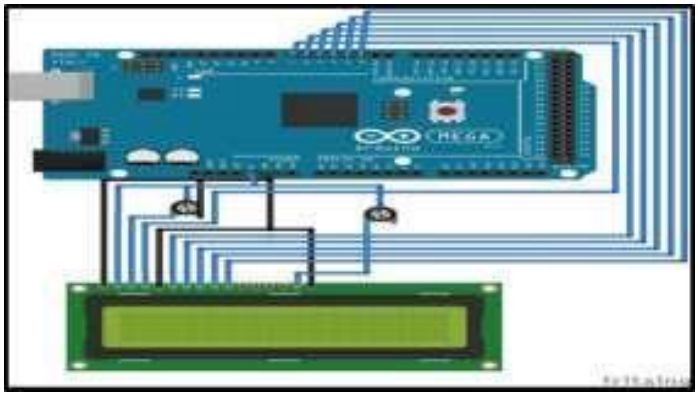

Fig 5.3 : Interface circuit of LCD with Arduino

The fig 5.3 represents circuit of LCD (20x4) interfaced with Arduino MEGA. The two potentiometer are used in order to control the contrast and brightness of the LCD. The LCD is used to display alphanumeric character. Four bit of data transmission is used to interface between the Arduino and LCD. Only write operation is used by sending a low signal to read/write terminal of the LCD.

5.3 IMPLEMENTED CIRCUIT

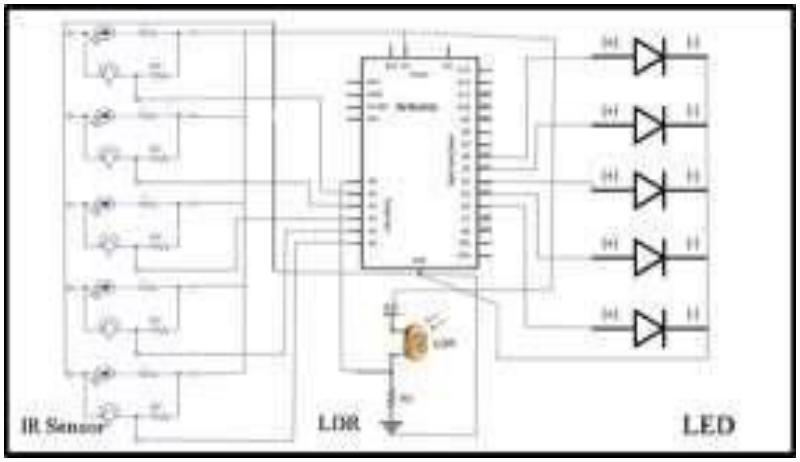

Fig 5.4 : Implemented Circuit

The aim of the project is to design a street light control system which automatically turns ON or OFF the street lights by detecting the movement of vehicles and depending on the intensity of sunlight. In dark, resistance of LDR is high. So the voltage drop across the LDR is also high. The IR sensor is placed directly in line of sight with IR receiver, so that the IR sensor receiver continuously receives the infrared rays. Once the receiver receives the infrared rays the microcontroller will ON or OFF depending on the instruction dumped in the program.

In dark, when a car or any other vehicle blocks any of the IR sensor, the microcontroller will immediately increase the intensity of the first LED.As the vehicle moves forward and blocks the second IR sensor, the corresponding next LED's will be turned ON and the first LED of the previous set is turned OFF. The process continues this way for all sensors and LED's .As the resistance value is maximum in the midnights, the controller checks peak time during which there is no traffic and switch OFF the lights.

5.4 SOFTWARE IMPLEMENTATION

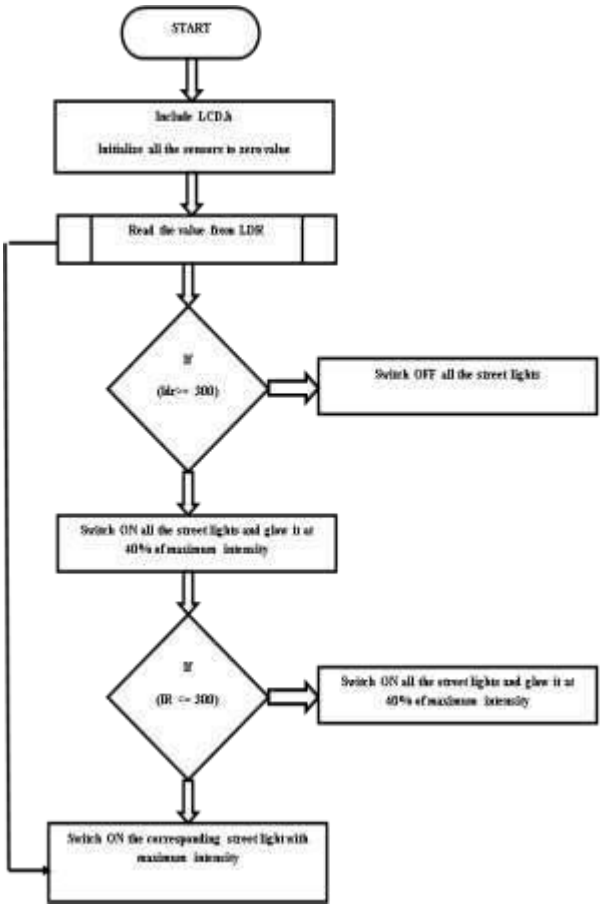

Fig 5.5 : Software Implementation process

The required Software components are

- Arduino IDE
- Arduino Code
- Motion Detection Algorithm

5.4.1 PROGRAM CODE FOR ARDUINO STREET LIGHTING WITH IR SENSING

```
int l1 = 2, l2 = 3, l3 = 4, l4 = 5, l5 = 6, l6 = 7;

#define bottom A1
#define top A0
```

```
void setup() {   pinMode(l1,
OUTPUT);  pinMode(l2,
OUTPUT);  pinMode(l3,
OUTPUT);  pinMode(l4,
OUTPUT);  pinMode(l5,
OUTPUT);  pinMode(l6,
OUTPUT);  pinMode(top,
INPUT);  pinMode(bottom,
INPUT);
}

void loop() {
if (digitalRead(bottom) == LOW) {
digitalWrite(l6, HIGH);
delay(500);
digitalWrite(l5, HIGH);
delay(500);
digitalWrite(l4, HIGH);
    delay(500);
```

```
 digitalWrite(l3, HIGH);
delay(500);
digitalWrite(l2, HIGH);
delay(500);
digitalWrite(l1, HIGH);
delay(500);
while(digitalRead(top)==HIGH);
digitalWrite(l6, LOW);
delay(500);
 digitalWrite(l5, LOW);
delay(500);
digitalWrite(l4, LOW);
delay(500);
digitalWrite(l3, LOW);
delay(500);
digitalWrite(l2, LOW);
delay(500);
digitalWrite(l1, LOW);
delay(500);
  }
```

```
  if (digitalRead(top) == LOW) {
digitalWrite(l1, HIGH);
delay(500);
digitalWrite(l2, HIGH);
delay(500);
digitalWrite(l3, HIGH);
delay(500);
digitalWrite(l4, HIGH);
delay(500);
digitalWrite(l5, HIGH);
delay(500);
digitalWrite(l6, HIGH);
delay(500);
 while(digitalRead(bottom)==HIGH);
 digitalWrite(l1, LOW);
delay(500);
digitalWrite(l2, LOW);
delay(500);
digitalWrite(l3, LOW);
```

```
    delay(500);
digitalWrite(l4, LOW);
delay(500);
digitalWrite(l5, LOW);
delay(500);
digitalWrite(l6, LOW);
delay(500);
  }
delay(500); }
```

5.5 CIRCUIT DIAGRAM USING IR SENSORS

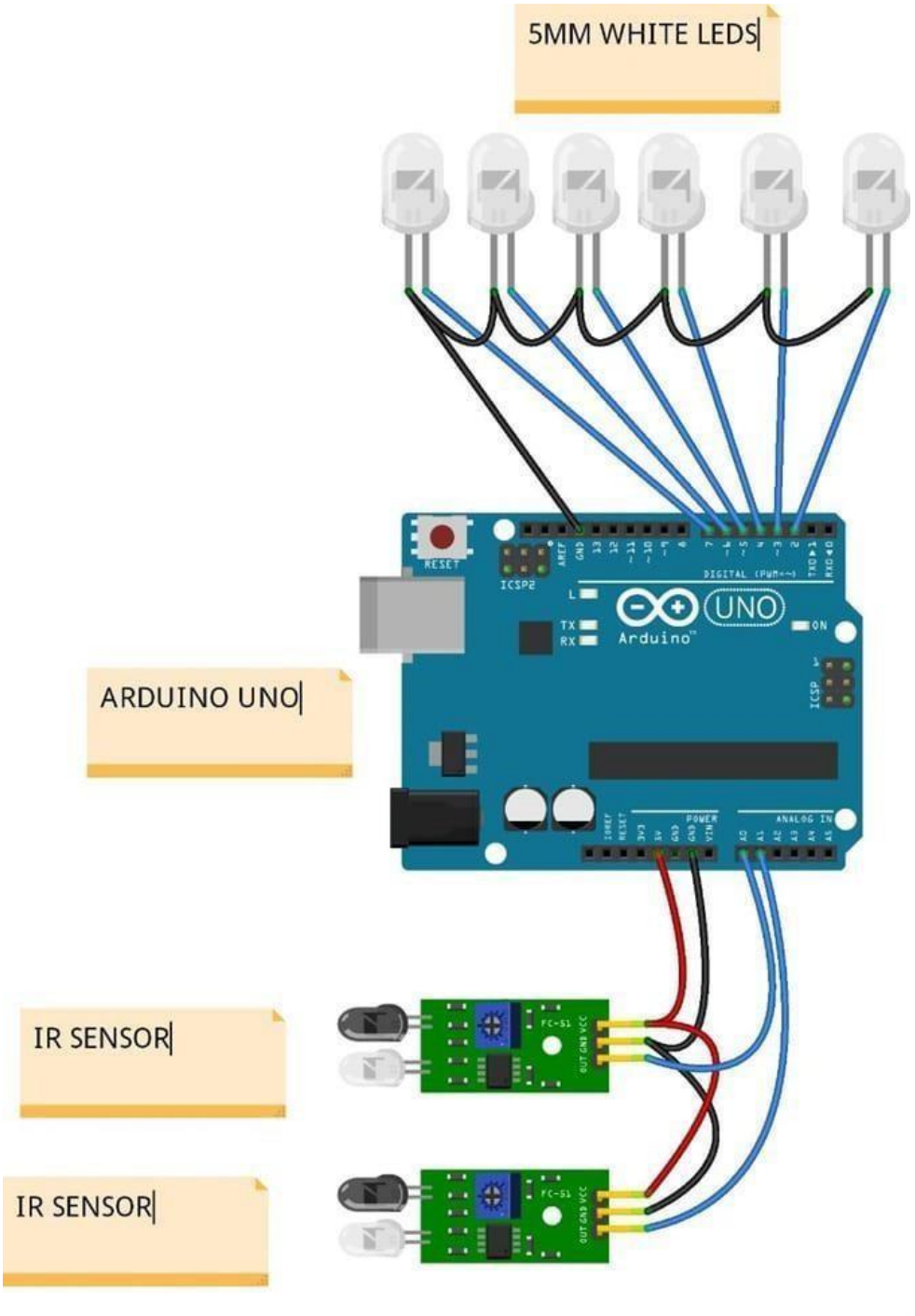

Fig 5.6 : Circuit Diagram of Arduino street lighting with IR Sensing

5.6 CONNECTIONS FOR ARDUINO STREET LIGHTING WITH IR SENSING

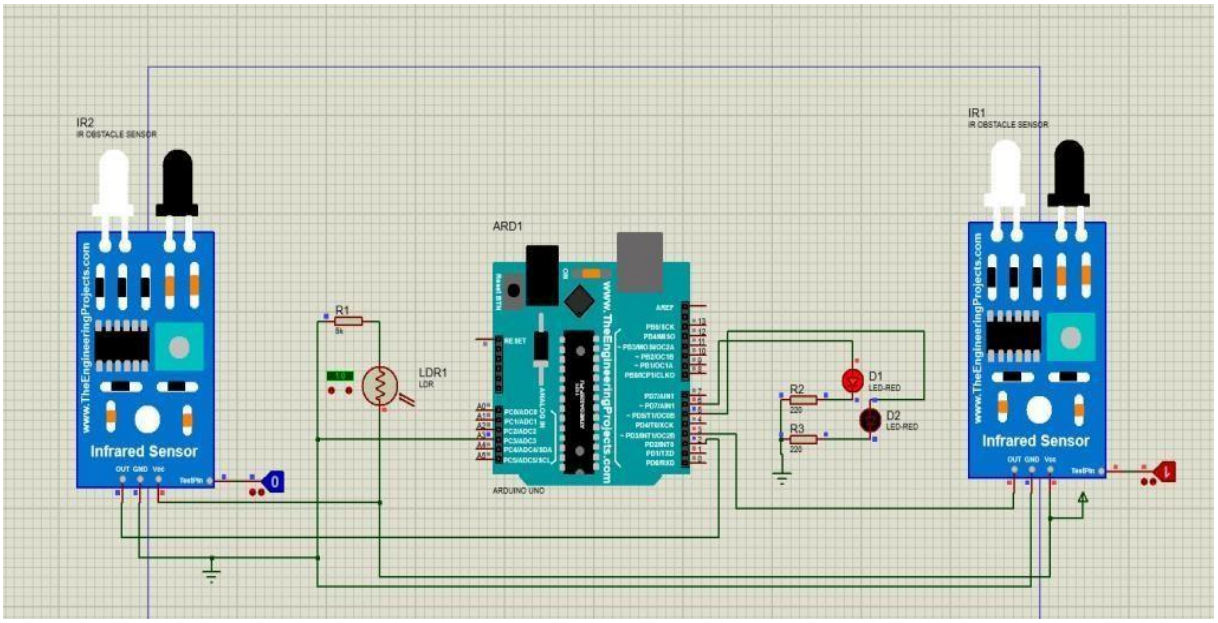

Fig 5.7 : connections for Arduino Street Lighting with IR sensing

The connections of Arduino based Smart street light project are

- Connect the VCC of both sensors with the 5V of the Arduino.
- Also, Connect the ground of both sensors with the ground of the Arduino.
- Likewise, Connect the output of the first IR sensor to the digital PIN 2 of the Arduino.
- Similarly, Connect the output of the second IR sensor to the digital PIN 3 of the Arduino.
- Connect the first led with the digital PIN 5 of the Arduino.
- Also, Connect the second led with the digital PIN 6 of the Arduino.
- And Connect the other terminal of both led with the ground through 220 Ohm resistor.
- Likewise, Connect one side of LDR with VCC.
- Also, Connect the other side of LDR with the ground through a 5K Ohm resistor.
- Similarly Connect the second leg of LDR with an A3 pin of Arduino.

CHAPTER 6

RESULT ANALYSIS

6.1 SIMULATION/HARDWARE RESULTS

Fig 6.1: Output of the Arduino street Lighting with IR Sensors

When any of IR Sensor, sense the position of vehicle,its output goes low i.e.,Zero.Then the Arduino read the low output value from that sensor and increases the light intensity by using pulse width modulation technique.when the position of the vehicle doesnot detect by sensor,Arduino read the high output value from the sensor then Arduino decreases the light intensity of the LED's.

6.2 Experimental Setup

The following depicts the experimental setup of the proposed concept.

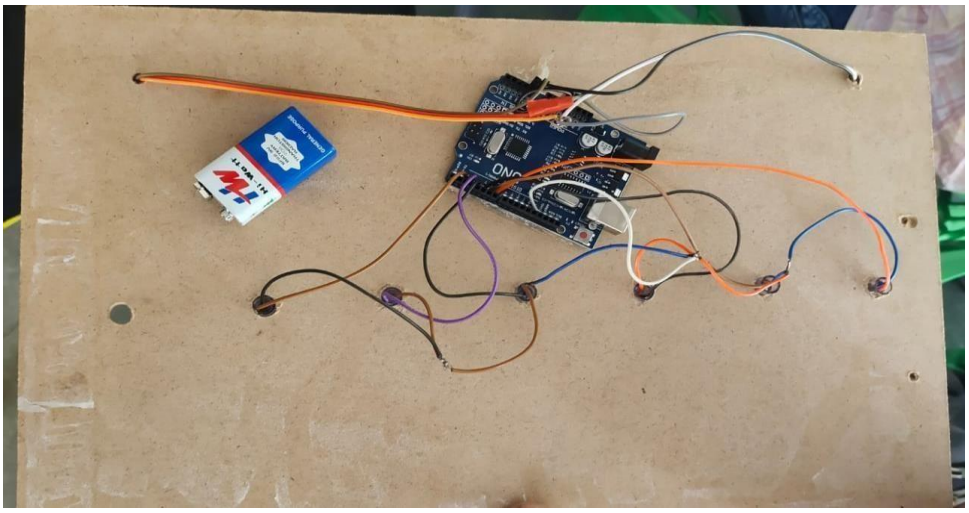

Fig 6.2 : Experimental setup

IR Sensor gives an electrical signal as an output when an object comes infront of it.By this the Arduino can decide whether there is a vehicle or not.

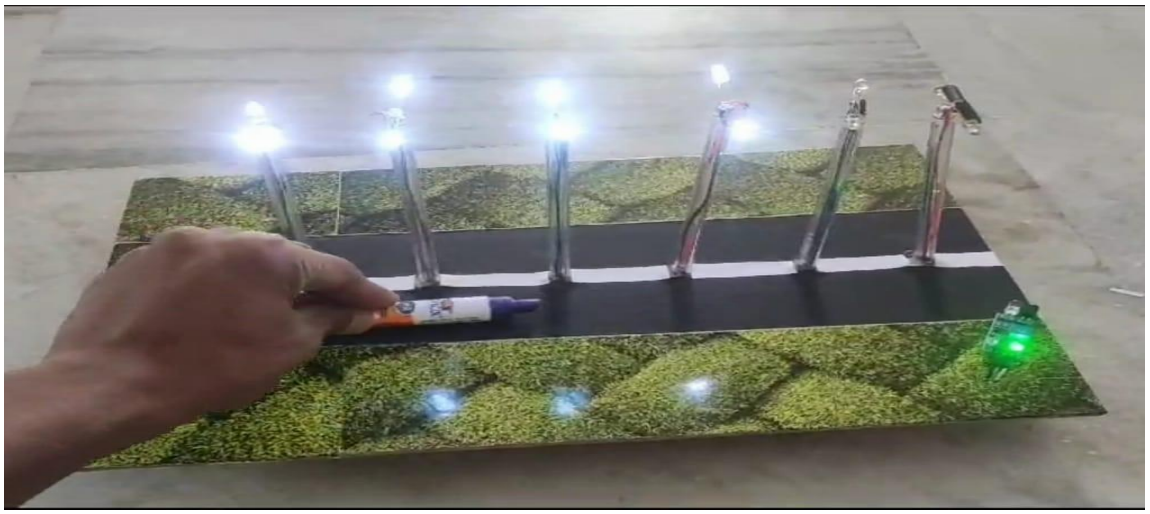

Fig 6.3 : Experimental setup in operating state

When the vehicle passes by particular IR Sensor,it senses the position of the vehicle and gives it's signal to the Arduino board and it will turn on the LED's.

6.3 ADVANTAGES

- Less power is used.
- Motion detection is also possible without light.
- For object detection, there is no contact needed.
- There is no data leakage.
- These sensors do not get distorted by corrosion or oxidation ❖ Very strong noise immunity.
- Energy efficiency.
- Remote Monitoring.

6.4 DISADVANTAGES

- There is a requirement of the line of sight.
- Limited range
- Weather can affect.
- The data transmission rate is low.
- Initial Cost.

- Power Outages
- Vandalism and Tampering

6.5 APPLICATIONS

- Residential Areas
- Urban Streets
- Parking Lots
- Public Parks
- Industrial Areas
- Smart Cities
- Pedestrian Crosswalks
- Energy efficient street Lighting
- Smart Traffic Management
- Remote monitoring and Control
- Data Collection
- Making maintenance and troubleshooting easier

These applications showcase how Arduino street lighting with IR sensing can improve energy efficiency, safety, and the overall quality of outdoor lighting in urban and suburban areas.

CHAPTER 7

FUTURE SCOPE AND CONCLUSION

7.1 FUTURE SCOPE

The future scope of an innovative Arduino street lighting system with IR sensing is promising and likely to see advancements and widespread adoption in the following areas:

1. **Smart Cities Integration**: Street lighting systems with IR sensing will play a significant role in the development of smart cities. These systems will be interconnected and communicate data to central control systems, optimizing lighting and energy consumption across the city.
2. **IoT Integration**: Integration with the Internet of Things (IoT) will enable real-time monitoring and control, making it easier to manage and maintain street lighting infrastructure remotely.
3. **Energy Efficiency:** Continuous improvement in sensor technology and algorithms will lead to even more energy-efficient systems, reducing costs and environmental impact.
4. **Renewable Energy Integration**: Future systems may integrate renewable energy sources like solar panels and wind turbines to power street lights, making them more sustainable and environmentally friendly.
5. **Artificial Intelligence (AI):** AI algorithms may be used to predict and adapt to lighting needs based on historical data, weather conditions, and real-time inputs.
6. **Environmental Sensors**: Beyond IR sensing, future systems may incorporate other environmental sensors to respond to factors like pollution, temperature, and humidity, making them more adaptable to changing conditions.
7. **Wireless Connectivity**: Enhanced wireless connectivity options, such as 5G, LoRa, and NB-IoT, will facilitate seamless data transmission and system control.
8. **Data Analytics:** More advanced data analytics will help cities and municipalities make datadriven decisions about lighting optimization and maintenance.
9. **Urban Planning:** Street lighting systems will be integral to urban planning, enhancing safety, security, and the overall quality of life in urban areas.

7.2 CONCLUSION

In conclusion, the light sensor and street light control system using Arduino is a practical and efficient solution for automatically adjusting street lights based on the detected light intensity. As the world is going digital so is the need of the hour that we must opt for new technologies. With a street light system using Arduino, we not only can manage electricity usage but also chances of accidents will be minimized. The best thing about these street lights is instead of turning on all night whenever any motion will be detected light will be turned on automatically. In case there will be no motion then these lights will be turned off. It can lead to energy savings, cost reduction, and improved safety.It reduces power consumption and human effort. The Arduino-based system can be easily integrated into existing street lighting infrastructure, making it a practical and sustainable solution for modern urban environments. Preliminary tests and simulations demonstrate its feasibility and effectiveness in optimizing street lighting while prioritizing energy efficiency and safety.

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