

AUTOMATIC VEHICLE HEADLIGHT INTENSITY CONTROL USING STM32

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Abstract-

This research focuses on developing a smart system for adjusting car headlight intensity according to ambient lighting conditions. The system will optimize visibility and driver comfort by controlling the nuance brightness of the emitted light. This will result in a consistent and pleasant illumination experience regardless of external lighting changes. The system employs an STM32 microcontroller to monitor the surrounding light levels and adjust the headlight intensity accordingly. This ensures optimal visibility for the driver while minimizing glare for other road users. This research paper showcases the integration of microcontroller programming, light sensing technology, and automotive control systems.

Keywords-

Intelligent Headlight Control System, Ambient Light Sensing, Vehicle Headlight Intensity Modulation, Driver Visibility Optimization, Glare Reduction, STM32 Microcontroller

I. INTRODUCTION

The increasing number of vehicles on the roads, particularly at night, has amplified the risks associated with high beam headlights. These intense beams can temporarily blind the drivers driving in opposite direction of road, increasing the likelihood of accidents. Studies indicate that accidents during night period accounts for a significant proportion of road accidents, with a higher fatality rate compared to the accidents during day period. To address this issue, an automated headlight dimming system is proposed in this research paper [1].

The proposed system would eliminate the dependency on drivers by manually dimming their headlights, ensuring consistent road safety. The system is cost-effective and can be implemented on existing and new vehicles, making it particularly suitable for countries like India with a large number of vehicles and a diverse economic demographic. While designing the system Troxler effect is taken into consideration. Troxler effect is a phenomenon where prolonged exposure to a constant light stimulus desensitizes the eye's neurons which leads to reduced signal strength to the brain. This effect explains how high beams can impair a driver's vision and concentration, leading to accidents. The proposed system offers a comprehensive and affordable solution to mitigate road accidents caused by high beam headlights at night. Its implementation has the potential to

significantly improve road safety and reduce accident related fatalities. [2]

II. METHODOLOGY

This section explain the block diagram of proposed system.

A. Block Diagram and working:

Figure 1 shows the block diagram of automatic vehicle headlight intensity controller using STM32 Microcontroller. It consists of a Regulated Power Supply, LDR Sensor, STM32 Microcontroller, Dimming circuit and Headlights, Ultrasonic Sensor and a Switch Button.

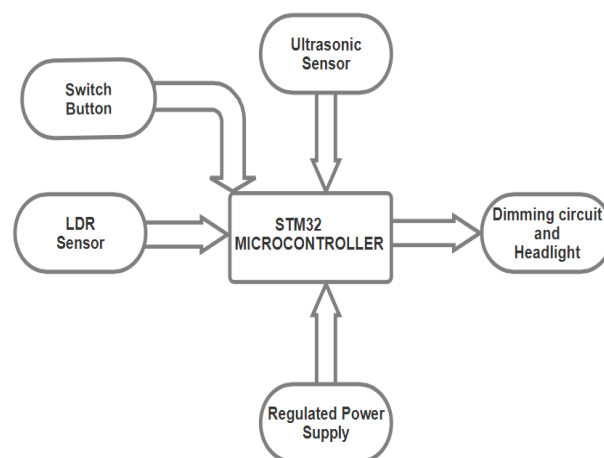


Figure 1: Block Diagram of Simulation of Automatic vehicle headlight Intensity controller using STM32 Microcontroller.

A Light Dependent Resistor, is a passive electronic device that adjusts its resistance in response to varying light levels. As the intensity of light increases, the resistance decreases, and vice versa. This unique characteristic makes LDR sensors valuable components in light-detection applications, including automatic night lights, streetlights, and camera controls. By leveraging the sensitivity of LDRs to ambient light, these sensors enable the creation of circuits that automatically adapt to changing lighting conditions, enhancing the efficiency and functionality of devices in diverse settings.

An ultrasonic sensor employs sound waves for distance measurement. The sensor functions by emitting a high-frequency sound wave and calculating the time it takes for

the wave to rebound from an object. This time delay is then translated into distance. Ultrasonic sensors find applications in robotics, self-driving vehicles, and obstacle avoidance systems. Their capability to provide reliable distance data makes them integral components in various automated and navigational technologies.

In this system, a power supply ensures a steady flow of electricity to all components. LDR sensor continuously measures ambient light levels, adjusting its resistance accordingly. This resistance data, along with object distance readings from an ultrasonic sensor, is fed to a microcontroller (STM32). The microcontroller acts as the system's brain, analyzing this sensor data and applying algorithms to determine the optimal headlight intensity. It then sends control signals to the LED headlights, instructing them to adjust their brightness accordingly. This ensures that the headlights provide sufficient illumination without blinding oncoming drivers or pedestrians. For situations requiring manual control, a switch button allows the driver to override the automatic system or switch between different modes.

B. Flowchart:

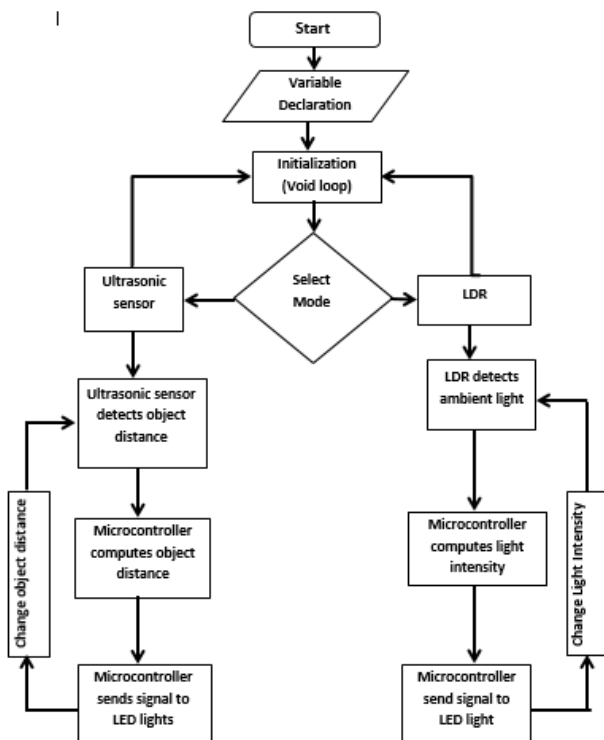


Figure 2: Flowchart of Automatic vehicle headlight Intensity controller using STM32 Microcontroller

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The process begins when the system is turned on.

Checking the condition of daytime or nighttime:

STM32 Microcontroller reads the value from LDR sensor. It checks if the light sensor reading is above a certain threshold, indicating daytime conditions. If it is daytime, the headlights are turned off, else the process of sensing will continue.

Read Object Sensor: The Microcontroller reads the value from the ultrasonic sensor. It checks if the object sensor reading is below a certain threshold, indicating an object is present. The headlights are dimmed to avoid glare. If there is no object, then the process of sensing will continue.

Set Headlight Intensity: The Microcontroller sets the headlight intensity based on the light sensor reading. Brighter ambient light will result in lower headlight intensity.

The process ends and the headlights remain at the set intensity of that time, until the next loop through the flowchart.

STM32 Microcontroller serves as core of the project. Initially, input and output pins are configured for seamless communication. The microcontroller receives signals from the Light Dependent Resistor (LDR), determining the ambient light levels and subsequently sending control signals to LEDs for adaptive dimming. Since presently in this work LDR sensor and Ultrasonic sensor are not used at the same time for sensing purpose. So a push button is incorporated in the system to switch between the modes to provide flexibility in choosing the desired sensing method. This feature enhances the overall functionality of the automatic headlight sensor by allowing users to customize its operation based on specific needs and conditions.

C. Implementation of Proposed System

The software development involves programming the STM32 Microcontroller to perform the following tasks of acquisition, interpretation and control explained below.

• Sensor Data Acquisition:

The Microcontroller continuously reads the light sensor's output voltage, which corresponds to the ambient light level.

• Light Level Interpretation:

It converts the sensor output voltage into a meaningful light intensity value.

• Headlight Intensity Control:

Based on the interpreted light intensity, Microcontroller determines the appropriate headlight intensity and generates control signals for the actuator circuit.

D. Testing Procedures:

The testing procedures includes:

- **Sensor Calibration:** The light sensor is calibrated to ensure accurate light intensity measurements.
- **Control Logic Validation:** The microcontroller's control logic is tested to ensure that it correctly interprets sensor data and generates appropriate control signals.
- **System Integration Testing:** The complete system is tested under various lighting conditions to verify its ability to adjust headlight intensity effectively.

II. EXPERIMENTAL RESULTS

The Sensor was tested at different ambient conditions of

intensity in the surrounding and its performance was evaluated. It will be efficient for the driver to automatically control the headlight intensity whenever it is necessary. Below Figure 3 and figure 4 shows the headlight of the vehicle under different brightness conditions during day and night times.

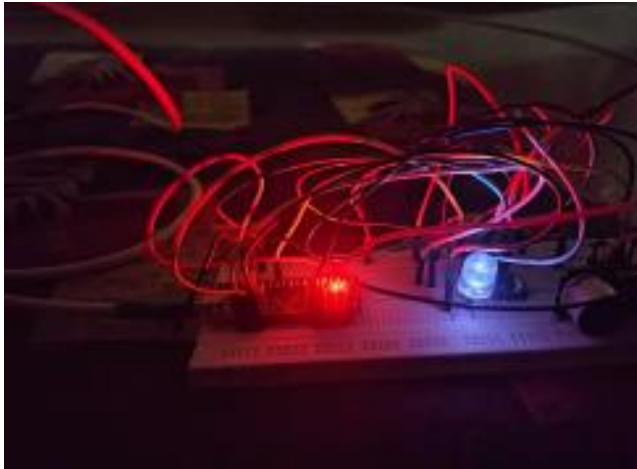


Figure 3: Output when LDR kept in (Daytime) lighting condition

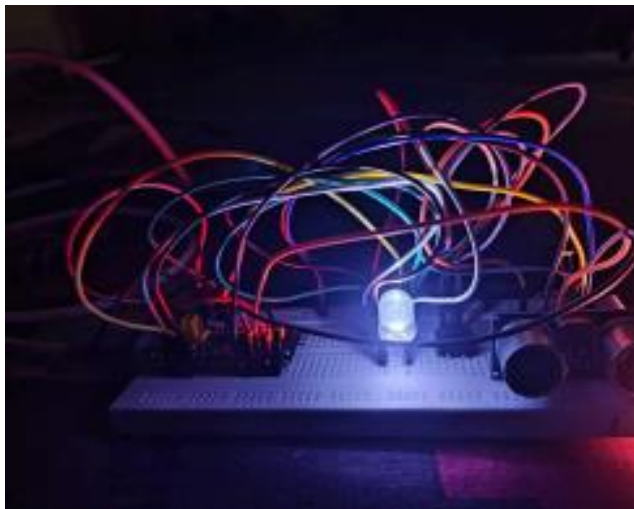


Figure 4: Output when LDR is kept in (Nighttime) dark condition

III. CONCLUSION

An automatic headlight intensity control system for vehicles using an STM32 Microcontroller is developed. The system can improve drivers comfort and visibility by

automatically adjusting headlight intensity based on ambient light for oncoming vehicles, and reduces the glare to enhance visibility in low-light conditions.

By automatically dimming headlights for approaching vehicles, the system helps prevent temporary blinding and potentially reduces the risk of night-time accidents thereby providing enhanced safety.

Increased driver control: The switch button allows for user-selectable modes, offering flexibility between automatic intensity control and manual object distance measurement.

Overall, the project showcases the effectiveness of utilizing sensor technology and microcontrollers to optimize headlight performance and contribute to safer driving experiences.

IV. FUTURE SCOPE

Automatic headlight intensity control systems (AHICS) are making our roads safer and driving more comfortable [4].

Further research and development can refine the system's accuracy, responsiveness, and range of functionalities, potentially leading to widespread implementation in modern vehicles. With its promise of safety, comfort, and convenience, this technology can become a standard feature in future vehicles.

V. REFERENCES

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