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GUARDIAN OF THE GHATS AND HEADLIGHTS FOR VISIBILITY

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Abstract - The abstract introduces a ground breaking project aimed at revolutionising road safety through adaptive lighting and collision detection in challenging driving environments. In the contemporary context, road accidents pose a significant threat to public safety, with statistics revealing a staggering number of incidents globally. According to recent data from the World Health Organization (WHO), over 1.3 million people die each year in road traffic accidents, and an additional 20 to 50 million suffer non-fatal injuries. A substantial portion of these accidents occurs during turns in hilly terrains, highlighting the need for innovative solutions. This project addresses the aforementioned issue by proposing a dynamic lighting system that utilises light intensity sensor to sense oncoming vehicle headlights. By adjusting the brightness of our vehicle's LED lights in response to detected light intensity, the system aims to reduce the risk of blinding oncoming drivers, thereby mitigating the likelihood of accidents. Furthermore, the introduction of Ghats Section Collision Detection using Infrared (IR) sensors enhances safety during turns. In Ghats sections, where accidents are more prevalent, IR sensors strategically placed on each side of the car detect potential collisions and activate warning indicators, such as a red light, to alert the driver. This dual-feature system provides a comprehensive approach to address the complex challenges associated with road safety, offering a promising solution to reduce accident rates and enhance overall driving experience.

1. INTRODUCTION

Road safety is an issue of great concern across the world. It has no demographic or geographic boundaries and impacts all countries, whether low, middle or high income. With rapid expansion of the road network, increasing number of vehicles and increase in average speed on roads, India is also witnessing a high number of road accidents and fatalities. This not only leads to significant human suffering, but also drains the GDP of the Country by claiming lakhs of economically productive lives. The high beam of the headlight creates a dangerous situation when driving at night. It can cause temporary blindness of the drivers, which can lead to a collision or sometimes even an accident. The human eye is capable of perceiving a wide range of light intensities, from very dim to extremely bright. However, the sensitivity of the human eye varies across different lighting conditions. In terms of LED light intensity, it's often measured in lumens, which is a unit of luminous flux.proper visibility of human eye is 100-4000 lumens.

Fig 1: Vehicle Head-light glares

A pedestrian crossing the road can also be injured. In fact, almost 30% of the accidents are caused by headlight glare! When there are enough streetlights, there is not a need for the high intensity of the headlight. The majorly used headlights are HALOGEN, LED, LASER HEADLIGHTS. A halogen headlight consists of a thin tungsten filament surrounded by a halogen gas in a glass filament capsule which is extremely resistant to high temperatures. It works by sending electricity through the tungsten filament inside the glass capsule.

Fig 2: halogen headlight

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LED is an acronym for Light Emitting Diode, LED headlights produce light by passing electricity through tiny little semiconductors which emit photons. This electrical process is what illuminates the road ahead. LED headlights emit a very bright white light.

Fig 3: LED headlight

Laser headlights incorporate a variety of tiny lasers that are fired at a small amount of phosphorus mounted within the unit itself. This creates a vibrant white light which is then reflected by internal mirrors and outwards onto the road in front of you.

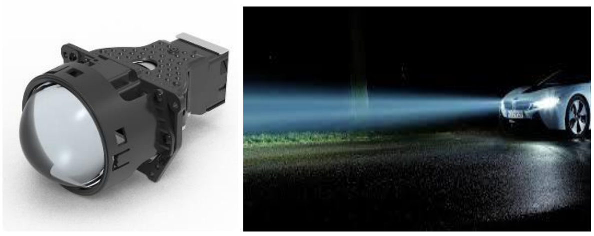

Fig 4: Laser headlight

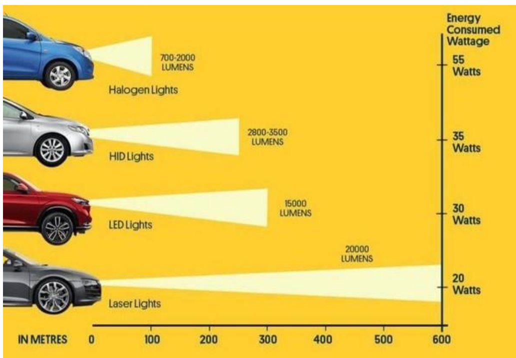

Fig 5: Vehicle Head-lights & distance

This graph appears to compare different types of automotive headlight technologies based on two main factors: the distance their light can reach (measured in meters) and the energy they consume (measured in watts). Additionally, it provides information on the light output of each technology, measured in lumens.

1. Halogen Lights: These are the traditional type of headlights, which have a range of light output from 700 to 2000 lumens. They consume 55 watts of energy.
2. HID Lights: High-Intensity Discharge lights, also known as Xenon lights, have a higher light output ranging from 2800 to 3500 lumens. They are more energy-efficient than halogen lights, consuming 35 watts.
3. LED Lights: Light Emitting Diode headlights provide a significant increase in light output, up to 15000 lumens, while further reducing energy consumption to 30 watts.
4. Laser Lights: The most advanced technology listed, laser headlights can achieve a light output of 20000 lumens with the least energy consumption of 20 watts.

The graph also visually represents the reach of each headlight type with a horizontal bar, indicating that laser lights have the longest reach, followed by LED, HID, and halogen lights, in descending order of reach. The exact distances in meters are not specified for each type, but the scale at the bottom suggests that laser lights have the farthest reach, extending beyond 600 meters.

This project will help to automatically control the intensity of headlight in vehicles. When the intensity value is higher than the desired intensity value, it will reduce the intensity of the light and provide a great relief to the driver from this irritating situation that happens during the night.

Fig 6: Hair-pin bend

In hilly terrain, where the elbow turns Accidents are more likely to occur in areas, the implementation of a real-time system with sensors can significantly improve safety measures. The goal of the system is to continuously monitor and analyze the road conditions in order to anticipate potential dangers. The embedded system consists of a network of strategically placed sensors along hilly roads with an eye on the elbow turn.

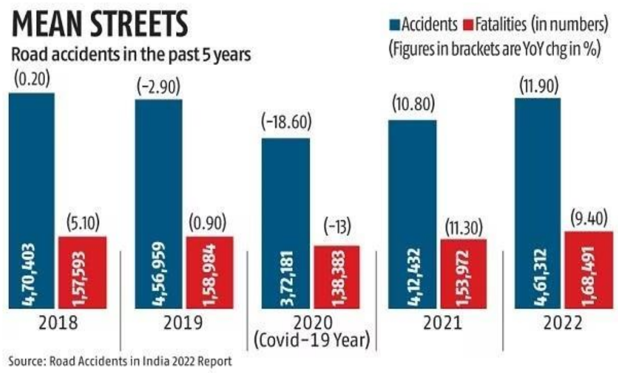

Fig 7: Accidents and deaths on road

According to graph shown above. In the year 2018 to 2022 more than 1 lakh road accident took place. Among this 30% is due to headlight glares at night in hilly region, elbow curve roads and also in regular roads

2. PROBLEM STATEMENT:

- Design and implement a collision avoidance system for vehicles traversing through a ghat section (mountainous terrain with steep slopes and sharp curves) to ensure the safety of drivers and passengers. The system should effectively detect and prevent potential collisions between vehicles, considering the unique challenges posed by the ghat section's topography and driving conditions.
- Safety Concerns: Fixed high beam intensity can cause discomfort and temporary blindness for oncoming drivers, increasing the risk of accidents. An adaptive system is needed to prioritize safety by automatically adjusting beam intensity.
- Energy Efficiency: Continuous use of high beam headlights at maximum intensity can lead to increased power consumption, affecting the vehicle's overall energy efficiency. There is a need for a system that optimizes energy usage while ensuring sufficient visibility.
- Environmental Considerations: Excessive high beam usage contributes to light pollution, negatively impacting the environment and wildlife. A smart control system should incorporate features to minimize light pollution while maintaining optimal visibility for the driver.
- Traditional vehicle lighting systems, with their fixed brightness levels, prove inadequately adaptable to dynamic road conditions, leading to increased risks, especially in challenging terrains like Ghats sections. Beyond these challenges, the escalating problem of drunk driving compounds the risks, demanding a comprehensive solution.

3. OBJECTIVES OF THE PROJECT:

The main objective of the proposed system is

1. To Enhance safety by integrating an alcohol sensor to prevent impaired driving.
2. To Implement adaptive lighting for improved visibility and reduced blinding.
3. To Integrate Ghats Section Collision Detection to mitigate collision risks during turns.

4. OVERVIEW OF THE PROJECT:

The proposed system employs an embedded system technology to enhance road safety and it is achieved through two integrated models. An embedded system refers to a specialized computing system that is designed to perform dedicated functions or tasks within a larger mechanical or electrical system.

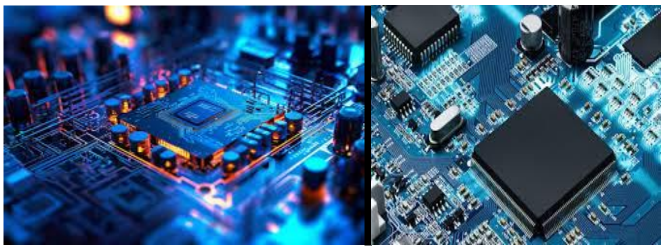

Fig 8: embedded system

Unlike general-purpose computers, which are designed to handle a wide range of tasks and applications, embedded systems are tailored to specific functions and are often optimized for performance, power consumption, size, and cost. These systems typically consist of a combination of hardware and software components, with the software often being specifically developed for the hardware platform to ensure efficient operation. Programming languages commonly used for embedded systems development include C, C++, and assembly language, as they offer low-level control over hardware resources and are well-suited to the constraints of embedded environments.This project focuses on enhancing vehicle safety through advanced lighting and alcohol detection systems. Ambient light intensity is accurately measured using sensors to dynamically adjust headlight brightness. An embedded system seamlessly switches between high and low beam lights based on surrounding conditions, ensuring optimal illumination without dazzling other drivers. Integration of an alcohol sensor adds an additional layer of safety by monitoring driver alcohol levels, triggering alerts

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when thresholds are exceeded. Safety precautions such as manual override options and fail-safe mechanisms prevent accidents in case of sensor malfunction. A user-friendly interface provides real-time feedback on system status and alcohol levels, promoting awareness and responsible driving behavior and also complements road safety by strategically deploying IR sensors along curves to detect vehicles,

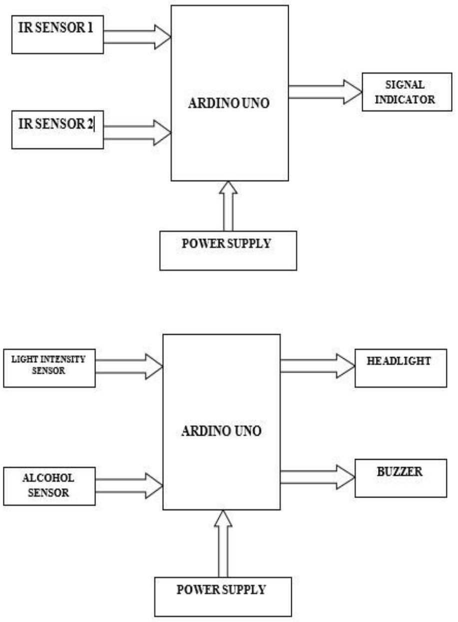

Fig 9: Block diagram

Activating red LED lights on the opposite side to warn oncoming drivers. Directional control mechanisms ensure LEDs are activated appropriately based on vehicle direction, avoiding confusion. Together, these models offer a holistic approach to road safety, combining advanced technology, user-centric design, and regulatory compliance to mitigate risks and protect lives.

5. CONCLUSION

The embedded system described in this project represents a comprehensive approach to enhancing vehicle safety through advanced lighting and alcohol detection systems. By integrating ambient light sensors, the system dynamically adjusts headlight brightness, ensuring optimal illumination without dazzling other drivers. Moreover, the seamless switching between high and low beam lights based on surrounding conditions enhances visibility and reduces the risk of accidents. The incorporation of an alcohol sensor adds an additional layer of safety by monitoring driver alcohol levels. This feature triggers alerts when thresholds are exceeded, promoting responsible driving behaviour and mitigating the risk of impaired driving-related accidents. Importantly, safety precautions such as manual override options and fail-safe mechanisms are in place to prevent accidents in case of sensor malfunction, ensuring the reliability of the system. A user-friendly interface provides real-time feedback on system status and alcohol levels, fostering awareness and encouraging responsible driving habits. Furthermore, the strategic deployment of IR sensors along curves to detect vehicles and activate warning lights enhances road safety by alerting oncoming drivers to potential hazards. The directional control mechanisms ensure that warning lights are activated appropriately based on vehicle direction, minimizing confusion and effectively communicating potential dangers to drivers. Overall, this embedded system offers a holistic approach to road safety, integrating advanced technology, user-centric design, and regulatory compliance to mitigate risks and protect lives on the road.

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