iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: V Month of publication: May 2025

DOI: https://doi.org/10.22214/ijraset.2025.71019

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Smartsteer Vehicle Headlight Controller

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Abstract: This project presents a wired communication-based motor and headlight control system designed for precise movement and automatic lighting adjustment. The system operates via a wired remote, allowing users to move forward, backward, and rotate a wheel using relay-controlled motors and a servo motor. A 12V power supply with buck converters ensures stable voltage for components like ESP8266 (wired mode), Arduino Nano, relays, and sensors. A 9V battery powers the motor flow mechanism separately. An LDR sensor detects ambient light, enabling the Arduino Nano to switch between high and low beam lights automatically. By eliminating wireless communication, the system ensures real-time control, reduced interference, and reliable operation.
Keywords: Wired communication, motor control, relay switching, servo motor, Arduino Nano, ESP8266, LDR sensor, automatic lighting

I. INTRODUCTION

Driving at night can be dangerous because poor visibility often causes accidents. Headlights play a crucial role in enhancing visibility, but improper usage can pose serious hazards. High-beam headlights, in particular, can blind drivers coming from the opposite direction, making it harder for them to see and react quickly. This momentary glare can lead to accidents.

To solve this, an *Automatic Headlamp Dimmer System* has been developed. The system uses sensors to spot the headlights of vehicles coming from the opposite direction and automatically lowers the beam from high to low drivers. It also avoids false triggers caused by road signs, flashing lights, or even windshield wipers blocking the sensor. This makes it a smart solution to prevent glare and improve safety for everyone on the road.

Another issue with regular headlights is that they don't light up the road properly during turns, especially in hilly areas. This makes driving at night on winding roads even riskier.To tackle this, a *Steering-Controlled Headlight* .

Mechanism is introduced. This system adjusts the direction of the headlights based on how the steering wheel is turned. It helps drivers see the road better around curves and ensures safer night driving on ghat roads.

This paper explains how these two systems work and how they can make night driving safer. By reducing headlight glare and improving visibility around curves, These concepts can go a long way in making roads safer and reduce the chances of accidents, especially when driving at night.

II. LITERATURE SURVEY

1) AslamMusthafa R. (2017) developed an automatic headlight beam controller that detects the light intensity of oncoming vehicles and automatically switches the headlights from high beam to low beam. This system effectively reduces glare, improving road safety for other drivers.
2) Williams E.A. (2016) designed and implemented an automatic headlight dimmer using a light-dependent resistor (LDR) sensor. The system detects light from oncoming vehicles and automatically switches the headlights to a low beam, preventing temporary blindness for approaching drivers.
3) Mali P.S. (2016) introduced an automatic headlight dipper system that uses an LDR sensor to identify whether the vehicle's headlights are in high or low beam mode. When the sensor detects a high beam from an oncoming vehicle, the system automatically switches to dipper mode to reduce glare.
4) Lakshmi K. (2019) developed an automated headlight management system using an LDR sensor to detect high-beam headlights from approaching vehicles. The system then adjusts the headlight beam accordingly to minimize glare and prevent temporary blindness.
5) Kaab Edroos and Khan Zaid (2023) proposed a Steering-Controlled Headlight Mechanism that aligns the headlights with the direction of the front wheels. This system enhances visibility on curved roads, especially at night, and helps reduce accidents in areas with sharp turns.

6) Pankaj Kumar Singh, Naman Taneja, and Alok Nath Sharma (2016) introduced an adaptive steering-controlled headlight system that uses mechanical linkages and gears to adjust the headlight angle based on the movement of the steering column. This system enhances road illumination, particularly on sharp turns and hilly terrain, making night driving safer.
7) Shrabana Saha, Md Ashifuddin Mondal and Zeenat Rehena(2023) Ensuring safe night driving is a critical aspect of vehicular automation, with research efforts increasingly focusing on intelligent headlight control mechanisms. Various approaches have been proposed in the past to mitigate issues related to high-beam glare, visibility optimization, and driver safety.

III. WORKING METHODOLOGY

The proposed system is designed to automatically control vehicle headlights, ensuring safer night driving by adjusting both the beam intensity and the headlight direction. This system consists of two mainfunctions:automaticbeam adjustment and directional control of headlights based on steering movement.

A. Automatic Beam Adjustment

The system uses a Light Dependent Resistor (LDR) to detect the surrounding light intensity. The LDR is part of a voltage divider circuit, which generates an analog voltage signal based on the ambient light level. This signal is sent to a microcontroller's Analog-to-Digital Converter (ADC) for processing.

ThresholdComparison*:*

If the detected ambient light is low (e.g., during nighttime or in dimly lit areas), the microcontroller activates the high beam using a relay to provide better visibility.

If the ambient light is high (e.g., in the presence of an oncoming vehicle or during daytime), the relay switches to low beam, reducing glare for other road users.

Avoiding False Triggers:

To prevent unwanted switching due to reflective road signs, sudden light changes, or temporary obstructions, the system includes a debounce mechanism in the microcontroller software. This ensures stable and accurate operation by filtering out momentary fluctuations.

B. Directional Headlight Control Using a Remote Controller

To improve visibility on curves and turns, the system automatically adjusts the direction of the headlights based on steering movement. This feature is tested using a remote-controlledprototype, which simulates real-life steering input

1) Steering Input Detection:

A 10k potentiometer is connected to the steering system to measure its rotation angle.The microcontroller reads the potentiometer’s voltage and maps it to a corresponding headlight position.

2) Servo Motor Control:

The microcontroller sends Pulse Width Modulation (PWM) signals to a servo motor, which moves the headlights in the direction of the turn.

When the steering wheel turns left, the headlights automatically shift left to illuminate the road ahead.

When the steering wheel turns right, the headlights shift right to improve visibility in that direction.

3) Mechanical Linkage for Real-Life Movement:

The servo motor is mechanically linked to the headlights, ensuring precise and smooth movement.

This setup makes the headlights rotate in real-time, just like in an actual vehicle.

This system provides a realistic and practical solution for safer night driving by addressing two key challenges:Reducing glare for oncoming drivers with automatic beam adjustment.

Improving visibility on curves with steering-controlled headlights that rotate based on direction.

By integrating microcontrollers, sensors, servo motors, anda remote-controlledsteering mechanism, this system successfully replicates real-life headlight movement. Future improvements could include faster response times, advanced AI-based detection, and high-precision sensors to make it even more accurate and efficient.

C. Remote Control Input:

The user operates a wired remote, which sends signals to the ESP8266 WiFi Board and ArduinoNano.These microcontrollers process the signals and activate the respective relays to control motors and lights.

1) Motor and Wheel Control:

When the user presses the forward button, the ESP8266 triggers Relay 1, allowing power to flow to the motor for forward motion.When the backward button is pressed, the ESP8266 switches Relay 2, reversing the motor's direction.A separate servo motor is used to rotate the wheel, controlled through the ESP8266's.

2) Wheel Rotation:

A servo motor is controlled via the ESP8266, which rotates the wheel as needed.

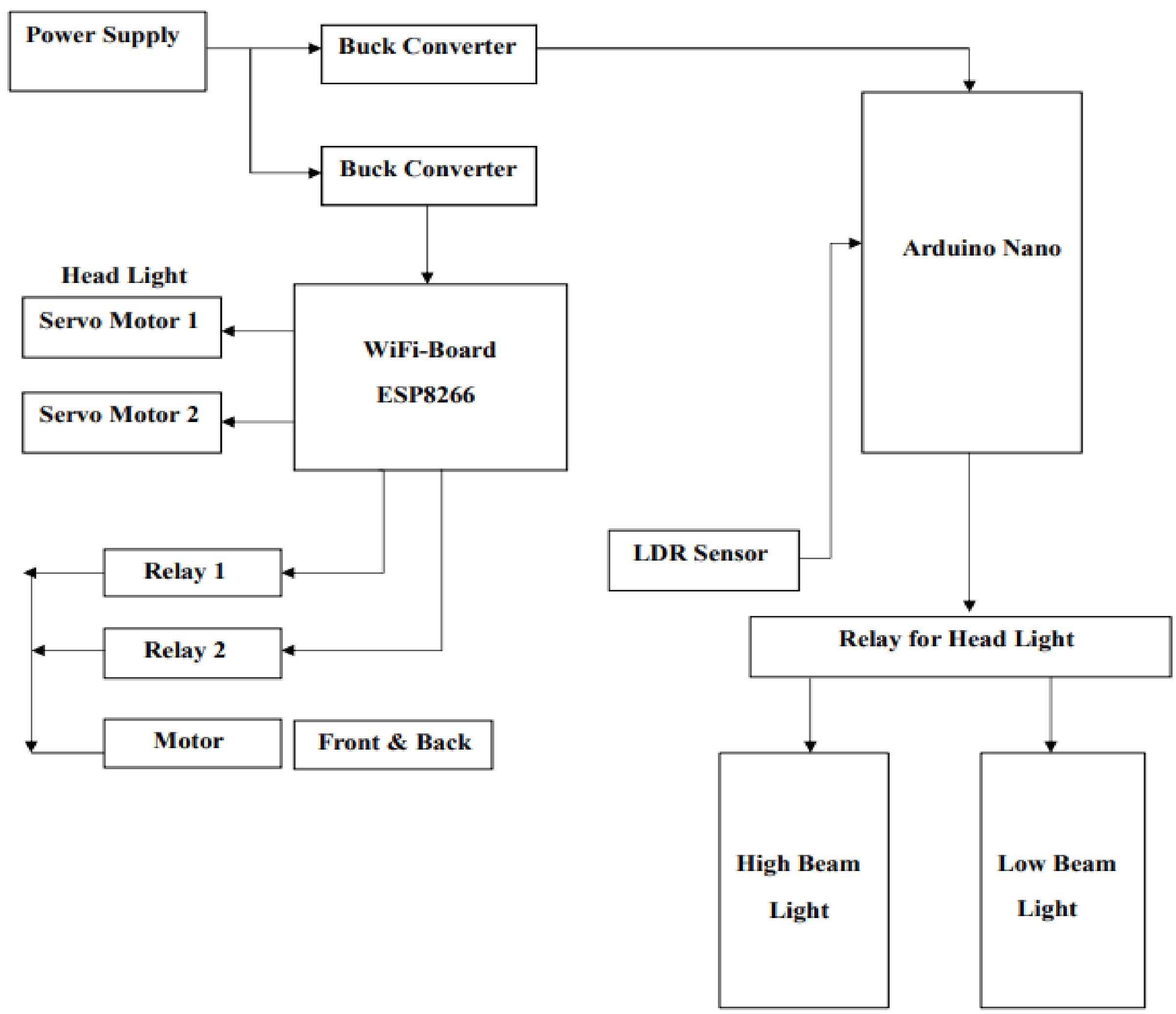

Figure 1: Block diagram of Smartsteer vehicle headlight controller

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue V May 2025- Available at www.ijraset.com

IV. WORKING PRINCIPLE

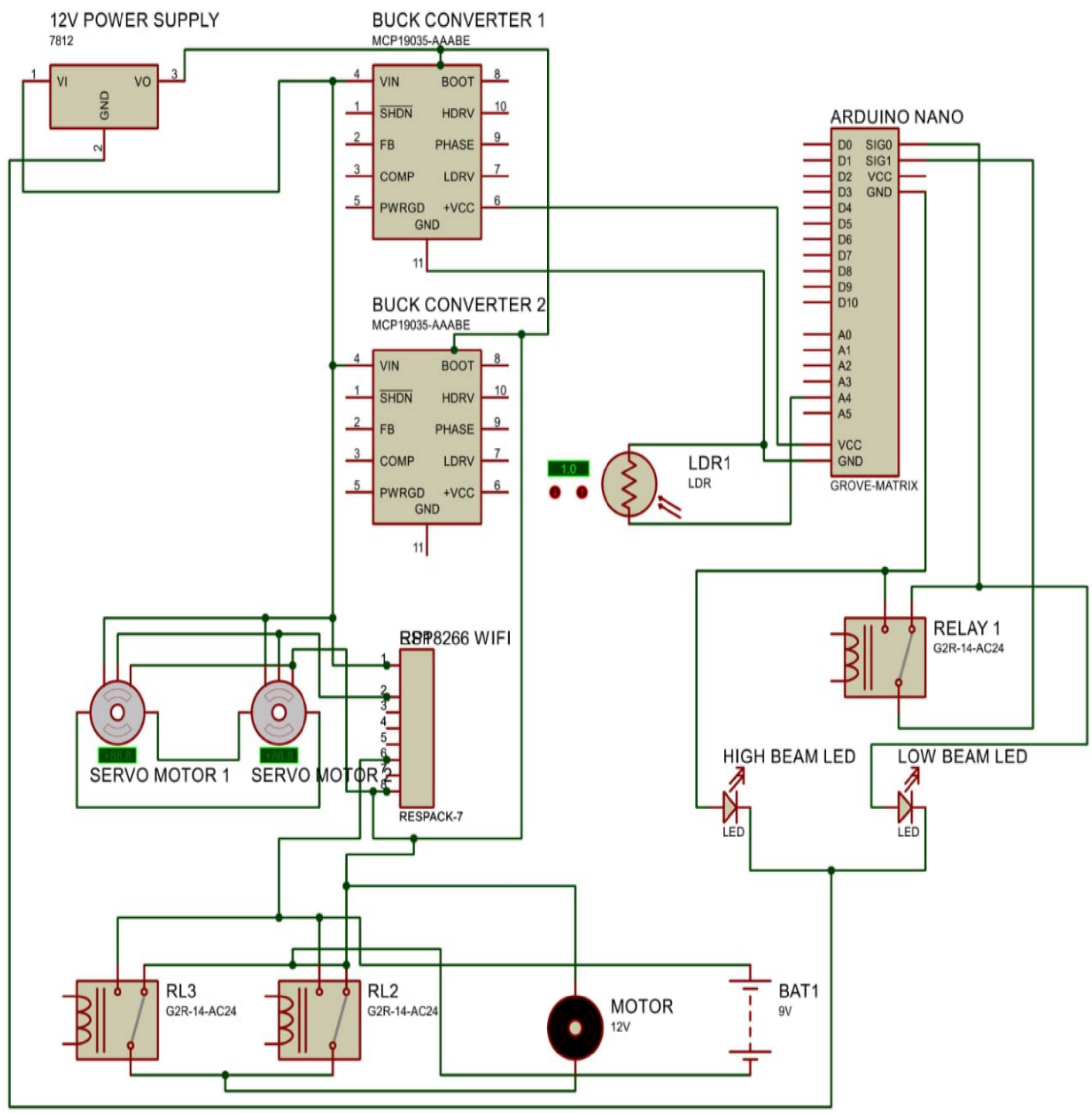

Figure 2: Circuit diagram of Smartsteer vehicle headlight controller

1) Power supply (12V adapter & 9V battery) distributes power through buck converters to the required components.
2) User operates the wired remote, sending signals to ESP8266 and Arduino Nano.
3) The motor moves forward or backward based on relay activation.
4) Servo motor rotates the wheel according to ESP8266 control.
5) LDR sensor detects ambient light levels and transmits data to Arduino Nano.
6) Arduino controls high/low beam lights via relays based on LDR input.

V. RESULT

This project developed an Automatic Headlight Dimmer and Steering-Controlled Headlight System to make night driving safer. The system has two main features: adjusting the beam automatically and moving the headlights based on steering direction.

The automatic beam adjustment works using an LDR sensor, which detects the brightness of oncoming headlights. If another vehicle is approaching, the system switches from high beam to low beam to prevent glare and improve visibility for both drivers. A debounce mechanism is included to avoid false triggers from streetlights or road signs.

The steering-controlled headlight system moves the headlights based on the steering wheel's movement. A potentiometer detects how much the wheel is turning, and a servo motor adjusts the headlights in the same direction. This helps drivers see better on curves and hilly roads.

A small remote-controlled prototype was built to test the system in real time. The results showed that it effectively reduces glare and improves road visibility, making night driving safer. In the future, better sensors, faster response times, and AI-based detection could make the system even more accurate.

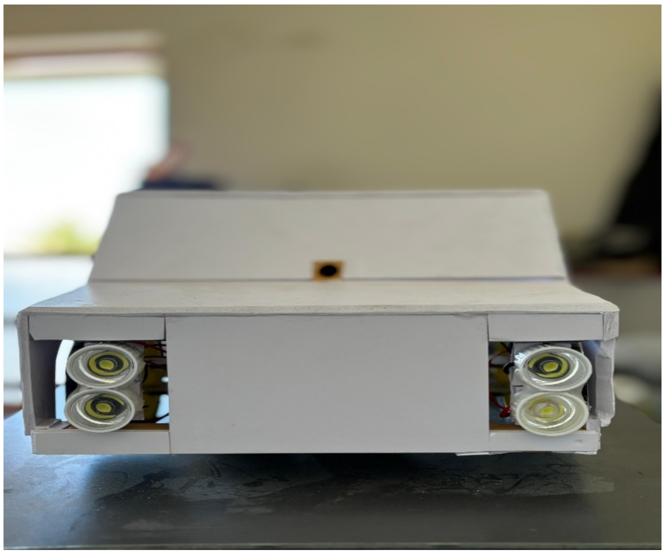

Figure3:Depicts headlight setup demonstrating dimmer and dipper functionality

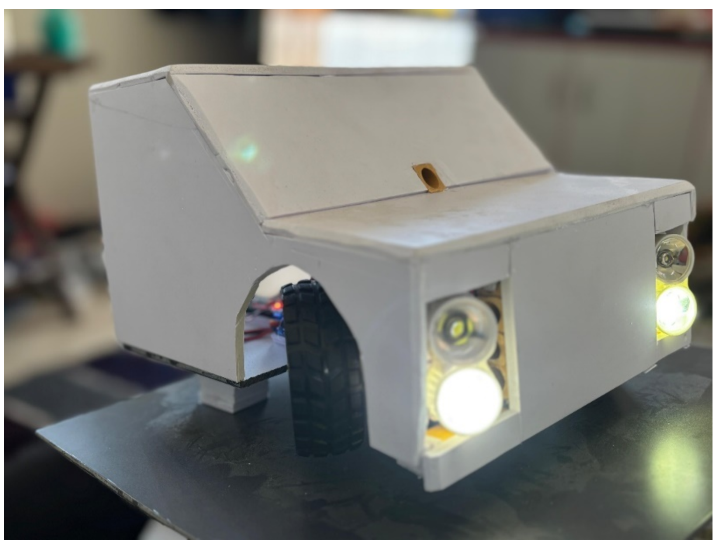

Figure4:Depicts headlight operating in low beam mode.

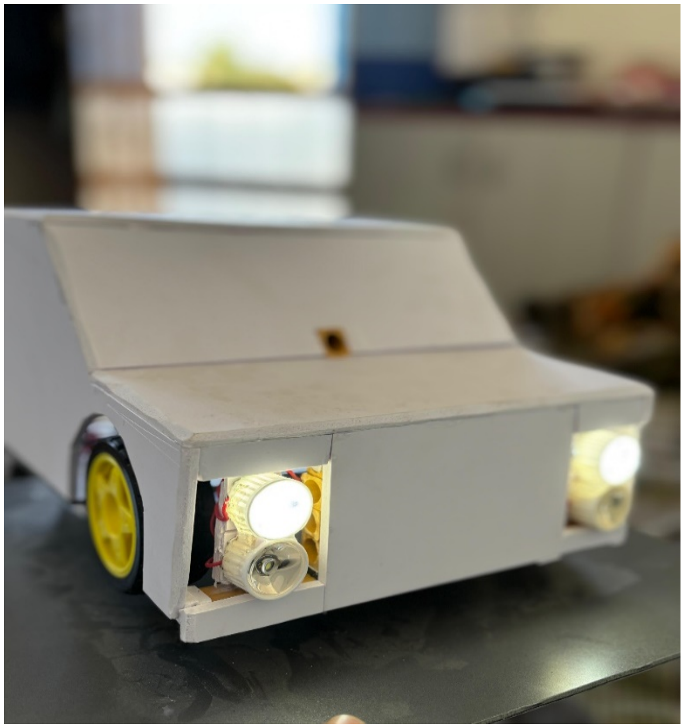

Figure5:Depicts headlight operating in high beam mode.

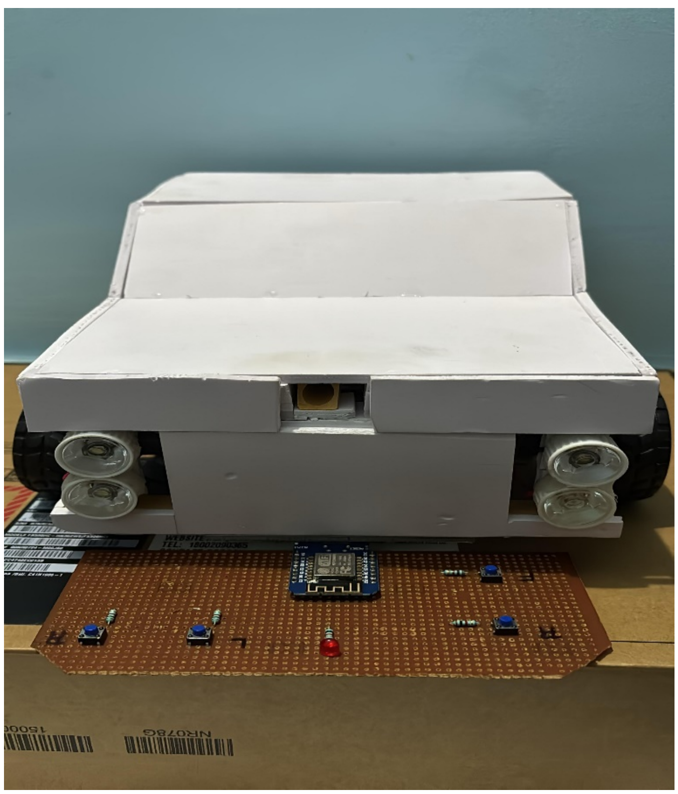

Figure6:ESP8266 wifi board for remote control

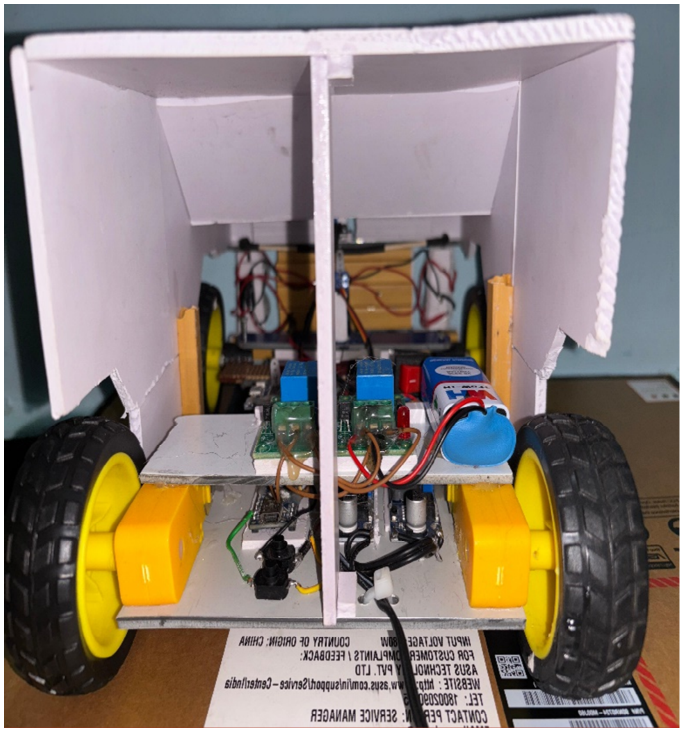

Figure7:Internal circuitry showing the switches used for control

VI. CONCLUSION

This system improves night driving safety by solving two key problems: headlight glare and poor visibility on curves. The automatic beam adjustment prevents drivers from being blinded by oncoming headlights, while steering-controlled headlights enhance visibility on winding roads. By combining sensors, microcontrollers, and servo motors, this smart headlight system offers a practical and effective way to make nighttime driving safer.

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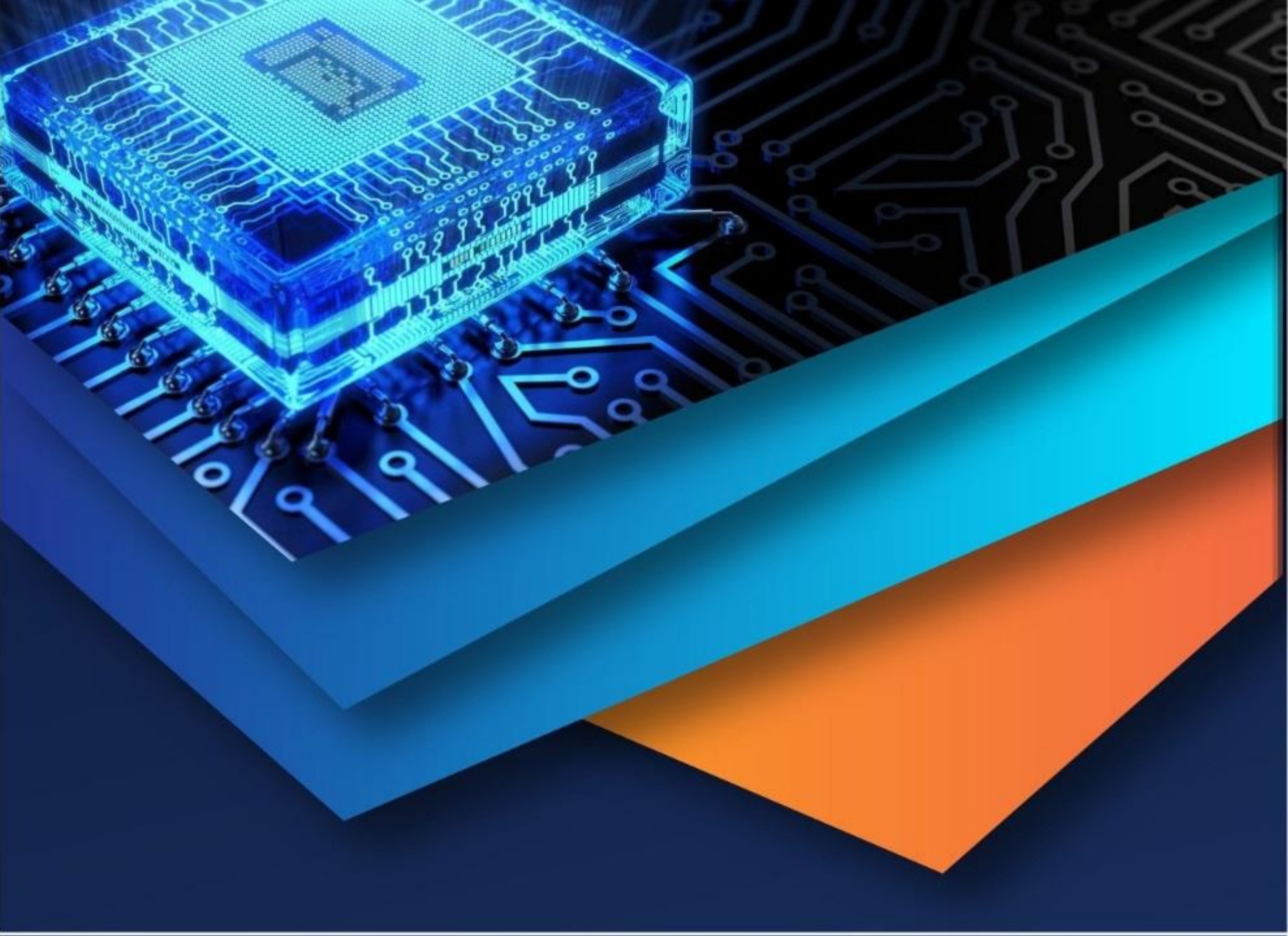

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