iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** VI **Month of publication:** June 2023

DOI: https://doi.org/10.22214/ijraset.2023.54486

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

Automatic Street Light Control System

Chaitrashree S R[1], Bhavana B Raj[2], Spandana Y N[3], Ankitha R[4]
[1, 2, 3, 4]*Department of Electrical & Electronics Engineering, GSSS Institutre of Engineering & Technology for Women, Metagalli, Mysuru*

Abstract: Automatic Street Light Control System is a simple yet powerful concept, which uses transistor as a switch. By using this system manual works are 100% removed. It automatically switches ON lights when the sunlight goes below the visible region of our eyes. This is done by a sensor called infrared sensor (IR) which senses the light actually like our eyes. It automatically switches OFF lights whenever the sunlight comes, visible to our eyes.
By using this system energy consumption is also reduced because nowadays the manually operated street lights are not switched off even the sunlight comes and also switched on earlier before sunset. In this project, no need of manual operation like ON time and OFF time setting. This project clearly demonstrates the working of transistor in saturation region and cut-off region.
Keywords: Ultrasonic sensor, location determination, visually impaired, emergency alerts, hindrance detection.

I. INTRODUCTION

Street light controllers are smarter versions of the mechanical or electronic timers previously used for street light ON-OFF operation. They come with energy conservation options like twilight saving, staggering or dimming. Also many street light controllers come with an astronomical clock for a particular location or a Global Positioning System (GPS) connection to give the best ON-OFF time and energy saving.

Automatic Street Light Control System is a simple and powerful concept, which uses transistor as a switch to switch ON and OFF the street light automatically. By using this system manual works are removed. It automatically switches ON lights when the sunlight goes below the visible region of our eyes. It automatically switches OFF lights under illumination by sunlight. This is done by a sensor called Light Dependant Resistor (LDR) which senses the light actually like our eyes By using this system energy consumption is also reduced because now-a-days the manually operated street lights are not switched off properly even the sunlight comes and also not switched on earlier before sunset. In sunny and rainy days, ON time and OFF time differ significantly which is one of the major disadvantage of using timer circuits or manual . This project exploits the working of a transistor in saturation region and cut-off region to switch ON and switch OFF the lights at appropriate time with the help of an electromagnetically operated switch.

A street light, lamppost, street lamp, light standard, or lamp standard is a raised source of light on the edge of a road or walkway, which is turned on or lit at a certain time every night. Modern lamps may also have light-sensitive photocells to turn them on at dusk, off at dawn, or activate automatically in dark weather. In older lighting this function would have been performed with the aid of a solar dial. It is not uncommon for street lights to be on poles which have wires strung between them, or mounted on utility poles.

This project exploits the working of a transistor in saturation region and cut-off region to switch ON and switch OFF the lights at appropriate time with the help of an electromagnetically operated switch.

II. LITERATURE SURVEY

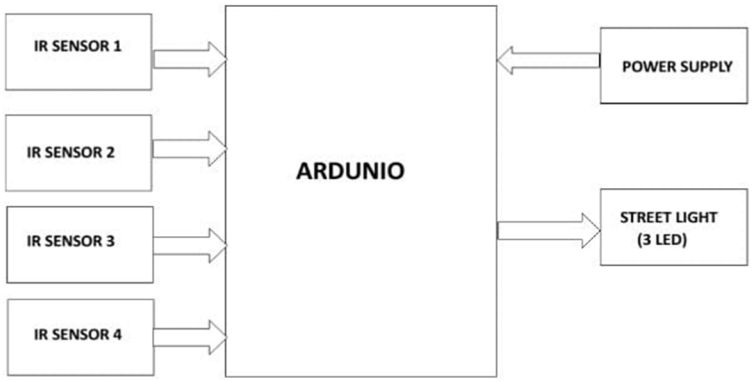
In [1] proposes about Street Light Glow on detecting vehicle movement using sensor isa system that utilizes the latest technology for sources of light as LED lamps. It is also used to control the switching of street light automatically according to the light intensity to develop flow based dynamic control statistics using infrared detection technology and maintain wireless communication among lamppost and control terminal using ZigBee Wireless protocol. It also combines various technologies: a timer, a statistics of traffic flow magnitude, photodiodes, LED, power transistors.In [2], have surveyed on Street Lighting System Based on Vehicle Movements. The system operates in the automatic mode which regulates the streetlight according to brightness and dimness algorithm and light intensity. The control can be made according to the seasonal variation. It includes a time cut-out function and an automatic control pattern for conserving more electricity. In [3] proposes a ZigBee based Remote Control Automatic Street Light Srikanth System. The system is designed with the help of ZigBee modules that helps in detecting the faulty lights and control the light. It also discusses about an intelligent system that takes automatic decisions for ON/OFF/DIMMING considering the vehicle movement or pedestrian and also the surrounding environment.

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PIR motion sensor is used to detect movement of both living and non-living things. In [5], have implemented design of traffic flow based street light control system with effective utilization of solar energy in the year 2015. They used the renewable source of energy i.e. the solar power for street lighting. They have also used 8052 series microcontroller and is developed by replacing the normal bulbs with the LEDs due to which the power consumption is reduced by 3 times. Sensors are placed on either side of the road which senses the vehicle movement and sends the commands to the microcontroller to switch ON and OFF the lights. Here all the street lights remain switched off and it glows only when it senses the vehicle movement. Hence, because of the microcontroller, even when its night the lights are switched off. In [6] have analyzed the street light with auto tracking system by which one can increase the conversion efficiency of the solar power generation. Here, the sun tracking sensor is the sensing device which senses the position of the sun time to time and gives the output to the amplifier based on light density of the sun. Sun tracking sensor is LDR, amplifier unit is used to amplify the LDR signals which converts low level signals to high level signals and the output is given to comparator. The LM324 IC is used as an amplifier. Comparator compares the signals and gives the command to AT89C51 microcontroller.

In [7], reports on the two installation case studied in Scotland and Wales and explains the details and benefits of the technology. The system was called as MINOS that had a track record of over 100,000 units installed and working successfully. In [8], describes a comparative analysis of photovoltaic (PV) street lighting system in three different lamps. Namely, a low pressure sodium lamp, a high pressure sodium lamp and a fluorescent lamp have been used for installation in each mast to determine the suitable system to install in a typical rural area of Thailand. All three systems have been mounted with the same module type and wattage in different places within the Rajamangala Institute of Technology, Thanyaburi district, Pathumthani province of Thailand. In [9] explains a system to reduce the power consumption of street lights by avoiding inefficient lighting which wastes significant financial resources each year. This is done by dimming the lights during less traffic hours. For this purpose PIR sensor is used which detects any movement. This work also aims at reducing the fatal crashes and road accidents caused due to alcohol consumption. This is done using skin sensors placed in vehicle doors and also using breadth sensors inside the vehicle. By implementing this death rates due to drunk driving can be reduced to a great extent. The prototype has been implemented and works as expected and will prove to be very useful and will fulfill all the present constraints if implemented on a large scale. It also aims at detecting consumption of alcohol by the driver and if it exceeds certain level it impairs the driver from entering into the Vehicle. This prevents occurrence of accidents or any fatal crashes. This initiative will help the government to save this energy and meet the domestic and industrial needs.

III. METHODOLOGY



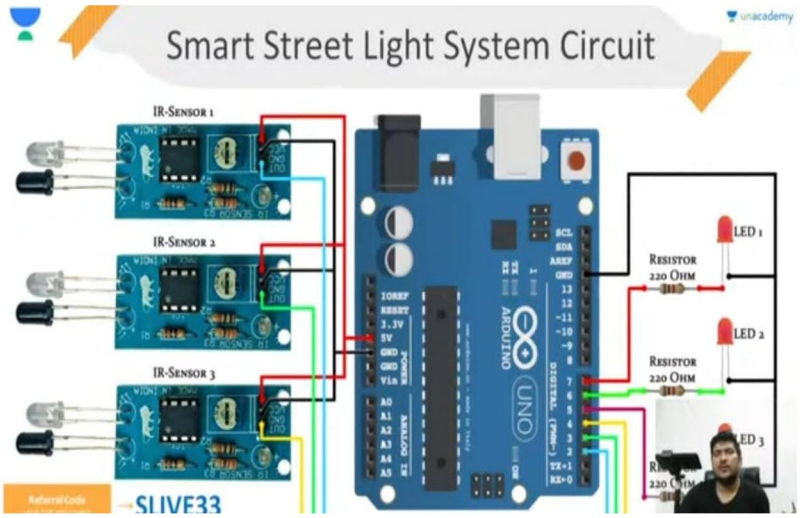
1) *IR Sensor:* The IR sensor is a key component of the system that detects the presence or absence of vehicles or pedestrians in its range. It emits infrared radiation and measures the reflection or interruption of the emitted beam to determine If an object is present or not.
2) *Arduino:* A arduino, is used to control the overall operation of the automatic streetlight system. It receives input from the IR sensor and processes the information to make decisions regarding turning the streetlights on or off.

3) *Power Supply:* The power supply provides electrical energy to the system components. It typically consists of a transformer, rectifier, and voltage regulator to ensure a stable power source.
4) *LED Streetlights:* These are the actual lighting units installed on the street. They are usually energy-efficient LED lights that consume less power compared to traditional streetlights.
5) *Light Intensity Sensor (Optional):* In certain designs, a light intensity sensor may be incorporated to detect ambient light conditions. This sensor can automatically adjust the brightness of the streetlights based on the natural lighting present, further optimizing energy usage.

The block diagram showcases the flow of signals and control between these components, with the acting as the central control unit. The IR sensor detects the presence of vehicles or pedestrians, which triggers the arduino to activate the relay module, turning on the streetlights. When there is no detection by the IR sensor, the microcontroller sends a signal to the relay module to switch off the lights. The power supply ensures that all components receive the necessary power for their operation.

IV. IMPLEMENTATION & WORKING PRINCIPLE

The automatic street light control system using an IR sensor and Arduino operates on the principle of detecting the presence or absence of vehicles or pedestrians using an IR (Infrared) sensor. Here is a step-by-step explanation of its implementation and working principle:



A. *Components Required:*

1) Arduino board (e.g., Arduino Uno)
2) IR sensor module (e.g., IR proximity sensor)
3) Relay module
4) Street light or LED module
5) Connecting wires

B. *Circuit Connections*

1) Connect the VCC pin of the IR sensor to the 5V pin on the Arduino.
2) Connect the GND (ground) pin of the IR sensor to the GND pin on the Arduino.
3) Connect the OUT pin of the IR sensor to a digital pin (e.g., pin 2) on the Arduino.
4) Connect the VCC pin of the relay module to the 5V pin on the Arduino.
5) Connect the GND pin of the relay module to the GND pin on the Arduino.
6) Connect the IN pin of the relay module to a digital pin (e.g., pin 3) on the Arduino.
7) Connect the relay module's COM (common) pin to the positive terminal of the street light or LED module.
8) Connect the relay module's NO (normally open) pin to the negative terminal of the street light or LED module.
9) Upload the code to the Arduino board using the Arduino IDE or any compatible software.
10) Upload the code to the Arduino board using the Arduino IDE or any compatible software.

C. Testing and Operation

1) Power the Arduino board using an appropriate power source.
2) Adjust the sensitivity of the IR sensor if necessary.
3) Place the IR sensor in a suitable position to detect the presence of vehicles or pedestrians.
4) When an object is detected by the IR sensor, the relay module will be activated, and the street light or LED module will turn on.
5) When no object is detected, the relay module will be deactivated, and the street light or LED module will turn off.
6) This system works by utilizing the IR sensor to detect the presence of objects within its range.

When an object is detected, the Arduino receives a high signal from the sensor and activates the relay module. The relay module, in turn, switches on the street light or LED module. When no object is detected, the Arduino receives a low signal from the sensor and deactivates the relay module, turning off the street light or LED module. The cycle repeats as the sensor continues to monitor the presence of objects, ensuring that the street light operates automatically based on the detected activity.

V. SOFTWARE & HARDWARE DESCRIPTION

A. Infrared Sensor

An infrared sensor is an electronic device,that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measure only infrared radiation, rather than emitting it that is called a passive IR sensor. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation.



Figure 1:IR sensor

B. Light Emitting Diode

A Light Emitting Diode (LED) is a semiconductor device, which can emit light when an electric current passes through it. To do this, holes from p-type semiconductors recombine with electrons from n-type semiconductors to produce light. The wavelength of the light emitted depends on the bandgap of the semiconductor material. Harder materials with stronger molecular bonds generally have wider bandgaps. Aluminum Nitride semiconductors are known as ultra-wide bandgap semiconductors.



Figure 2 :LED`s

C. DC JACK

A standard DC power jack or plug has two conductors with the center pin typically for power and the outer sleeve typically for ground. However, reversing this conductor configuration is acceptable.



Figure 3: DC jack

D. Battery

A battery is a source of electric power consisting of one or more electrochemical cells with external connections for powering electrical devices. When a battery is supplying power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. When a battery is connected to an external electric load, a redox reaction converts high-energy reactants to lower-energy products, and the free-energy difference is delivered to the external circuit as electrical energy.



Figure 4 : Battery

E. Resistor

A resistor is an electrical component that limits or regulates the flow of electrical current in an electronic circuit. Resistors can also be used to provide a specific voltage for an active device such as a transistor.



Figure 5: Resistor

F. Jumber Wire

A jumper wire is an electric wire that connects remote electric circuits used for printed circuit boards. By attaching a jumper wire on the circuit, it can be short-circuited and short-cut (jump) to the electric circuit.

By placing the jumper wire on the circuit, it becomes possible to control the electricity, stop the operation of the circuit, and operate a circuit that does not operate with ordinary wiring. Also, when specification change or design change is necessary on the printed circuit board, reinforcement of the defective part, partial stop of the unnecessary function, and change of the circuit configuration of the unnecessary output part by attaching or detaching the jumper wire can do.



Figure 6: Jumber wire

G. Software

```
void setup()
{
pinMode (2,INPUT);   //IR Sensor 1
pinMode (3,INPUT);   //IR Sensor 2
pinMode (4,INPUT);   //IR Sensor 3
pinMode (5,OUTPUT);   //LED 1
pinMode (6,OUTPUT);   //LED 2
```

```
pinMode (7,OUTPUT);   //LED 3
}
void loop()
{
if (digitalRead(2)==HIGH&&digitalRead(3)==HIGH&&digitalRead(4)==HIGH)
{
digitalWrite(5,HIGH);
digitalWrite(6,HIGH);
      digitalWrite(7,HIGH);
    }
else if (digitalRead(2)==HIGH&&digitalRead(3)==HIGH)
   {
      digitalWrite(5,HIGH);
      digitalWrite(6,HIGH);
      digitalWrite(7,LOW);
    }
     else if (digitalRead(3)==HIGH&&digitalRead(4)==HIGH)
   {
       digitalWrite(5,LOW);
digitalWrite(6,HIGH);
digitalWrite(7,HIGH);
    }
else if (digitalRead(2)==HIGH&&digitalRead(4)==HIGH)
   {
digitalWrite(5,HIGH);
digitalWrite(6,LOW);
digitalWrite(7,HIGH);
    }
     else if (digitalRead(2)==HIGH)
    {
digitalWrite(5,HIGH);
       digitalWrite(6,LOW);
       digitalWrite(7,LOW);
     }
else if (digitalRead(3)==HIGH)
    {
       digitalWrite(5,LOW);
digitalWrite(6,HIGH);
digitalWrite(7,LOW);
      }
else if (digitalRead(4)==HIGH)
      {
digitalWrite(5,LOW);
digitalWrite(6,LOW);
digitalWrite(7,HIGH);
      }
        else
      {
digitalWrite(6,LOW);
```

```
digitalWrite(7,LOW);
digitalWrite(5,LOW);
      }
    }
```

The automatic street light system using an IR sensor and Arduino is designed to efficiently control street lighting based on the presence or absence of vehicles or pedestrians. It utilizes an infrared (IR) sensor to detect motion and trigger the lighting system accordingly. Here's a description of the software components involved in this system:

1) *IR Sensor Integration:* The IR sensor is connected to the Arduino board. The Arduino continuously reads the output of the sensor to detect any changes in the infrared radiation pattern caused by nearby objects.
2) *Initialization:* The software initializes the Arduino and sets up the necessary pins for communication with the IR sensor. It also configures the digital output pin that controls the street lights.
3) *Motion Detection:* The Arduino continuously monitors the output of the IR sensor to detect any motion or movement. When the sensor detects a change in the infrared radiation pattern, indicating the presence of a vehicle or pedestrian, it triggers the next step.
4) *Light Control:* Upon detecting motion, the software activates the digital output pin connected to the street lights. This action turns on the lights, illuminating the street for a specified duration.
5) *Delay and Timeout:* After turning on the lights, the software introduces a delay to keep the lights on for a specific period, allowing sufficient time for the vehicle or pedestrian to pass through the area. It prevents frequent toggling of the lights due to minor disturbances.
6) *Motion Monitoring:* While the lights are on, the Arduino continuously monitors the IR sensor output. If no motion is detected during this period, it indicates that the area is clear, and the software proceeds to the next step.
7) *Light Deactivation:* When no motion is detected for a predefined timeout period, the software turns off the street lights by deactivating the digital output pin. This helps conserve energy when the area is unoccupied.
8) *Looping:* The software then loops back to the motion detection stage, starting the process again. It continuously monitors the IR sensor and repeats the cycle whenever motion is detected.

By combining the IR sensor, Arduino board, and the described software logic, the automatic street light system can effectively control the lighting based on the presence or absence of vehicles or pedestrians, improving energy efficiency and enhancing safety in the area.

VI. FUTURE SCOPE

The future scope of automatic street lights using IR sensors and Arduino mini projects is quite promising. Here are a few potential advancements and applications:

1) *Energy Efficiency:* Future developments may focus on optimizing energy consumption by incorporating advanced algorithms and sensor technologies. This could involve adaptive lighting control that adjusts the intensity of street lights based on real-time traffic conditions, pedestrian presence, or ambient lighting levels, resulting in reduced energy consumption and cost savings.
2) *Smart City Integration:* With the advent of smart city initiatives, automatic street lights can be integrated into a larger network of interconnected devices and sensors. This integration allows for centralized monitoring, control, and data analysis. For example, street lights can communicate with other devices and systems in the city, such as traffic management systems, to optimize overall efficiency and enhance safety.
3) *Environmental Monitoring:* IR sensors can be utilized not only for detecting human presence but also for monitoring environmental factors. Future developments may involve integrating additional sensors to measure air quality, temperature, humidity, or noise levels. This data can be collected and analyzed to make informed decisions regarding urban planning and environmental management.
4) *Wireless Connectivity:* As wireless technologies continue to advance, future automatic street light systems may incorporate wireless connectivity options such as Bluetooth, Wi-Fi, or LoRaWAN. This enables remote monitoring, control, and even over-the-air firmware updates, making the maintenance and management of the street light network more efficient.
5) *Machine Learning and Artificial Intelligence:* By employing machine learning algorithms and artificial intelligence techniques, automatic street light systems can become more intelligent and adaptive. These systems can learn from historical data, analyze patterns, and optimize lighting schedules and intensities accordingly. This can lead to further energy savings and improved performance.

6) *Integration with Renewable Energy Sources:* As the world moves towards sustainable energy solutions, automatic street light systems can be integrated with renewable energy sources such as solar panels or wind turbines. This integration allows for the use of clean energy and reduces dependence on the grid, making the street lighting infrastructure more sustainable.
7) *Security Enhancements:* IR sensors can also be used for security purposes. Future developments may involve incorporating additional features such as surveillance cameras or motion detection capabilities into the street light system. This can enhance public safety by providing better lighting in dark areas and enabling real-time monitoring of the surroundings.

It's important to note that the future scope of any technology is dynamic and subject to ongoing advancements. These potential developments indicate the direction in which automatic street light systems using IR sensors and Arduino mini projects may evolve, but specific implementations will depend on various factors, including technological advancements, regulatory frameworks, and market demands.

VII. CONCLUSIONS

In conclusion, the automatic street light using an IR sensor and Arduino is an efficient and practical mini project. The system utilizes an IR sensor to detect the presence of vehicles or pedestrians, triggering the Arduino to control the street lights accordingly. Here are the key points to consider:

1) *Energy Efficiency:* The project helps conserve energy by only turning on the street lights when necessary. When no vehicles or pedestrians are detected, the lights remain off, saving electricity and reducing unnecessary light pollution.
2) *Cost-effectiveness:* By automating the street lights based on real-time sensor data, the project optimizes the usage of lighting systems, resulting in reduced energy costs for the municipality or organization responsible for the street lights.
3) *Safety Enhancement:* The automatic activation of street lights ensures improved safety for pedestrians and drivers. When vehicles or pedestrians are detected, the lights turn on promptly, providing better visibility and reducing the risk of accidents or crime in poorly lit areas.
4) *Ease of Installation:* The project can be implemented relatively easily, requiring minimal hardware components such as an IR sensor, Arduino board, and appropriate wiring. This makes it accessible for individuals or small communities looking to enhance their local street lighting infrastructure.
5) *Scalability and Customization:* The project can be scaled up to cover larger areas by deploying multiple IR sensors and Arduino boards. Additionally, the system can be customized to include additional features, such as adjusting the brightness of the street lights based on ambient light conditions.

Overall, the automatic street light system using an IR sensor and Arduino provides an effective solution for energy-efficient and intelligent street lighting, contributing to improved safety, cost savings, and reduced environmental impact.

VIII. ACKNOWLEDGMENT

We would like to express our gratitude to our Principal, Dr. M Shivakumar, for encouraging and providing us a congenial environment for engineering studies.

We express our heart filled thanks to Dr. G Sreeramulu Mahesh, Professor and Head, Department of Electrical and Electronics Engineering, GSSSIETW, Mysuru whose guidance and support goes beyond words.

We wholeheartedly thank our guide Chaitrashree S R, Assistant Professor, Department of Electrical and Electronics Engineering, GSSSIETW, Mysuru, for having shared a genuine desire to make a positive contribution to address the challenges associated with every element of the project.

We gratefully acknowledge the help and cooperation offered by all the teaching and nonteaching staff members of Electrical and Electronics Engineering, GSSSIETW, Mysuru.

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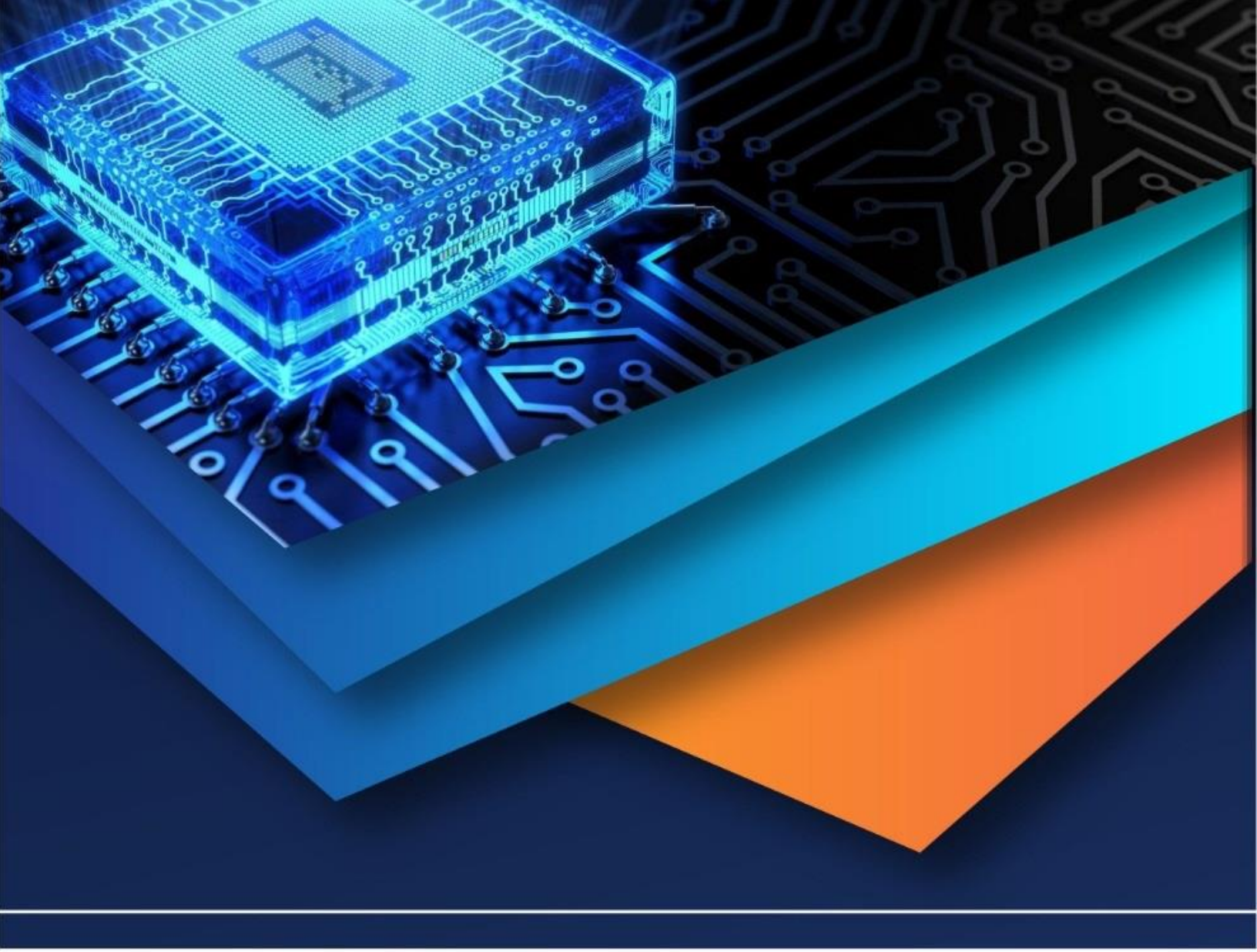
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