ADAPTIVE STREET LIGHTING SYSTEM AND SECURITY APPLICATIONS

A

Project Report

Submitted By

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For The Degree Of

B.Tech. 6th Semester

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CERTIFICATE

This is to certify that Aashna Mehta, Suhani Rastogi, Swechchha Mishra and Vanshika Sinha of B.Tech. VI Semester, 2023-24, have presented a project entitled "**Adaptive Street Lighting System and Security Applications"** in partial fulfilment for the award of the degree of Bachelor of Technology under Banasthali Vidyapith, Rajasthan.

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CANDIDATE'S DECLARATION

We hereby declare that the work, which is being presented in the project, entitled **"Adaptive Street Lighting System and Security Applications"** in partial fulfillment for the award of Degree of "*Bachelor* of *Technology*" submitted to the Department of Physical Sciences, Banasthali Vidyapith, Rajasthan is a record of our own investigations carried under the Guidance of Ms. Pooja Srivastava, Department of Physical Sciences, Banasthali Vidyapith**.**

We have not submitted the matter presented in this report anywhere for the award of any other Degree.

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ABSTRACT

This abstract presents a proposal for implementing energy efficient streetlights in various projects. In today's world, electricity is something that is used in every corner of the world. Along with consumption, smart conservation of electricity is also important. Lighting systems play a very important role at home, offices, industrial sectors, urban and rural areas. The goal is to create streetlamps that use less energy while providing enough light for improved safety and visibility. For enhanced safety purposes, the 24*7 use of cameras for surveillance enhances safety. To improve energy consumption, the suggested solution makes use of IR sensors, PIR motion sensors, sophisticated control systems, innovative LED technology, and a camera with FTDI to detect over speeding of cars. The project aims to evaluate the feasibility and effectiveness of these energy-saving streetlights through pilot installations in selected areas. Additionally, the economic benefits of reduced energy consumption and maintenance costs will be analyzed. The results of this study will provide valuable insights into the potential energy savings and environmental impact of implementing energy efficient streetlamps, contributing to sustainable urban development and will look after the safety on the road.

In addition to the advancements in street lighting technology, the integration of cameras and infrared (IR) sensors further enhances the functionality and effectiveness of smart streetlight systems. IR sensors play a crucial role in detecting the presence of vehicles and pedestrians, allowing for more accurate monitoring of traffic flow and pedestrian activity. These sensors provide real-time data on vehicle speed, enabling the system to differentiate between normal traffic patterns and instances of over speeding.

By incorporating cameras into the smart streetlight infrastructure, the system gains the ability to capture visual data of the surrounding environment. These cameras can be utilized for various purposes such as surveillance, traffic monitoring, and law enforcement. With the advancements in image processing and machine learning algorithms, the captured footage can be analyzed to detect anomalies, identify vehicles or individuals, and even predict potential safety hazards or traffic congestion.

Overall, the integration of cameras and IR sensors into smart streetlight systems represents a significant advancement in lighting infrastructure. By combining automated lighting control with real-time monitoring and data analysis capabilities, these systems contribute to improved safety, energy efficiency, and overall quality of life in urban environments. Additionally, the economic benefits derived from reduced energy consumption and maintenance costs further underscore the importance of investing in such innovative solutions for sustainable urban development.

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 lighting was proposed by ancient Romans. A civilized and planned system was first used in the 16th century. Since then, streetlights have undergone many changes and updates to become what they are today.

The traditional lights have their pros and cons. These lights are switched ON and OFF manually. Hence sometimes by mistake the lights even remain ON during the day and OFF during the night. Streetlights run using the electricity supplied by the respective electric boards. Sometimes at night if the supply cuts off due to any reason, the streets are completely engulfed with darkness which leads to several mishaps.

To overcome these shortcomings the idea of smart streetlights was proposed. These lights are equipped with sensors, microcontrollers, etc. i.e. automated equipment which makes this system smart. LDRs (Light Dependent Resistors) are the trigger to turn ON or OFF these streetlights at twilight. PIR sensors sense the presence of vehicles and humans and switches ON or OFF the streetlights. LEDs used in place of Sodium lights are both energy and cost-efficient. Overall, this system is costly to install but is profitable in the long run.

2. HISTORY

2.1 HISTORY OF STREET LIGHTS

During night time, there is negligible natural light present in the surroundings or the environment. This has always been a problem. People can be attacked, mugged, or robbed in the shadow of dark during the night.

The history of streetlights is much older than known because this issue has always prevailed in society irrespective of the type and culture.

It is known that in early B.C., the gas leaked from volcano was used as a fuel for streetlamps with the help of bamboo pipes. Oil lamps were filled with vegetable oil and used as streetlights by the ancient Romans.

The very first organized method of public lighting was done in 1417 by Sir Henry Barton, Mayor of London. He brought a law that every house must hang lanterns outside their house at the time of dawn.

After this in 1524, the streets of Paris were also illuminated. An order was given that every house must have a light on its window facing the street. There was another method known as “Link boys” according to which the wealthy citizens of London along with servant boys travel throughout the night, carrying lamps.

Then came the era which focused on the efficiency of light. In 1802 William Murdock lit the first gas light fueled by coal gas. After this London also used its first gas light in the year 1807. By1820, mostly countries got illuminated by streetlight using gas lamps.

A few years later electricity got invented. This proved to be the turning point in the history of streetlights. Since then, streetlights have become more efficient.

2.2 MODERN LIGHTS

After World War 2, efficient lamps like high-intensity discharge lamps and low-pressure sodium lamps came into use. They had the advantage of low power consumption and long life. Such lamps are still used at some places. As the 20th century proceeded, the later years saw the use of high-pressure sodium lamps and metal halide lamps. These lamps provided greater photopic illumination for less electricity consumption.

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

Now time demands more efficient and automated streetlights for our roads and streets which can work as per the intelligence. These lights will automatically turn ON/OFF as per the movement on the road. This will play a major role in transiting to a smart world.

In the late 1990s came the first patent for automatic streetlights and were first installed in the year 2006 in Europe.

2.3 HISTORY OF CAMERA

A camera is a device capable of capturing still or moving images by using light. Everything that surrounds us looks a certain way because of light. Without it, we wouldn't have colors, highlights, shadows, or contrast. A camera takes advantage of that by combining optics and mechanics, chemistry and electronics, in such a way that light gets imprinted on a light-sensitive material. In the case of analog cameras, the medium is the photographic film. In the case of digital cameras, the medium is an electronic sensor.

Going back to around 1550, lenses were used in the openings of walls or closed window shutters in dark rooms to project images, aiding in drawing. The images produced by these early cameras could only be preserved by manually tracing them, as no photographic processes had been invented yet. The first cameras were large enough to accommodate one or more people, and over time they evolved into increasingly compact models. Camera obscura is a dark room or box having a small hole (aka pinhole camera) or lens on one side that lets the light get through and projects an image on the opposite wall. It was late in 1816 then that a light-sensitive material was used such that a permanent image would survive even after the camera obscura was closed.

After the initial systems, engineers introduced reel-to-reel recording systems. These could capture footage but still required ongoing manual controls. These early cameras were typically large and cumbersome, and they required a lot of manpower to operate. Security cameras were first used in the motion picture industry in the 1920s to monitor film production sets and ensure the safety of actors and crew members. However, they were an important tool for filmmakers who wanted to capture realistic and authentic scenes without putting their actors and crew at risk. Another span of 15 years passed until a true surveillance camera came into existence.

2.4 MODERN CAMERA

Nowadays, anybody with a smartphone can take at least passible pictures with ease. But even when we still had to rely on Kodak to commemorate our vacations, it was still a massive improvement over the early days of photography. It’s hard to imagine how professional-grade images can be produced with nothing but a timer button and a selfie stick.

The modern cameras have accurate auto-focus, low light processing, burst speed shutter settings, and more. Their automatic mode is also capable of taking beautiful shots without much fiddling with its settings. They work by allowing light to enter through the lens, which then hits the image sensor, where it’s converted into an electrical signal. This signal is then processed and transformed into a digital image, which is saved onto the memory card.

Just like the advanced photographic cameras and DLSRs it’s hard to remember a time when surveillance cameras weren’t as common as they are today. In a relatively brief span, they’ve become ubiquitous. It’s believed that there are more than 1 billion cameras installed worldwide. Now they’re everywhere. On telephone poles, traffic lights, dashboards, and buildings. They dot the ceiling and walls in businesses and private homes. It’s nearly impossible to escape them.

Security cameras, dash cams, traffic cameras, and body cams have become an essential part of everyday life practically everywhere. With a variety of hardware and software used in conjunction to create holistic security and simplify management, the importance of cloud-connected cameras that work with existing systems and an open platform has made is use easier. The growth of deep learning in video security is one of the new security features that has made a way to many new features. It is now possible to turn hours of previously redundant footage into data, which can then be analyzed for video security trends and patterns using AI. The cloud servers, IOT, are also updating and enhancing to the latest innovation possible to make human interaction with technology easier. Cybersecurity is also increasing with increase in real security.

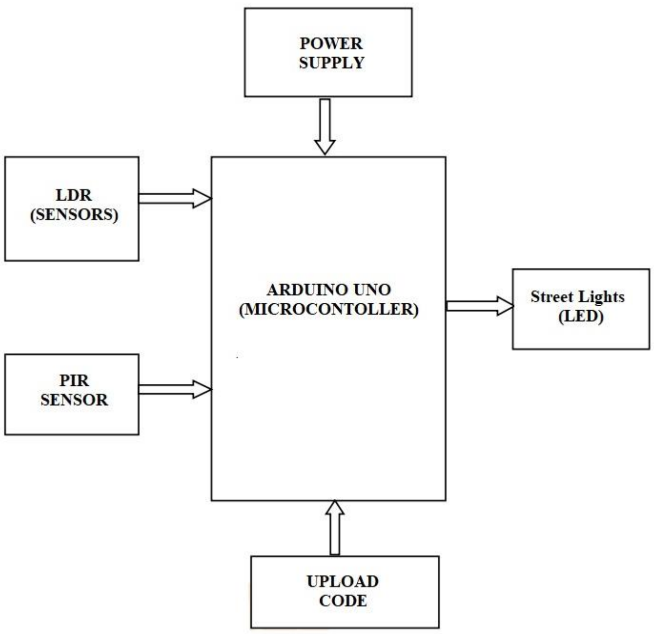
This is not enough, till date, we haven't stopped innovating, and there are new frontiers still out there, which are making security faster, easier, more convenient, and potentially cheaper.

3. PROJECT OBJECTIVES

1. To design and study a system capable of accurately monitoring streetlight.
2. To reduce energy consumption and operational costs, contributing to a more sustainable and eco-friendly lighting solutions.
3. To create a software solution that is affordable, making it accessible for widespread implementation in security areas by using Arduino UNO.
4. To develop a hardware system which will incorporate features to minimize light pollutions, ensuring that the streetlights are directed where needed without causing unnecessary glare or disturbances to the night sky.

4. METHODOLOGY

4.1 BLOCK DIAGRAM FOR LDR SENSOR, PIR SENSORS AND LEDs



1. **Input Sensors:**

- LDR (Light Dependent Resistor): This sensor detects the ambient light level. It changes its resistance based on the amount of light it receives.
- PIR (Passive Infrared) Motion Sensor: This sensor detects object movement by sensing changes in the infrared radiation in its field of view.

2. **Microcontroller (Arduino Uno):**

- Arduino Uno acts as the central processing unit (CPU) of the system.
- It reads the data from the LDR and PIR sensors and processes it.
- The microcontroller makes decisions based on the sensor data and the working code uploaded to it.
- It controls when the LED light will glow.

3. **Decision Logic:**

- The microcontroller uses an internal decision logic or algorithm to determine how to control the streetlight based on the sensor inputs.
- It checks two conditions:

<u>LIGHT INTENSITY</u>: If the light intensity is below a certain threshold (set value), it indicates that it's dark or is getting dark.

<u>MOTION DETECTION</u>: If motion is detected by the PIR sensor, it indicates the presence of a person or an object.

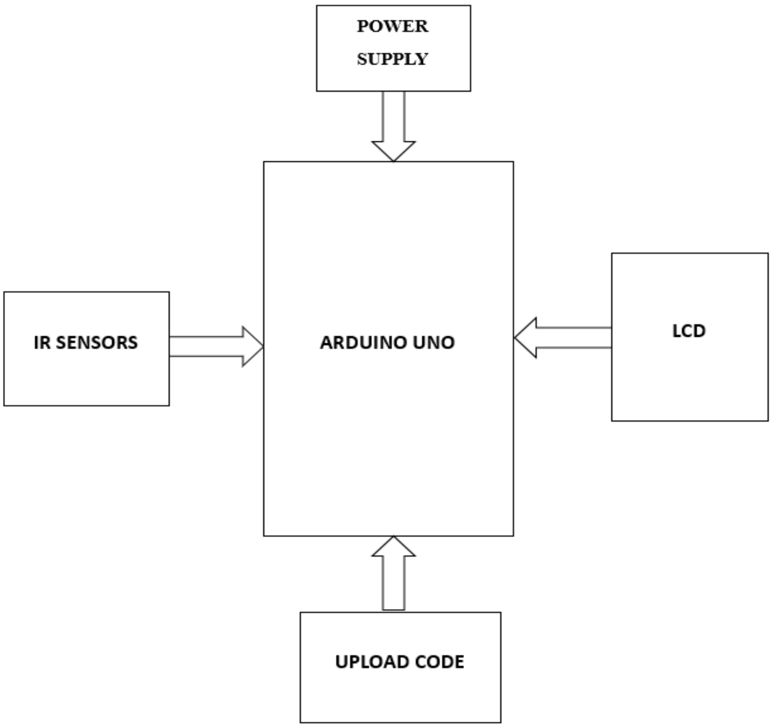
4. **Output:**

<u>STREETLIGHT (LED):</u> The output of the system is the streetlight, represented here as LED.

- If both conditions (low light intensity and motion detection) are met, the microcontroller sends a control signal to the LED, turning it ON to illuminate the street.
- If any of the conditions are not met, the microcontroller keeps the streetlight (LED) OFF.

5. Power Supply: In this setup, two kinds of power supply are used. One is an external power supply, and another is an internal power supply. The internal power supply is given from the microcontroller to the sensors. The external power supply is given from the battery or external power source to the microcontroller.

4.2 BLOCK DIAGRAM FOR IR SENSORS AND LCD



1. Input Sensor:

- IR (InfraRed) Sensor: This sensor detects the motion of any object such as any vehicle.

2. Microcontroller (Arduino Uno):

- Arduino Uno acts as the central processing unit (CPU) of the system.
- It reads the data from the LDR and PIR sensors and processes it.
- The microcontroller makes decisions based on the sensor data and the working code uploaded to it.
- It controls when the LCD will show the output.

3. Decision Logic:

- The microcontroller uses an internal decision logic or algorithm to determine how to control the streetlight based on the sensor inputs.
- Using speed, distance and time formula the sensors calculate the speed of the vehicle for which the two IR sensors are placed at a fix distance.

4. Output:

The output of the system is shown on LCD.

- If the speed of vehicle is in the defined range, the LCD with show the speed of vehicle and define it as “Normal Speed”.
- If the speed of vehicle is not in the defined range, the LCD with show the speed of vehicle and define it as “Over Speed”.

5. Power Supply:

In this setup, two kinds of power supply are used. One is an external power supply, and another is an internal power supply. The internal power supply is given from the microcontroller to the sensors. The external power supply is given from the battery or external power source to the microcontroller.

4.3 FLOWCHART

In this project, two sensors are employed to independently control the streetlights: LDR (Light Dependent Resistor) and PIR (Passive Infrared) sensor. The described system can be represented using a flowchart explained as:

- <u>OBJECT DETECTION:</u>

The flowchart can be explained by the following steps:

1**. Start:** This is the initial step of the process, indicating the beginning of the operation.

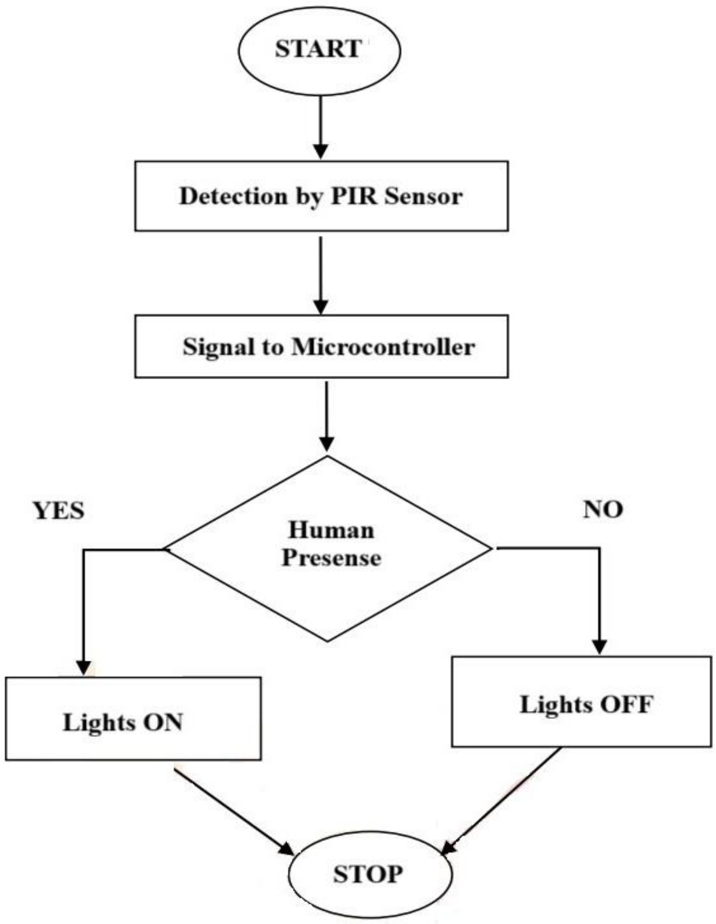
2. **Detection by PIR sensor:** The PIR sensor continuously monitors its surroundings for any changes in infrared radiation, which indicates the presence of any person or object. If the sensor detects any such changes, it signifies that something has passed within its range.

3**. Signal to Microcontroller:** Once the PIR sensor detects the presence of a person or any object, it transmits the corresponding signal or value to the microcontroller. This signal serves as a trigger for the microcontroller to initiate the subsequent action.

4**. Light Activation (ON):** Upon receiving the signal from the PIR sensor, the microcontroller activates the connected light source if any object is detected. This action results in the light being turned on, hence illuminating the area.

5. **Light Deactivation (OFF):** In the absence of the person, the microcontroller turns off the light to conserve energy and reduce unnecessary operation. This step ensures that the light source is not needlessly left ON when there is no one present in the monitored area.

6. **Stop:** This signifies the end of the process.



This system essentially provides automated control over the activation and deactivation of the light source based on the detection of human presence by the PIR sensor. By turning the light ON only when necessary, the system aims to conserve energy and promote efficient usage of the light source.

- LIGHT DETECTION:

The flowchart can be explained by the following steps:

1. **Start:** This is the initial step of the process, indicating the beginning of the operation.

2**. LDR Sensor detects light:** The LDR sensor detects the ambient light intensity. If the intensity of light surpasses a certain threshold, it implies that the environment is bright or there is sufficient light present.

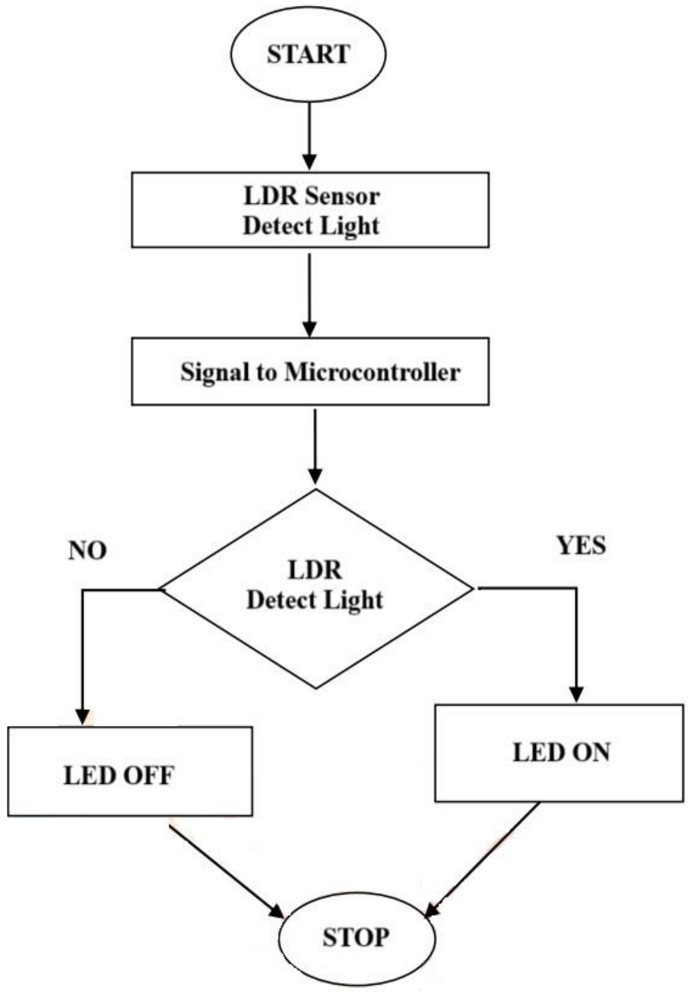
3. **Signal to Microcontroller:** Once the LDR sensor detects the light, it sends a corresponding signal to the microcontroller. This signal likely serves as an input for the microcontroller to make decisions based on the detected light intensity.

4**. Light Activation (ON):** If the light intensity matches the predetermined value set within the microcontroller, it indicates that the current light level is below, or it just matches the value set. In this scenario, the microcontroller activates the connected light source. This action results in the light being turned ON, hence illuminating the area.

5**. Light Deactivation (OFF):** If the light intensity does not match the value set in the microcontroller, it indicates that the current light level is enough or higher than the value set. In this scenario, the microcontroller keeps the light dim or off, depending on the system's settings.

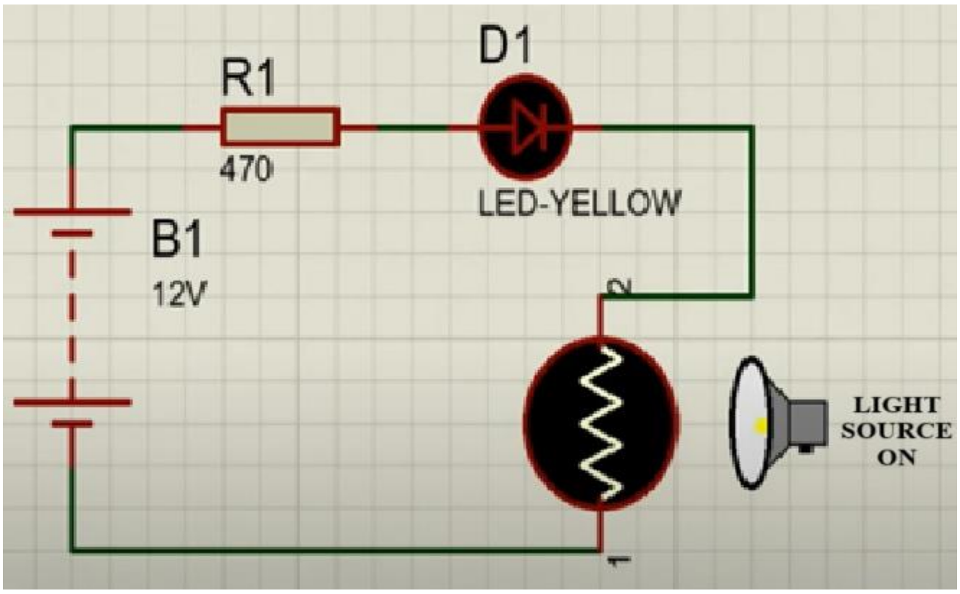
6. **Stop:** This step signifies the end of the process.

This system allows for the automatic adjustment of the connected light source based on the ambient light level detected by the LDR sensor. By controlling the light output in response to environmental light changes, this helps in maintaining an appropriate level of illumination.

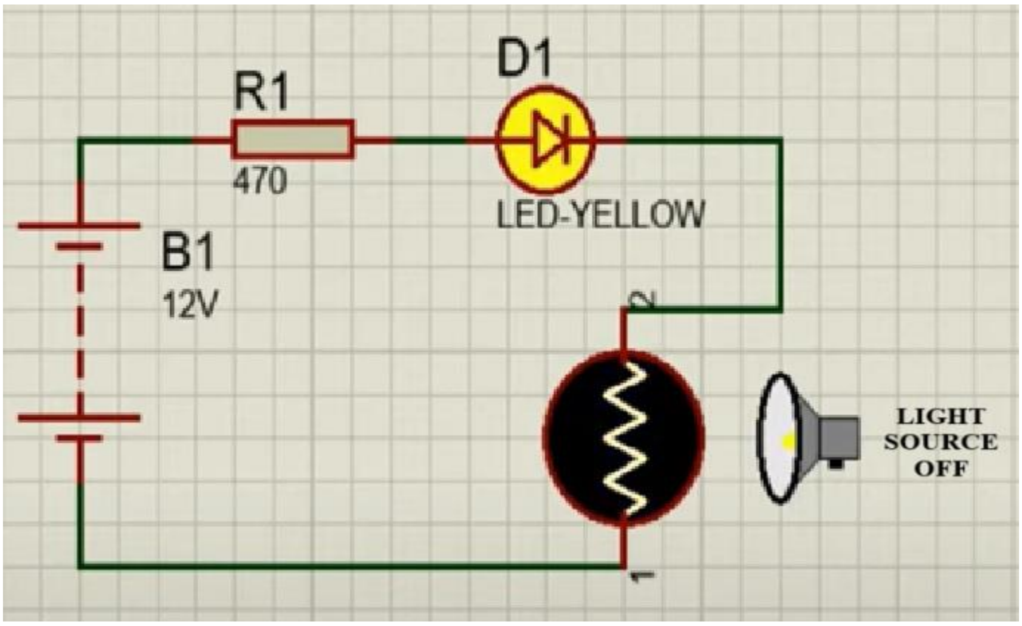


5. CIRCUIT DIAGRAM

- <u>CIRCUIT DIAGRAM FOR LDR</u>

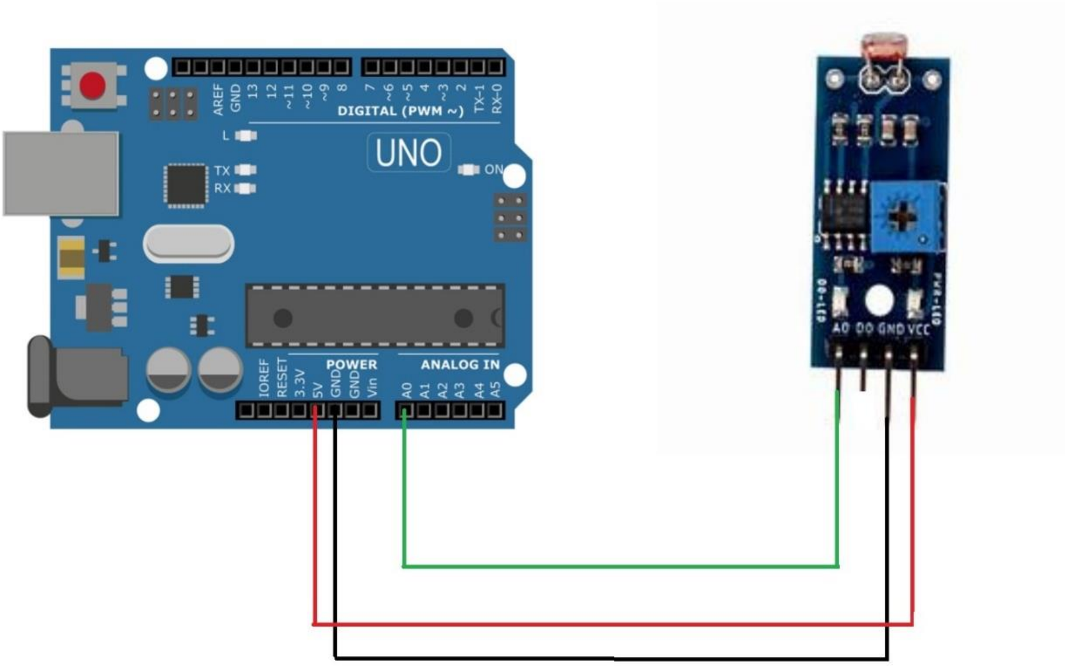


Light Source ON, LED doesn't glows

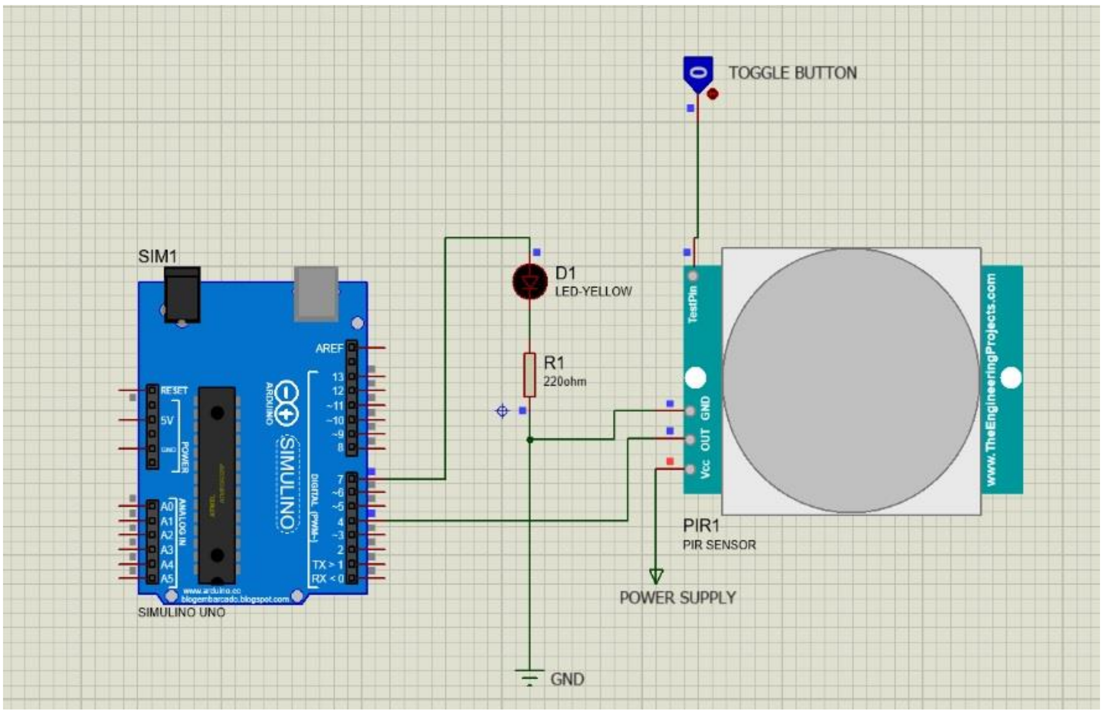


Light Source OFF , LED glows

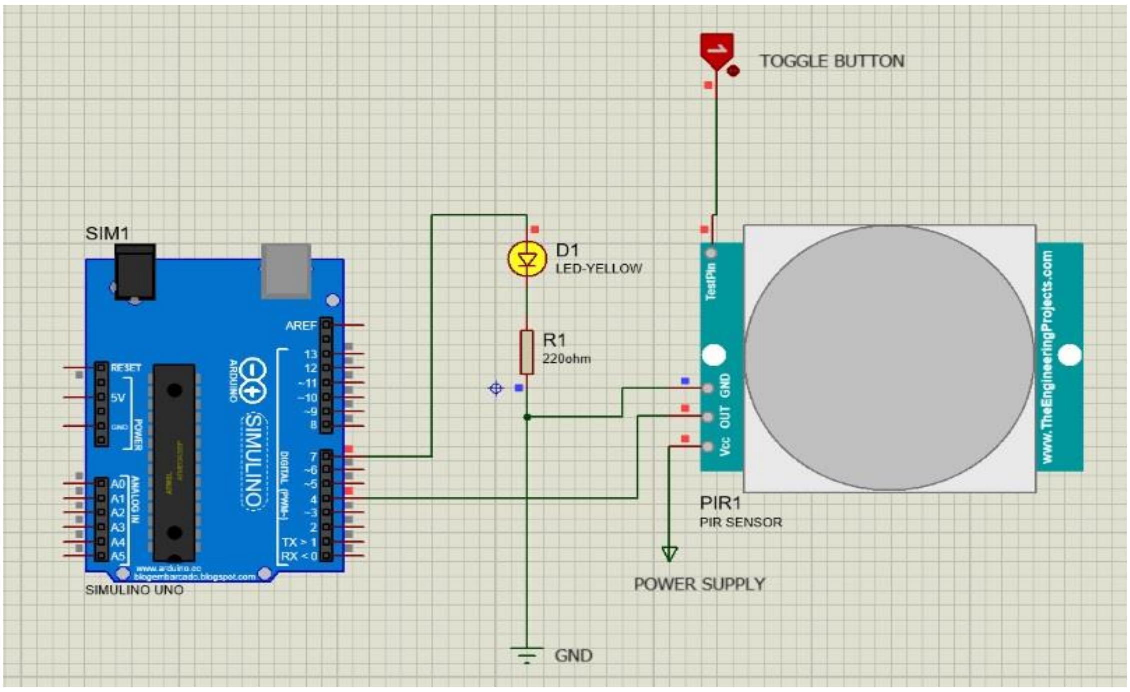
- <u>CIRCUIT DIAGRAM FOR LDR AND ARDUINO</u>



- <u>CIRCUIT DIAGRAM FOR PIR SENSOR AND ARDUINO</u>

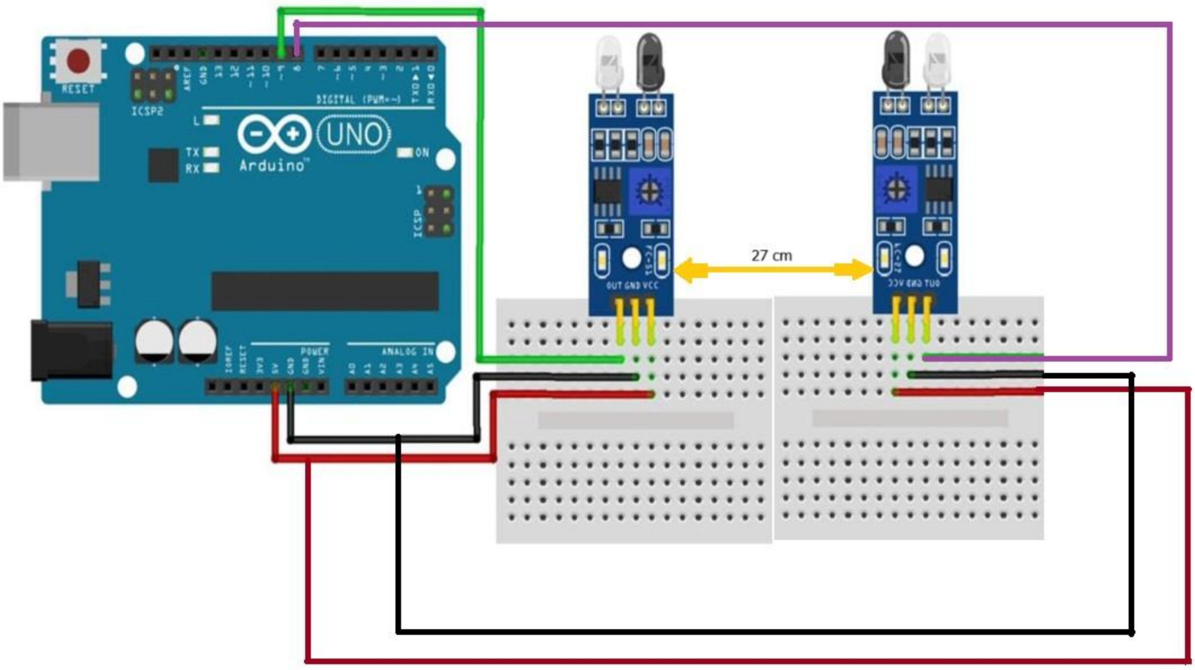


When Toggle Button is 0, LED dosen’t glow

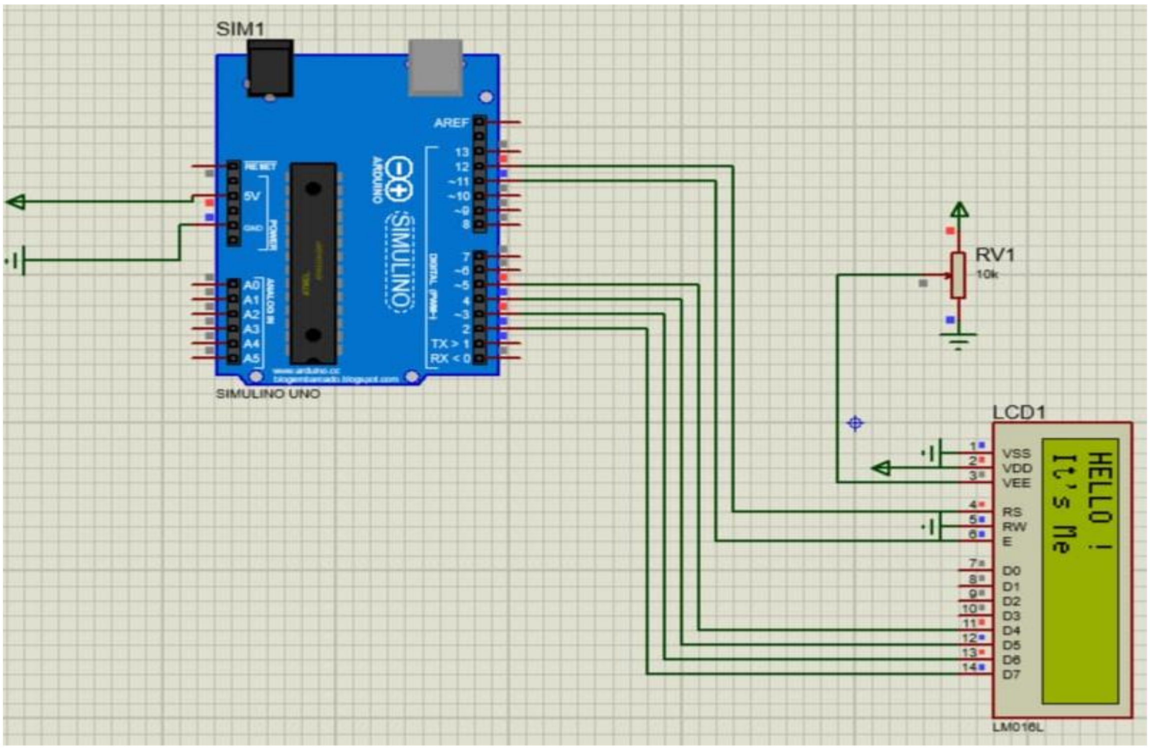


When Toggle Button is 1, LED glows

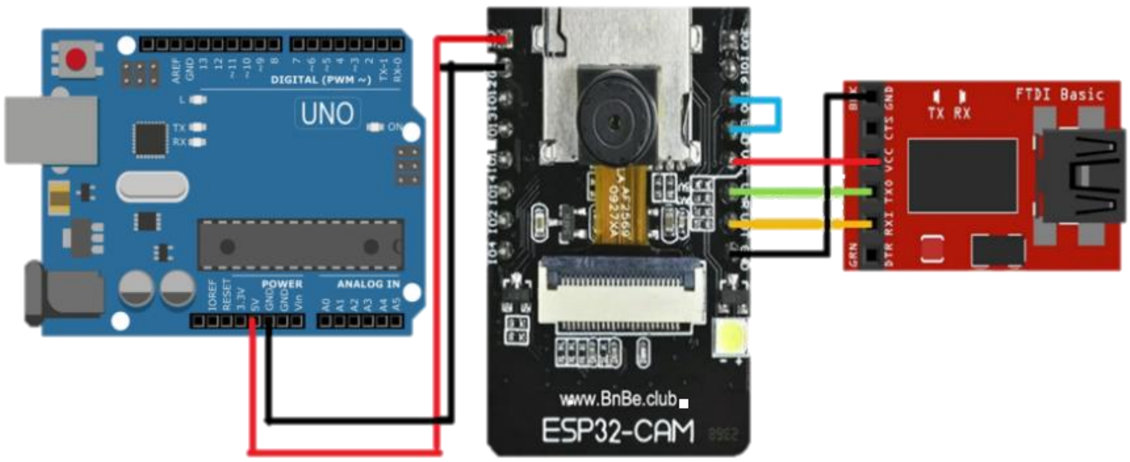
- <u>CIRCUIT DIAGRAM FOR IR SENSOR AND ARDUINO</u>



- CIRCUIT DIAGRAM FOR LCD AND ARDUINO



- CIRCUIT DIAGRAM FOR ESP-32 CAM , FTDI AND ARDUINO



6. WORKING OF PROJECT

Sensor-based streetlights for security purposes using motion sensors to detect movement in the vicinity of the light. When motion is detected, the sensor triggers the streetlight to turn on, providing illumination in the area. These sensor-based streetlights can be integrated with surveillance cameras to provide real-time monitoring of the area.

Sensors used in this project were Passive Infrared Sensors (PIR). PIR sensors detect infrared radiation emitted by objects in their field of view. When an object, such as a person or vehicle, moves within the detection range of the sensor, it causes a change in the infrared radiation detected by the sensor. The PIR sensor then sends the signal to the control unit of the streetlight, which triggers the light to turn on.

The light remains on for a predetermined period, typically ranging from a few seconds to a few minutes. If no further motion is detected during this time, the streetlight will automatically turn off. However, if additional motion is detected, the timer is reset, and the light remains on for an extended period. This allows for energy-efficient lighting that only activates when needed, providing enhanced security and visibility while reducing energy consumption and costs.

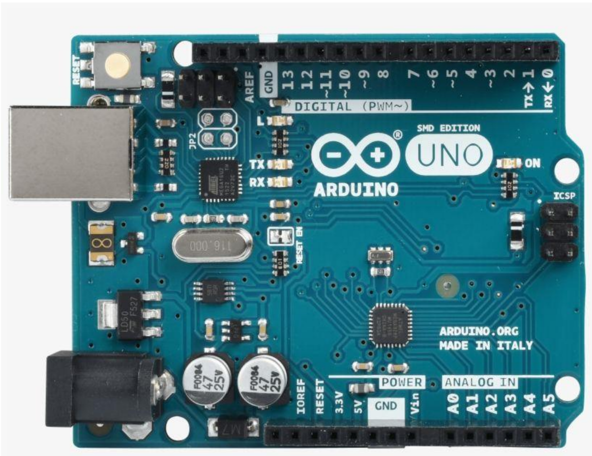
Here we have installed a camera along with the system, which continuously monitors the area. The system utilizes image processing algorithms to analyze and calculate the speed of each vehicle based on their movement within the camera's field of view.
If a vehicle is determined to be over speeding based on the predefined speed limit set in the system, the algorithm triggers an alert signal and sends it to the control system. Upon receiving the over speeding alert signal, the control unit activates the LCD screen connected to the street light system. A message such as "Over speeding" or a speed limit violation warning is displayed on the LCD screen.
These sensor-based streetlights can also be programmed to send alerts to security personnel or authorities when motion is detected, allowing for a quick response to any suspicious activity. By integrating a camera with the system, you can not only improve security and monitoring but also enhance traffic management capabilities, by detecting and addressing over speeding violations in real-time. This integrated system provides a comprehensive solution for both lighting and surveillance needs in public areas.

7. COMPONENT LIST

S.No	COMPONENTS	SPECIFICATIONS
1	ARDUINO UNO	22 pins, Operating Voltage 5-20V
2	LED	5mm, Operating Voltage 5V
3	PIR MOTION SENSORS	Voltage: 4.5V to20V, Range: 3-7metres, Angle: 110 degree
4	LDR MODULE	----------
5	RESISTORS	220 ohms
6	JUMPER WIRES	-------------
7	9V BATTERY	Voltage 9V
8	MINI BREADBOARD	-----------
9	FTDI PROGRAMMING BOARD	USB –TTL converter
10	ESP32-CAM	OV2640 Camera Module mounted on ESP32 development board
11	LCD	16 x 2
12	IR SENSORS	----------------
13	BUZZER	----------------
14	POTENTIOMETER	10K

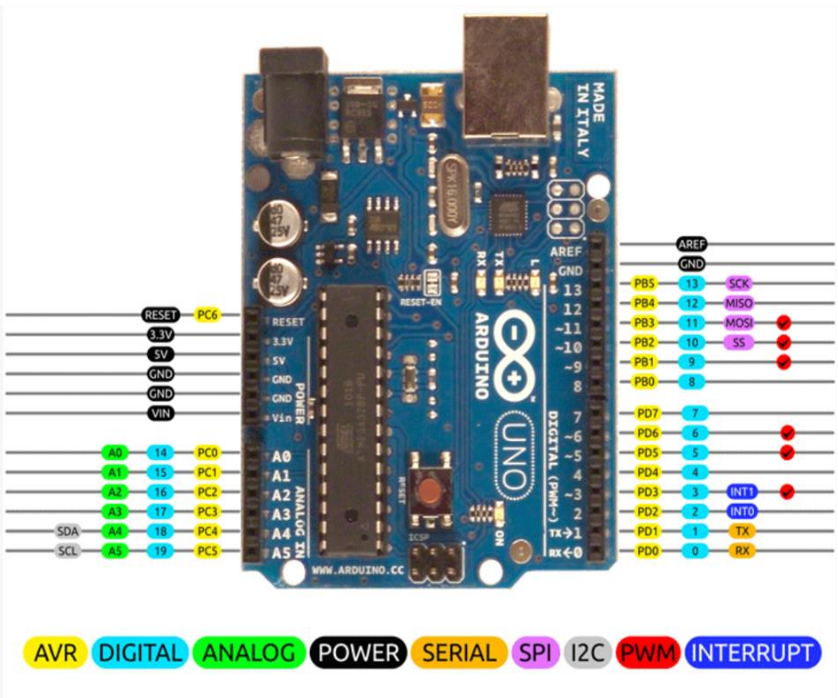
7.1 HARDWARE REQUIREMENTS

7.1.1 ARDUINO UNO



Arduino Uno is an open-source microcontroller board designed for developing electronics projects. Arduino Uno is based on the ATmega328P microcontroller and is equipped with digital Input/output pins, analog input pins, and a USB interface for programming and power. The Arduino UNO board has 14 digital pins, 6 of which can be used as PWM outputs, and 6 analog input pins. It also has a 16MHz quartz crystal oscillator, a USB connection for programming and power, an ICSP, header for programming with an external programmer, and a rest button.

One of the key features of the Arduino Uno is its ease of use. It can be easily programmed using the Arduino Integrated Development Environment (IDE), which provides a simple and intuitive interface for writing, compiling, and uploading code to the board.

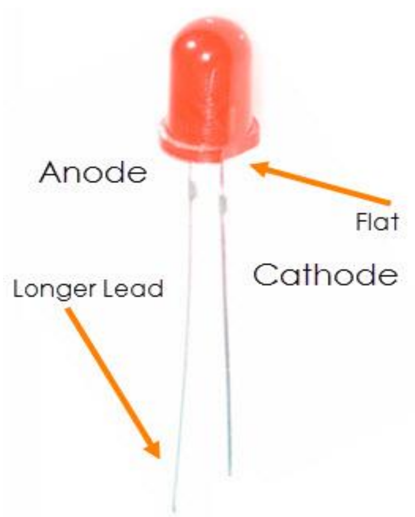


Arduino board description:

1. **AVR Microcontroller:** The Arduino Uno board is based on the AVR (Advanced Virtual RISC) microcontroller family, which is designed for low power consumption and high performance. The ATmega328P is the main microcontroller used in the Arduino Uno board, which is an 8-bit RISC architecture microcontroller.
2. **Digital Pins:** The Arduino Uno board has 14 digital input/output pins, labeled from 0 to 13. These pins can be used as either digital inputs or digital outputs. Each pin can output a maximum of 40mA and has an internal pull-up resistor. They can also be configured as PWM (Pulse Width Modulation) outputs to control the speed of motors or the brightness of LEDs.
3. **Analog Pins:** The Arduino Uno board has 6 analog input pins labeled A0 to A5. These pins can read analog signals from 0V to 5V and convert them into digital values using the on-board Analog-to-Digital Converter (ADC). The ADC has a resolution of 10 bits, which means it can represent analog signals with 1024 levels of granularity.
4. **Power Pins:** The Arduino Uno board has a few power pins that can be used to power external components connected to the board. The board has a VIN pin, which accepts an input voltage of 7V to 12V, a 5V pin, which provides a regulated 5V output, and a 3.3V pin, which provides a regulated 3.3V output.
5. **Serial Communication**: The Arduino Uno board has a built-in USB-to-serial converter that allows it to communicate with a computer through a USB cable. This enables the board to be programmed and debugged using the Arduino Integrated Development Environment (IDE). It also has two dedicated pins, labeled TX and RX, that can be used for serial communication with other devices.
6. **SPI:** The Arduino Uno board has a dedicated SPI (Serial Peripheral Interface) bus that can be used to communicate with other SPI-compatible devices, such as sensors, displays, or memory chips. The SPI bus consists of four pins: MISO (Master In, Slave Out), MOSI (Master Out, Slave In), SCK (Serial Clock), and SS (Slave Select).
7. **I2C:** The Arduino Uno board also supports I2C (Inter-Integrated Circuit) communication protocol, which is a two-wire serial communication protocol used to communicate with I2C-compatible devices, such as sensors or displays. The I2C bus consists of two pins: SDA (Serial Data) and SCL (Serial Clock).
8. **PWM:** The Arduino Uno board has 6 digital pins that can be used as PWM outputs. PWM is a technique used to control the speed of motors or the brightness of LEDs by varying the duty cycle of a pulse signal.

9. **Interrupt Pins:** Arduino Uno board has two external interrupt pins, labeled 2 and3. These pins can be used to trigger an interrupt when a certain event occurs, such as a change in the state of an input pin or the reception of a signal. The board also has a dedicated pin, labeled INT0, that can be used as an additional interrupt input.

7.1.2 LED – Light Emitting Diode



LED, which stands for Light Emitting Diode, is a semiconductor device that emits light when an electric current passes through it. LEDs are simply diodes that are designed to emit light.

An LED is a two-terminal device. It looks like a little lightweight bulb with 2 legs. The longer leg is the positive connection, known as Anode and the shorter leg is the negative connection, known as Cathode.

The operation of an LED is based on the principles of semiconductor physics, and it involves the interaction of electrons and electron holes within a semiconductor material. The theory behind LED is based on the principle of electroluminescence.

Inside an LED, there are two layers of semiconductor material – the p-type and n-type layers. The p-type layer has an excess of positively charged holes, while the n-type layer has an excess of negatively charged electrons.

When a diode is forward-biased so that electrons and holes are zipping back and forth across the junction, they're constantly combining and wiping one another out. Sooner or later, after an electron moves from the n-type into the p-type silicon, it will combine with a hole and disappear.

That makes an atom complete and more stable, and it gives off a little burst of energy (a kind of "sigh of relief") in the form of a tiny "packet" or photon of light. LEDs have several advantages over traditional light sources.

They are more energy-efficient, as they convert a higher percentage of electrical energy into light compared to incandescent bulbs or fluorescent lamps. LEDs also have a longer lifespan and are more durable, as they do not have a filament or glass envelope that can break.

7.1.3 PIR SENSOR

A Passive Infrared (PIR) sensor is a device that detects infrared radiation emitted by an object in its field of view. It is commonly used in motion detection applications, such as security systems and automatic lighting.

The word “passive” in the term “passive infrared” refers to the principal nature of sensor. It is made up of crystalline material which generates surface electric charge when exposed to heat in the form of infrared.

A PIR sensor detects motion by sensing changes in infrared radiation emitted by objects. It is widely used in various applications for its ability to provide reliable and cost-effective motion detection.

The theory behind a PIR sensor is based on the concept of detecting changes in infrared radiation. The sensor consists of a pyroelectric material, which generates an electric charge when exposed to infrared radiation. This material is typically made of a thin film of lithium tantalate or lithium niobate.

Due to their high ended sensitivity and area of detection PIR sensors are popular in security. When there is no motion in the sensor's field of view, the pyroelectric material remains at a constant temperature, and the electric charge generated is also constant.

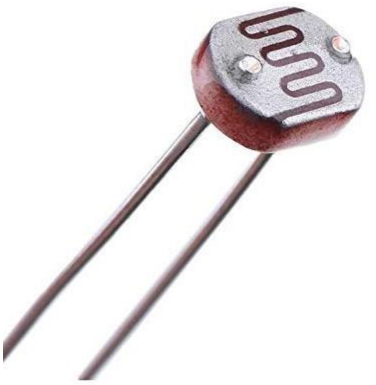
However, when an object moves within the sensor's range, it emits infrared radiation, which causes a change in the temperature of the pyroelectric material. To enhance the sensitivity of a PIR sensor, it is often designed with multiple sensing elements arranged in a grid pattern.

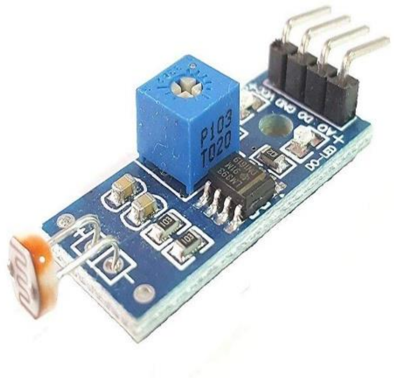
Each sensing element detects changes in infrared radiation independently, and their outputs are combined to provide a more accurate detection of motion.

They are mostly used in triggering an intruder alarm and activate household appliances upon the presence of a human. However, the output from the sensor is proportional to several temporal relationships between an object in the field of view of the sensor, the sensitivity of the sensor,

PIR lens features, and the environmental heat conditions.They are mostly used in triggering an intruder alarm i.e. for security purposes, automatic ticket gates, entry way lighting, security lighting, automated sinks, hand dryers and doors.

7.1.4 LDR/ LDR MODULE





A Light-Dependent Resistor (LDR), also known as a photoresistor or photocell, is a type of resistor that changes its resistance based on the intensity of light falling on it. It is a light-controlled variable resistor that has high resistance in the dark and low resistance in the present of light. LDR is often used in sensing circuits, mainly for the detection of day and night.

LDR Module is a module that can control the functioning of many LEDs using one module only. It has an onboard LDR that helps it to detect light. It has 4 pins as supply pin, ground pin, analog and digital output pin. It has a potentiometer to set the sensitivity of light detection intensity.

It can be used in both analog and digital circuits. In analog circuits, the resistance of the LDR can be used to control the voltage or current flowing through the circuit. In digital circuits, the LDR can be used as a sensor to detect the presence or absence of light.

It is used in automated lights, laser-based security systems, smoke detector alarm, clock with automatic light, photographic light meters, solar cells and many more. In the dark, the photoresistor can have a resistance as high as several megaohms (MΩ), while in the light, it can have a resistance as low as a few hundred ohms. If incident light on the photoresistor exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band.

The resulting free electrons (and their hole partners) conduct electricity, thereby lowering resistance.LDR is widely used in varying light intensity. It is done by using a resistor in series with each LDR making a voltage divider circuit. Whenever the intensity of light on LDR changes, its resistance and hence the output voltage are changed; change in intensity is translated into a change in voltage.

7.1.5 POTENTIOMETER

The potentiometer is a device that essentially functions as a variable resistance divider or a variable resistor. The word 'potentiometer' is the combination of potential difference and metering. It is a three-terminal device. Two of its terminals are connected to the opposite ends of a resistive element, and the third terminal connects to a sliding contact, called a wiper, moving over the resistive element. If a reference voltage is applied across the end terminals, the position of the wiper determines the output voltage of the potentiometer.

The basic principle of the potentiometer is that the potential drop across any section of the wire will be directly proportional to the length of the wire, provided the wire is of a uniform cross-sectional area and a uniform current flow through the wire.

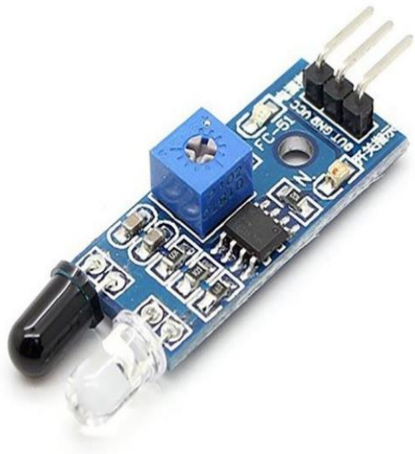
When current passes through a potentiometer, it experiences a voltage drop proportional to the resistance value. It is a very sensitive device. It measures the slightest change made

.It can be used to determine the emf and internal resistance of the given cell and also used to compare the emf of different cells. Potentiometers are extensively used as user controls and can be used to control a wide range of equipment functions.

It is employed in radio and television (TV) receivers to control volume, tone, and linearity. It is of various types and can be categorized as the types of Rotary potentiometers, Linear potentiometers, Digital potentiometers, Rheostat. Each type has different areas of applications like controlling resolution, car radios, measurement of distance etc.

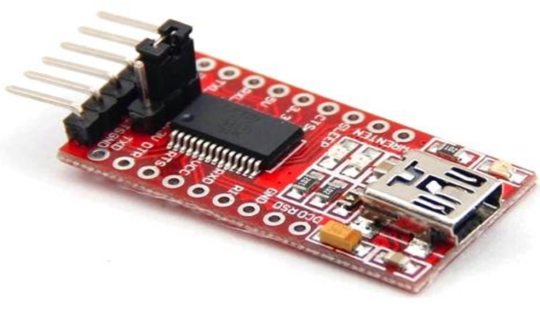
7.1.6 IR Sensors

An infrared sensor (IR sensor) is a radiation-sensitive optoelectronic component. It consists of two parts, the emitter circuit, and the receiver circuit. The emitter is an IR LED and the detector is an IR photodiode. They work by detecting infrared radiation emitted by objects in the environment. The IR transmitter continuously emits the IR light and the IR receiver keeps on checking for the reflected light. If the light gets reflected back by hitting any object in front it, the IR receiver receives this light and the object is detected. While using the transmitter and receiver together, the receiver's wavelength must equal the transmitter. Its sensitivity range is controlled by a rotator potentiometer. It works by using the principle of photodiode. The photo-diode's resistance and output voltage changes in proportion to the IR light received.



IR sensor has three pins are- VCC, GND, and Out. It has two small LED indicators – one for power, which is ON the entire time the sensor is ON; the other is the Signal LED which detects the object. The range i.e. from how far the object will be detected by changing the value of the potentiometer.Its non-contact operation leads to its wide use in motion detectors, which are used in building services to switch on lamps or in alarm systems to detect unwelcome guests. In a defined angle range, the sensor elements detect the heat radiation (infrared radiation) that changes over time and space due to the movement of people and objects.

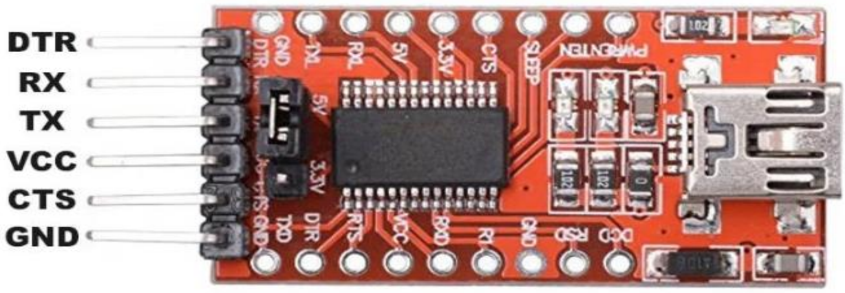
7.1.7 FTDI PROGRAMMING BOARD



Future Technology Devices International (FTDI) is a company that specializes in designing and manufacturing integrated circuits (ICs) for USB connectivity and conversion. One of their most popular products is the FTDI chip. The FTDI chip, is widely used for various applications that require USB connectivity and communication. They are commonly used

in programming and debugging scenarios. They provide a convenient way to establish a USB connection between a computer and microcontrollers, such as Arduino boards or other embedded systems. This allows developers to upload code, monitor output, and debug their applications using a USB connection.The USB to RS232 converter cables provide a simple communication method between serial devices with RS232 to modern USB supported devices. FTDI cable comes with an internal mounted electronic circuit which uses FTDI

FT232R chip.This FTDI chip converts USB data to serial and vice versa. In other words, this cable provides an effective and cheap solution to connect TTL serial interface to USB. It consists of 6 pins. But mostly four pins are used to connect UART based devices with the computer through this FTDI cable. Out of these four pins, two are power supply pins such as Vcc and GND. Two other pins are Rx and Tx Pins. The other side of the FTDI cable is just a type-A USB connector. You can simply plug it into your computer or laptop.



Pin Configuration

Following are the details and functionality of all pins.

(GND): Connect to the ground pin of the device to which you want to connect with the computer

(CTS): Clear to Send = This is control input and is used to clear the send request of Data.

(Vcc): Connect it with Vcc

(TxD): Transmit Asynchronous Data = This is an output pin and used to transmit output data asynchronously

(RxD): Receive Asynchronous Data = This is an input pin and used to receive input data asynchronously.

(RTS): This is a control output pin and is used to make a request for sending the data.

7.1.8 BUZZER

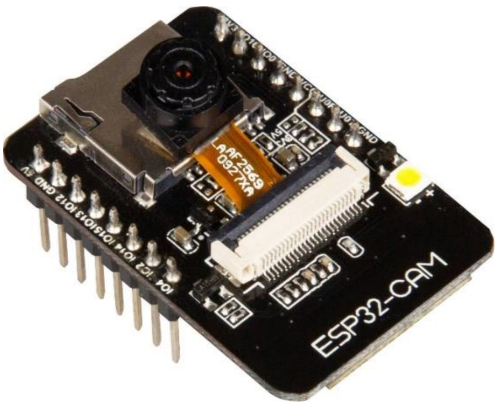
A buzzer is a device that can produce sound when connected to an Arduino board. It can be used as an alarm for sensors. A buzzer has a piezo element inside, which is a ceramic disc that vibrates with different voltages and frequencies.

The buzzer generates sound based on the reverse of the piezoelectric effect. They were designed to help technicians integrate their alarm systems or other automated systems for sound feedback. There are two types of buzzers: active and passive.

Active buzzers can generate sound by themselves while passive buzzers need a signal from Arduino. Buzzer comprises an outer case with two pins to attach it to power and ground. Inside is a piezo element, there is a ceramic disc covered with a metal vibration disc.

Once the current is supplied, the ceramic disk is made to contract or expand. This then makes the surrounding disks vibrate. That’s the output and creates the sound you hear. The vibration rate varies by regular changes of the buzzer frequency, and the pitch of the resulting sound also changes.

7.1.9 ESP32 CAM



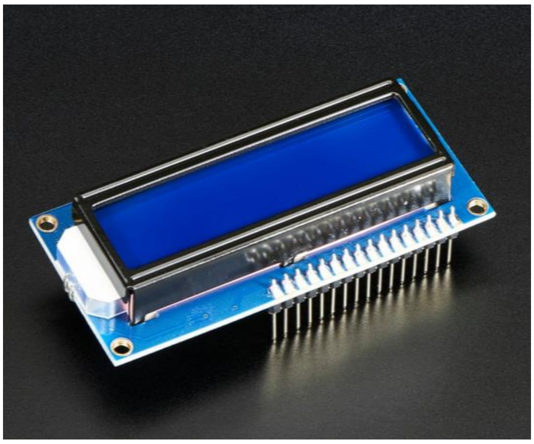
ESP32-CAM is a low-cost ESP32-based development board with an onboard camera and integrated Wi-Fi. It is suitable for home smart devices, industrial wireless control, wireless monitoring, QR wireless identification, wireless positioning system signals and other IoT applications.

The ESP32-based development board has built-in Wi-Fi and Bluetooth interfaces that simplify connection and communication with other devices or networks. It provides many GPIO (general purpose input/output) pins that facilitate connection with and control of external devices and sensors.

These pins support a variety of interfaces. The ESP32 is designed to be power efficient, thus enabling the development of energy-efficient IoT applications. It can be connected to displays, touchscreens, or LED indicators to provide a user-friendly interface. It can be programmed using various development frameworks and languages. The most commonly used programming language is C++ which can be programmed using the Arduino IDE.

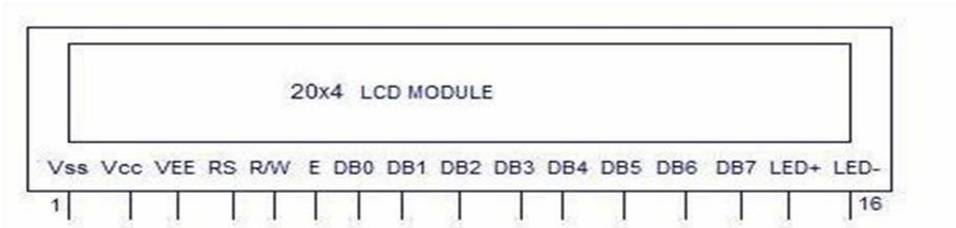
It uses the OV2640 Camera Module. It is an ESP32 compatible camera that is programmed using Arduino IDE via ESP32-based development board and interfaced using FTDI chip. It is highly sensitive for low-light operation with face recognition technology. It can capture and store images and videos in an external storage device i.e. SD Card or can send them continuously on a web server.

7.1.10 LCD



The full form of LCD is a Liquid Crystal Display. It is a flat panel display system that is primarily seen in televisions and computer screens, which are also used in cell phones. It is a passive device, which means that it does not deliver any light to display characters. LCDs uses fluorescent lights, and these lights are usually placed behind the screen.

It is a combination of two phases of liquid and solid matter. The solid element is the crystal, and the combination of liquid and crystal makes the image clear. The LCD has two layers consisting of two polarized filters and electrodes. LDC screen works by blocking the light bean rather than releasing the light. There are two types of pixel grids in LCD- Active-Matrix Grid and Passive Matrix.



Pin description

- **Pin1 (Ground/Source Pin):** This pin connects the microcontroller's GND terminal or power source to the display's GND pin.
- **Pin2 (VCC/Source Pin):** This pin connects the supply pin of the power source to the voltage supply pin of the display.
- **Pin 3 (V0/VEE/Control Pin)**: controls the display's contrast and is used to connect a movable POT that can deliver 0 to 5V.
- **Pin 4 (Register Select/Control Pin):** This pin switches between a command and a data register. It connects to a microcontroller unit pin and receives either 0 or 1 (where 0 is data mode and 1 is command mode).
- **Pin 5 (Read/Write/Control Pin):** switches between reading and writing to the display and is attached to a microcontroller unit pin to receive either 0 or 1 (where 0 indicates a write action and 1 indicates a read operation).

- **Pin 6 (Enable/Control Pin):** This pin connects to the microcontroller unit and is continuously held high, allowing the Read/Write process to be carried out.
- **Data pins 7–14:** You can transfer data to the display using these pins. Two-wire connections are made between these pins in the 4-wire and 8-wire modes, respectively.
- **Pin 15**: is connected to +5V (the positive pin of the LCD).
- **Pin 16**: is connected to ground (the negative pin of the LCD)

7.2 SOFTWARE REQUIREMENTS

7.2.1 ARDUINO IDE

The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports many programming languages like C and C++. The Arduino IDE is Arduino Integrated Development Environment, a popular platform for programming and developing projects with Arduino microcontrollers.

Arduino Board can be easily programmed using the Arduino Integrated Development Environment (IDE), which provides a simple and intuitive interface for writing, compiling, and uploading code to the board. The Arduino IDE is also an open source and free to download software, making it accessible to anyone.

Programs written using Arduino Software (IDE) are called sketches. The Arduino IDE comes with a standard library and allows the user to add external libraries. Libraries are collections of pre-written code that can be used in sketches to make development faster and easier.

It also has a built-in serial monitor that allows the user to send and receive data from the Arduino board. It's a useful tool for debugging and interacting with the project.

Arduino Libraries:

Arduino IDE Libraries are a collection of pre-written codes that are designed to help programmers save time by providing easy-to-use functions and tools that can be used in their Arduino projects. Libraries are essentially a set of functions that are grouped together under a single header file.

The Arduino IDE comes with a set of default libraries that are installed when the software is downloaded. These libraries include basic functions such as digitalWrite(), pinMode(), and analogRead (), which are used to control the functioning of the microcontroller.

8. APPLICATIONS

- This system can be implemented in places like parks, parking lots, bus shelters, streets where the system itself detects whether there is a need for light or not.
- Smart lights can be integrated with other smart devices and systems in homes, creating a comprehensive smart home ecosystem. This integration allows advanced automation and energy-saving routines. For example, lights can be set to turn off automatically when you leave home or when no motion is detected.
- Smart lights can be programmed to detect the presence at home if any, when you're away, deterring potential intruders.
- Camera installation in cities along with speed detection can lead to vehicle challan if over speedy driving is done.
- Continuous camera surveillance can give emergency help if needed.

9.RESULT

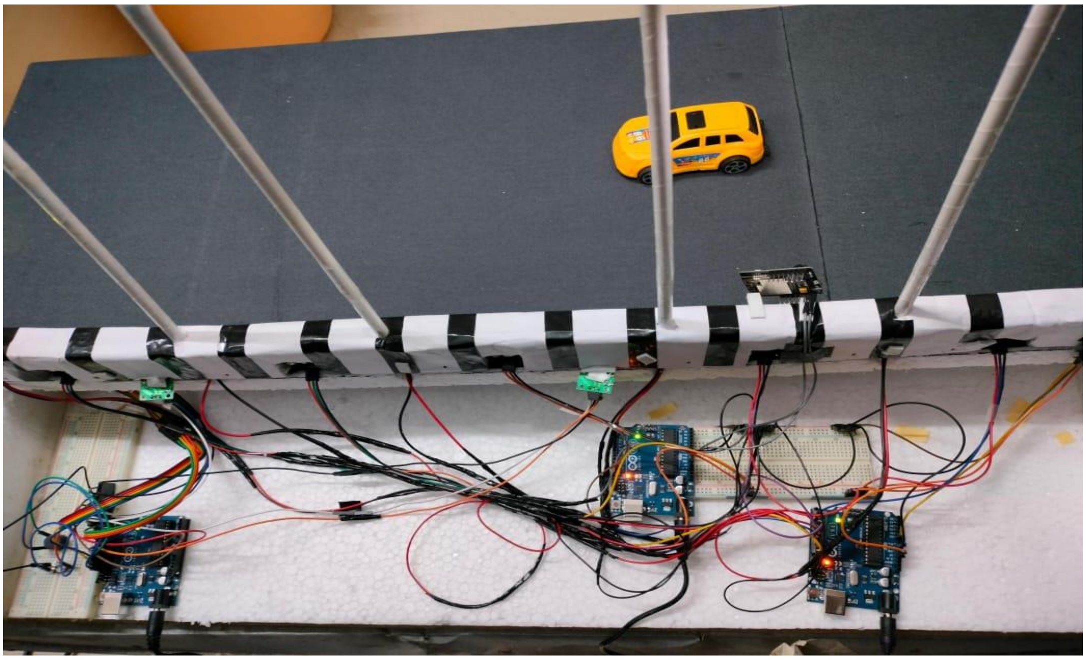
The successful development of the Bright Street project represents a significant milestone in urban infrastructure innovation, offering a multifaceted solution that addresses energy efficiency, traffic safety, and public security. This integrated system combines advanced technologies to create a smarter and safer environment for residents and commuters.

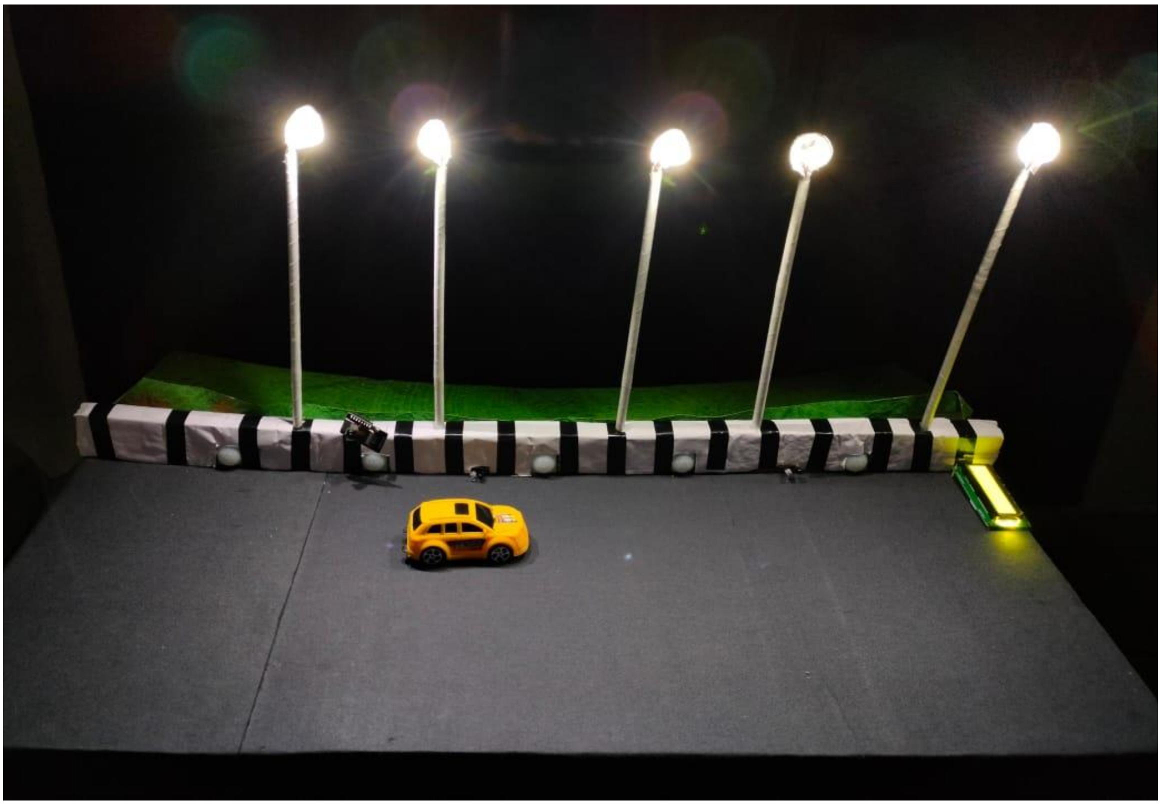
At its core, the Bright Street project is designed to enhance energy efficiency through intelligent lighting solutions. By incorporating energy-efficient LED lighting fixtures equipped with motion sensors and programmable controls, the project minimizes energy consumption while ensuring adequate illumination levels based on real-time conditions. This not only reduces operating costs but also contributes to creating a more sustainable urban ecosystem.

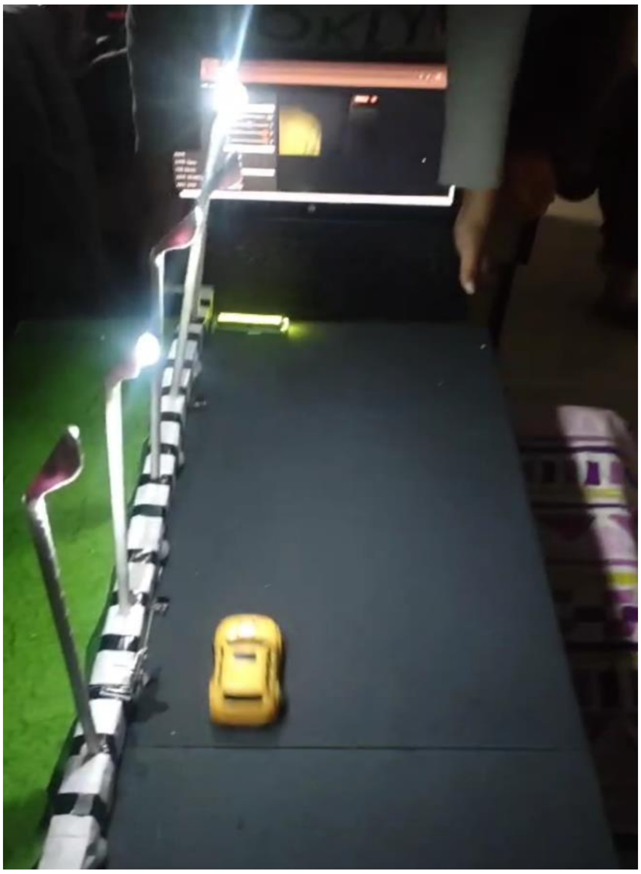
Moreover, the incorporation of surveillance cameras into the Bright Street project adds an extra layer of security and safety. The 24x7 surveillance capability enables continuous monitoring of the street environment, cameras are equipped with advanced image processing algorithms capable of detecting overspeeding vehicles, contributing to traffic management and accident prevention efforts.

The improved lighting and enhanced security contribute to creating a more welcoming and safer environment, encouraging pedestrian activity and community engagement. Moreover, the project's focus on energy efficiency aligns with sustainability goals, reducing the city's environmental footprint and promoting responsible resource management.

The successful development of the Bright Street project represents a significant advancement in urban infrastructure management, combining energy efficiency, traffic safety, and public security in an integrated solution. By leveraging advanced technologies and data-driven approaches, the project demonstrates the potential to create smarter, safer, and more sustainable cities for the future. Here, are some references images of our project.







10.CONCLUSION

Our project introduces cutting-edge LED lighting technology to replace conventional bulbs, achieving substantial energy savings. The incorporation of automated LEDs with dimming and on/off switches optimizes energy usage to meet specific road and vehicle requirements.

The camera captures and stores the data all day and night long. In addition to the numerous benefits highlighted, the integration of cameras and IR sensors further enhances the safety and efficiency of our LED lighting system The result is a highly efficient, eco-friendly, and low power-consuming street light system with enhanced power security system.

- **Eco-Friendly:** The use of LED technology reduces greenhouse gas emissions and contributes to a cleaner, more sustainable environment.
- **Long-Term Cost Savings:** The adoption of LED technology offers substantial long-term cost savings. LED lights have significantly longer lifespans compared to traditional bulbs, reducing the frequency of replacements and associated maintenance costs. Moreover, the energy efficiency of LEDs results in lower electricity consumption, translating into reduced operational expenses for municipalities and local governments. By investing in our system, communities can achieve considerable cost savings over the lifetime of the street lighting infrastructure.
- **Automation:** Self-controlled and automated functionality adapts to the needs of the road and vehicle traffic, enhancing safety and energy efficiency. The automatic face recognition and capturing feature of camera leads to
- **Minimized Energy Wastage:** LEDs can be dimmed or turned off when not needed, minimizing energy wastage and promoting responsible energy use. A key advantage of our system is its ability to minimize energy wastage through intelligent control mechanisms. By dynamically adjusting lighting levels based on real-time conditions, energy consumption is optimized to match actual requirements. During periods of low traffic or reduced activity, LEDs can be dimmed or turned off entirely, preventing unnecessary energy expenditure. This proactive approach not only conserves resources but also promotes responsible energy use, aligning with sustainability objectives and environmental stewardship.
- **Enhanced Safety through Surveillance:** The incorporation of cameras facilitates real-time surveillance of the surrounding area, promoting safety by deterring potential criminal activities and providing valuable data for law enforcement. The continuous monitoring capability

ensures that the area is well-lit and under constant surveillance, enhancing the overall security of the environment.

- **Speeding Detection with PIR Sensors:** PIR sensors can detect the speed of vehicles passing through the illuminated area, allowing for the implementation of speed monitoring and enforcement measures. By capturing vehicle speeds and identifying potential violations, our system contributes to road safety efforts, reducing the risk of accidents and enhancing traffic management capabilities.
- **Integrated Automation for Optimal Performance:** The automated functionality of our system, incorporating both LED lighting control and surveillance features, ensures seamless operation tailored to specific road and vehicle requirements. This integration allows for dynamic adjustments based on real-time data, optimizing energy usage while maintaining safety and security standards.
- **Comprehensive Data Collection and Analysis:** The camera's ability to capture and store data throughout the day and night enables comprehensive analysis of traffic patterns, pedestrian movements, and environmental conditions. This data can be utilized to identify trends, optimize infrastructure planning, and implement targeted interventions to improve overall urban mobility and safety

By combining cutting-edge LED lighting technology with advanced surveillance capabilities and IR sensors, our project offers a holistic solution that not only reduces energy consumption and operational costs but also prioritizes safety, security, and sustainability in urban environment. In conclusion, our project represents a paradigm shift in street lighting technology, combining LED illumination with advanced automation features to achieve unprecedented levels of efficiency and safety.

By leveraging automated LEDs, cameras, and IR sensors, our system offers numerous benefits, including eco-friendly illumination, long-term cost savings, enhanced safety, and minimized energy wastage. As communities worldwide seek sustainable solutions for urban infrastructure, our project provides a compelling blueprint for the future of street lighting, where innovation and efficiency converge to create safer, more livable environments for all.

11. FUTURE SCOPE AND LIMITATIONS

Smart streetlights can be equipped with advanced communication technologies such as 5G and IoT (Internet of Things) to enable real-time data exchange and communication with other city infrastructure, vehicles and devices. Smart streetlights can be equipped with environmental sensors to monitor air quality, temperature, humidity and other parameters. Smart streetlights can offer public

Wi-Fi and act as charging stations for mobile phones, improving connectivity and convenience for residents. The data collected by smart streetlights will be harnessed for data analytics, allowing cities to make informed decisions for urban planning, resource allocation, and infrastructure maintenance. They can provide real-time data on traffic patterns, monitor road conditions and assist in optimizing traffic signal timings to reduce gridlocks and improve transportation efficiency. The output of Camera i.e. recordings or specific photos of the faulty vehicles that have been overspeeding along with their speed can be used as a database to produce their e-challan. An emergency button can be installed near to the cameras such that real time problem surveillance at the place can be done and respectively help can be sent.

Limitations

Integrating cameras into sensor-based street lights adds to the overall project cost. This includes expenses related to purchasing, installing, and maintaining both the camera and sensor systems. The cost of networking infrastructure for real-time data transmission and storage should also be taken into account.

Transmitting high-quality video streams in real-time over a network requires considerable bandwidth. This can pose challenges, especially in areas with limited internet connectivity or where the existing infrastructure cannot support the required data transfer rates

12. APPENDICES

Appendix 1. Code for interfacing of LDR, PIR Sensors and LEDs using Arduino Uno

```
#define LDR A0

#define PIR1 7

#define PIR2 8

#define PIR3 9

#define PIR4 10

#define PIR5 11

#define LED1 2

#define LED2 3
```

```
#define LED3 4
#define LED4 5
#define LED5 6
void setup()
{
    pinMode (A0, INPUT);
    pinMode (7, INPUT);
    pinMode (8, INPUT);
    pinMode (9, INPUT);
    pinMode (10, INPUT);
    pinMode (11, INPUT);
    pinMode (2, OUTPUT);
    pinMode (3, OUTPUT);
    pinMode (4, OUTPUT);
    pinMode (5, OUTPUT);
    pinMode (6, OUTPUT);
}
void loop()  {
    int status_ldr = digitalRead(LDR);
    int status_pir1 = digitalRead(PIR1);
    int status_pir2 = digitalRead(PIR2);
    int status_pir3 = digitalRead(PIR3);
    int status_pir4 = digitalRead(PIR4);
    int status_pir5 = digitalRead(PIR5);
```

```
if (status_ldr ==1 && status_pir1 ==1 )
{
    digitalWrite(2, HIGH);
}
else
{
    digitalWrite(2, LOW);
}
if (status_ldr ==1 && status_pir2 ==1 )
{
    digitalWrite(3, HIGH);
}
else
{
    digitalWrite(3, LOW);
}
if (status_ldr ==1 && status_pir3 ==1 )
{
    digitalWrite(4, HIGH);
}
else
{
    digitalWrite(4, LOW);
```

```
}
if (status_ldr ==1 && status_pir4 ==1 )
{
    digitalWrite(5, HIGH);
}
else
{
  digitalWrite(5, LOW);
}
if(status_ldr ==1 && status_pir5 ==1 )
{
  digitalWrite(6, HIGH);
}
else
{
  digitalWrite(6, LOW);
}
}
```

Appendix 2. Code for interfacing of IR Sensors and LCD using Arduino Uno

```
const int sensorPin1 = 8;
const int sensorPin2 = 9;
const int buzzerPin = 13;
#include <LiquidCrystal.h>
```

```
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);

const float threshold = 0.05;

const float distanceBetweenSensors = 27.0;


void setup() {

    pinMode(sensorPin1, INPUT);

    pinMode(sensorPin2, INPUT);

    pinMode(buzzerPin, OUTPUT);

    lcd.begin(16, 2);

}

void loop() {

    int sensorValue1 = digitalRead(sensorPin1);

    int sensorValue2 = digitalRead(sensorPin2);

    float speed = calculateSpeed();

    if (sensorValue1 == LOW && sensorValue2 == LOW)

    {

        lcd.clear();

        lcd.setCursor(0,0);

        lcd.print("No Car Detected");

        lcd.setCursor(0,1);

        lcd.print("Searching...");

        delay(500);

    }

else
```

```
 {
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("Speed: ");
  lcd.print(speed);
  lcd.print(" km/h");

 if (speed > threshold)
 {
    lcd.setCursor(0,1);
    lcd.print("Over Speeding!");
    tone(buzzerPin, 1000);
    delay(1000);
    noTone(buzzerPin);
 }
 else
 {
    lcd.setCursor(0,1);
    lcd.print("Normal Speed");
    delay(2500);
 }
 delay(500);
}
float calculateSpeed()
```

```
{
    long time1 = micros();
    while (digitalRead(sensorPin1) == HIGH || digitalRead(sensorPin2) == HIGH);
    long time2 = micros();
    long timeDiff = time2 - time1;
    float speed = distanceBetweenSensors / ((timeDiff / 1000000.0) *3600.0);
    return speed;
}
```

Appendix 3. Code for interfacing of ESP32-CAM using FTDI

```
#include "esp_camera.h"
#include <WiFi.h>
// WARNING!!! PSRAM IC required for UXGA resolution and high JPEG quality
// Ensure ESP32 Wrover Module or other board with PSRAM is selected
// Partial images will be transmitted if image exceeds buffer size
// You must select partition scheme from the board menu that has at least 3MB APP space.
//Face Recognition is DISABLED for ESP32 and ESP32-S2, because it takes up from 15
//seconds to process single frame. Face Detection is ENABLED if PSRAM is enabled as well
#define CAMERA_MODEL_WROVER_KIT // Has PSRAM
#define CAMERA_MODEL_ESP_EYE // Has PSRAM
#define CAMERA_MODEL_ESP32S3_EYE // Has PSRAM
#define CAMERA_MODEL_M5STACK_PSRAM // Has PSRAM
#define CAMERA_MODEL_M5STACK_V2_PSRAM // M5Camera version B Has PSRAM
#define CAMERA_MODEL_M5STACK_WIDE // Has PSRAM
#define CAMERA_MODEL_M5STACK_ESP32CAM // No PSRAM
```

```
#define CAMERA_MODEL_M5STACK_UNITCAM // No PSRAM

#define CAMERA_MODEL_AI_THINKER // Has PSRAM

#define CAMERA_MODEL_TTGO_T_JOURNAL // No PSRAM

** Espressif Internal Boards **

#define CAMERA_MODEL_ESP32_CAM_BOARD

#define CAMERA_MODEL_ESP32S2_CAM_BOARD

#define CAMERA_MODEL_ESP32S3_CAM_LCD

#define CAMERA_MODEL_DFRobot_FireBeetle2_ESP32S3 // Has PSRAM

#define CAMERA_MODEL_DFRobot_Romeo_ESP32S3 // Has PSRAM

#include "camera_pins.h"


// ===========================

// Enter your WiFi credentials

// ===========================

const char* ssid = "**********";

const char* password = "**********";

void startCameraServer();

void setupLedFlash(int pin);

void setup()

{

    Serial.begin(115200);

    Serial.setDebugOutput(true);

    Serial.println();

    camera_config_t config;
```

```
config.ledc_channel = LEDC_CHANNEL_0;
config.ledc_timer = LEDC_TIMER_0;
config.pin_d0 = Y2_GPIO_NUM;
config.pin_d1 = Y3_GPIO_NUM;
config.pin_d2 = Y4_GPIO_NUM;
config.pin_d3 = Y5_GPIO_NUM;
config.pin_d4 = Y6_GPIO_NUM;
config.pin_d5 = Y7_GPIO_NUM;
config.pin_d6 = Y8_GPIO_NUM;
config.pin_d7 = Y9_GPIO_NUM;
config.pin_xclk = XCLK_GPIO_NUM;
config.pin_pclk = PCLK_GPIO_NUM;
config.pin_vsync = VSYNC_GPIO_NUM;
config.pin_href = HREF_GPIO_NUM;
config.pin_sccb_sda = SIOD_GPIO_NUM;
config.pin_sccb_scl = SIOC_GPIO_NUM;
config.pin_pwdn = PWDN_GPIO_NUM;
config.pin_reset = RESET_GPIO_NUM;
config.xclk_freq_hz = 20000000;
config.frame_size = FRAMESIZE_UXGA;
config.pixel_format = PIXFORMAT_JPEG; // for streaming
config.pixel_format = PIXFORMAT_RGB565; // for face detection/recognition
config.grab_mode = CAMERA_GRAB_WHEN_EMPTY;
config.fb_location = CAMERA_FB_IN_PSRAM;
```

```
            config.jpeg_quality = 12;
            config.fb_count = 1;

// if PSRAM IC present, init with UXGA resolution and higher JPEG quality
//          for larger pre-allocated frame buffer.
           if(config.pixel_format == PIXFORMAT_JPEG)
           {
           if(psramFound())
           {
               config.jpeg_quality = 10;
               config.fb_count = 2;
               config.grab_mode = CAMERA_GRAB_LATEST;
            }
            else
           {
 // Limit the frame size when PSRAM is not available
               config.frame_size = FRAMESIZE_SVGA;
               config.fb_location = CAMERA_FB_IN_DRAM;
               }
               }
               else
               {
 // Best option for face detection/recognition
               config.frame_size = FRAMESIZE_240X240;
```

```
#if CONFIG_IDF_TARGET_ESP32S3
config.fb_count = 2;
#endif
}
#if defined(CAMERA_MODEL_ESP_EYE)
pinMode(13, INPUT_PULLUP);
pinMode(14, INPUT_PULLUP);
#endif
// camera init
esp_err_t err = esp_camera_init(&config);
if (err != ESP_OK)
{
Serial.printf("Camera init failed with error 0x%x", err);
return;
}
sensor_t * s = esp_camera_sensor_get();
// initial sensors are flipped vertically and colors are a bit saturated
if (s->id.PID == OV3660_PID)
{
s->set_vflip(s, 1); // flip it back
s->set_brightness(s, 1); // up the brightness just a bit
s->set_saturation(s, -2); // lower the saturation
}
// drop down frame size for higher initial frame rate
```

```
if (config.pixel_format == PIXFORMAT_JPEG)
{
    s->set_framesize(s, FRAMESIZE_QVGA);
}
#if defined(CAMERA_MODEL_M5STACK_WIDE) ||
defined(CAMERA_MODEL_M5STACK_ESP32CAM)

s->set_vflip(s, 1);
s->set_hmirror(s, 1);
#endif
#if defined(CAMERA_MODEL_ESP32S3_EYE)
s->set_vflip(s, 1);
#endif
// Setup LED FLash if LED pin is defined in camera_pins.h
#if defined(LED_GPIO_NUM)
setupLedFlash(LED_GPIO_NUM);
#endif
WiFi.begin(ssid, password);
WiFi.setSleep(false);
while (WiFi.status() != WL_CONNECTED)
{
    delay(500)
    Serial.print(".");
}
Serial.println("");
```

```
        Serial.println("WiFi connected");

        startCameraServer();

        Serial.print("Camera Ready! Use 'http://");

        Serial.print(WiFi.localIP());

        Serial.println("' to connect");

}

void loop()

{

    delay(10000);

}
```

13. REFERENCES

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