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IOT Based Automatic High/Low Beam Control

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Abstract: One common issue while driving at night is the careless use of high beams by oncoming vehicles, which can dangerously impair the vision of drivers, making it difficult to see the road clearly. To address this problem, we propose a solution that involves automatically adjusting the vehicle's headlights between high and low beams using various sensors and a microcontroller. The system will include a microcontroller, such as an Arduino or ESP32, along with several sensors: an IR sensor, ultrasonic sensor, LDR (Light Dependent Resistor), and a relay. When a vehicle approaches from the opposite direction and your vehicle's headlights are set to high beam, the system will automatically dim the both headlights, allowing both drivers to maintain clear road visibility without being blinded by the high beams.
Keywords: IoT, Automatic Headlight Control, LDR, Ultrasonic Sensor, Arduino, Night Driving Safety.

I. INTRODUCTION

Night time driving safety is significantly compromised by the improper use of high-beam headlights, which can cause temporary blindness and reduce road visibility for oncoming drivers. This glaring issue not only increases the risk of accidents but also contributes to driver stress and fatigue. While modern vehicles often feature manual high-beam controls, these rely heavily on driver attentiveness, leaving room for human error and delayed reactions. To tackle this problem, we propose an intelligent, sensor-based automatic headlight adjustment system that dynamically switches between high and low beams without driver intervention. Using a microcontroller (such as Arduino or ESP32) paired with an ultrasonic sensor for distance detection and an LDR (Light Dependent Resistor) for ambient light monitoring, our system detects approaching vehicles and instantly dims the headlights to prevent glare. This ensures optimal visibility for both drivers while maintaining safety and convenience. By automating high-beam control, our solution eliminates the need for manual adjustments, reduces the risk of accidents caused by blinding lights, and enhances overall night time driving comfort. This paper explores the design, implementation, and benefits of this smart headlight system, demonstrating how embedded technology can make roads safer for everyone. In addition to improving safety and efficiency, the system incorporates fail-safe mechanisms such as manual override options and error detection alerts, ensuring reliable and consistent operation. With advancements in smart vehicle technology and IoT-based automation, this project contributes to a safer and more intelligent transportation system, paving the way for next-generation adaptive lighting solutions in modern vehicles.

II. OBJECTIVES

1) Automatically adjust headlight brightness based on ambient light conditions.
2) Dip/Dim headlight in response to opposing vehicles.
3) Automatic switching OFF of headlight system when driver is not there in Vehicle after 2 min.

III. LITERATURE SURVEY

Previous works use Several studies have explored the development of automatic headlight dimming systems to enhance night-driving safety by reducing glare from oncoming vehicles. Research published in the International Journal for Multidisciplinary Research (IJFMR, 2024) proposed an Automatic Light Intensity Controller using LDRs and microcontrollers to dynamically adjust headlight brightness based on ambient light. Another study in the DogoRangsang Research Journal (2023) combined headlight dimming with obstacle detection, using IR and ultrasonic sensors to identify approaching vehicles and switch to low beam. Earlier work presented at the ICSSCCET Conference (2016) introduced a dim-dip assistance system that replaced manual dimming with sensor-based automation. These systems commonly use microcontrollers like Arduino or ESP32, integrating LDRs for glare detection and proximity sensors for vehicle detection, with relays or PWM circuits to control headlight intensity. Collectively, the literature emphasizes automation, real-time responsiveness, and improved driver visibility as key benefits of sensor-driven headlight control systems.

IV. EXISTING SYSTEM

The current headlight systems in automobiles primarily rely on manual control, where drivers switch between high and low beams depending on the surrounding environment. In traditional vehicles, this is achieved using a toggle switch or stalk control, allowing the driver to manually select the appropriate beam. While this system provides flexibility, it often leads to improper usage of high beams, causing glare and reduced visibility for oncoming drivers. Modern advancements in automotive lighting have introduced automatic headlight control systems, which utilize sensors to detect ambient light levels and switch the headlights on or off accordingly. Some high-end vehicles are equipped with adaptive lighting systems, which dynamically adjust the beam angle and intensity based on vehicle speed, steering input, and road conditions. Additionally, camera-based high beam assist systems detect oncoming vehicles and automatically dim the headlights, reducing glare.

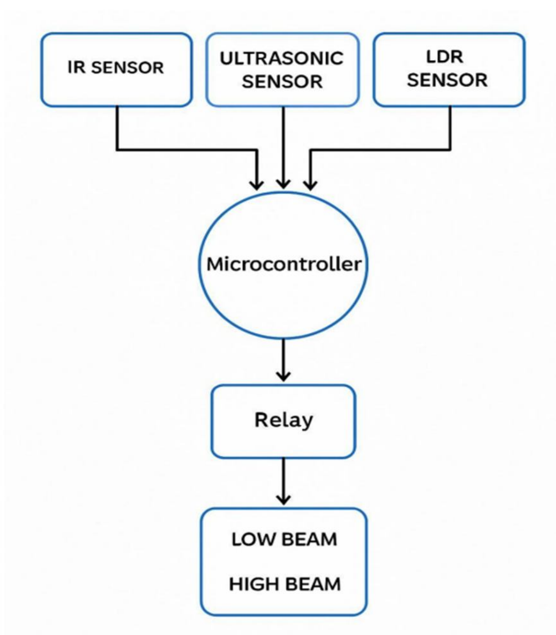
V. PROPOSED SYSTEM

The IoT-Based Automatic High/Low Beam Control System is designed to address the issue of headlight glare caused by improper high beam usage at night. This system leverages sensor-based automation and microcontroller control to ensure seamless switching between high and low beams, improving road safety and driving comfort.

VI. SYSTEM DESIGN

The proposed system consists of a microcontroller (Arduino/ESP32), an ultrasonic sensor, an LDR (Light Dependent Resistor), and a headlight control mechanism. The system continuously monitors ambient light levels and detects oncoming vehicles. When an approaching vehicle is detected within a predefined range, the system automatically switches the headlights to low beam. Once the vehicle passes, the system restores the high beam mode for better visibility.

VII. DATA FLOW



VIII. PERFORMANCE ANALYSIS

A. *System Responsiveness*

• Sensor Reaction Time: IR and ultrasonic sensors respond within milliseconds, enabling near-instant detection of oncoming vehicles.
• Microcontroller Processing: Arduino/ESP32 handles sensor input and decision logic with minimal latency
• Relay Switching Delay: Mechanical relay introduces a slight delay (~100–200 ms), which is acceptable for non-critical transitions like beam switching.

B. Power Efficiency:

• Low Power Consumption: Sensors and microcontroller operate at low voltage (typically 5V or 3.3V), making the system energy-efficient.

• PWM Dimming (if used): Offers smoother transitions and reduced power draw compared to abrupt switching.

C. Accuracy and Reliability

• Detection Accuracy:

IR Sensor: Effective in identifying vehicle heat signatures but may be affected by ambient temperature.

Ultrasonic Sensor: Accurate within 2–3 cm range, ideal for proximity detection.

LDR: Sensitive to glare but requires calibration to avoid false positives from streetlights or reflections.

IX. CONCLUSION

The IoT-Based Automatic High/Low Beam Control System addresses a critical problem faced by drivers during nighttime travel—the blinding glare from oncoming vehicles that use high beams irresponsibly. This issue not only causes discomfort but also significantly increases the risk of accidents due to temporary blindness or reduced road visibility. The proposed system offers a smart, automated solution that enhances both driver safety and convenience. By incorporating essential components such as an ultrasonic sensor and an LDR (Light Dependent Resistor), the system is capable of detecting both the presence of approaching vehicles and the level of ambient light. These sensors provide real-time input to the microcontroller, which then makes intelligent decisions to automatically switch the headlight from high beam to low beam when necessary. Once the road ahead is clear, the system reverts the lights back to high beam, ensuring optimal visibility for the driver. The use of a microcontroller platform such as Arduino or ESP32 makes the system highly flexible, cost-effective, and easy to implement in both existing and new vehicles. This eliminates the need for constant manual adjustment by the driver, reducing stress and increasing overall focus while driving. In conclusion, the project successfully demonstrates how IoT and sensor-based automation can be harnessed to solve real-life problems in the automotive domain. It provides a solid foundation for developing more intelligent and safety-focused vehicle technologies. With the growing demand for smart and autonomous systems in vehicles, this project holds strong potential for real-world application and commercial scalability.

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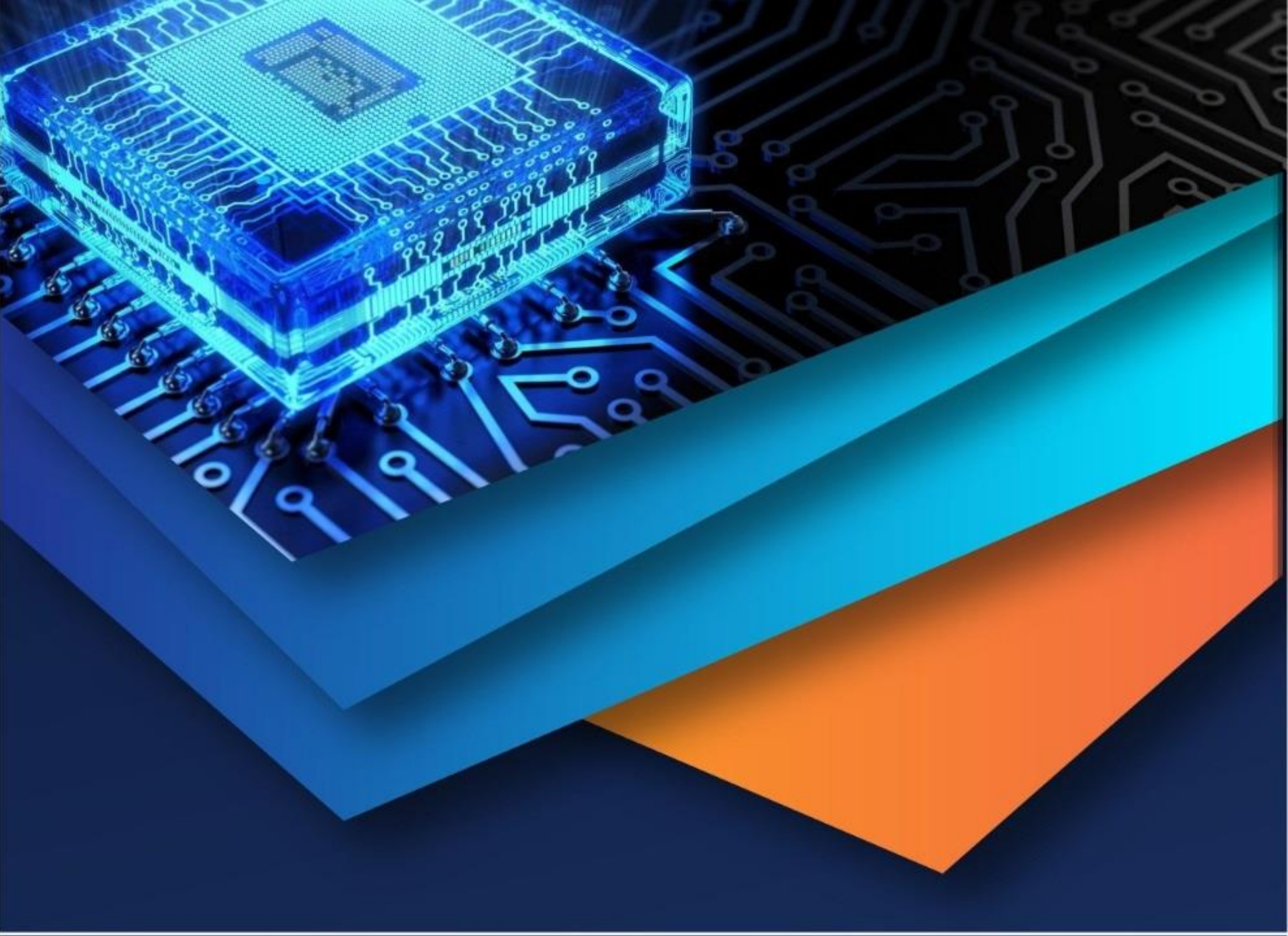

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