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CHAIN ACCIDENT PREVENTION BY APPLYING AUTOMATIC BRAKE

[1]Chidambar P M 1st Author, [2]Chinmay S 2nd Author, [3]D N Mithun 3rd Author,

[4]Karthik D 4th Author, [5]Dr.Devika B 5th Author

[1]Stundent 1st Author, [2]Student 2nd Author, [3]Student 3rd Author,
[4]Student 4th Author, [5]Professsor 5th Author [1]Electronics and Communication Engineering1st Author, [1]K S Institute Of Technology 1st Author, Bengaluru, India

Abstract : This IoT-based project aims to prevent chain accidents and reduce high-beam glare using ESP32 microcontrollers. Ultrasonic sensors detect obstacles and nearby vehicles to trigger automatic braking. ADXL accelerometers sense collisions, stopping the vehicle and sending alerts via Zigbee to nearby vehicles. Zigbee enables real-time vehicle-to-vehicle communication for prompt responses. LDR sensors detect high-beam glare and automatically switch to low beam using a voltage regulator. A central hub sends accident alerts to emergency contacts through Telegram for rapid emergency response.

IndexTerms **- ESP32 Microcontroller, Arduino IDE, Power Supply, LDR Sensor, UV Sensor, Voltage Regulator, Relay, DC Motor, Motor Driver, LCD Display, Embedded C.**

I. INTRODUCTION

This project focuses on improving road safety by helping prevent chain collisions and reducing the impact of highbeam glare. It uses an IoT-based system that enables real-time communication between vehicles and supports automatic braking when needed.ESP32 microcontrollers coordinate various sensors to detect obstacles, monitor blind spots, and sense accidents. If a collision is detected, Zigbee communication is used to instantly alert nearby vehicles, which can automatically apply brakes to avoid further incidents.To reduce high-beam glare, LDR sensors detect bright headlights from oncoming traffic and automatically switch the vehicle's lights to low beam. Additionally, a central hub sends accident notifications to emergency contacts via Telegram, ensuring quick assistance in critical situations

II. LITERATURE SURVEY

[1]. Today, many people drive at high speeds, which often leads to accidents—especially in areas like school zones, hilly regions, and highways. While the highways department installs signboards to warn drivers about speed limits, these signs can sometimes be missed or not clearly visible, increasing the risk of accidents.To tackle this issue, a smart system has been developed and installed in vehicles to enhance safety and communication. Each vehicle is equipped with sensors at the front and rear to detect crashes and immediately alert nearby vehicles. An IR sensor and an LCD display inside the vehicle provide real-time alerts to the driver.Controlled by an ESP32 microcontroller, the system delivers four types of warnings: accidents, landslides, roadblocks, and traffic congestion. These alerts help drivers stay informed and avoid dangerous situations. The communication protocol used is efficient and reliable, ensuring quick delivery of emergency warnings while optimizing bandwidth, especially during high-stress road conditions.

[2]. This paper offers an in-depth look at vehicle-to-everything (V2X) communication within the context of intelligent connected vehicles (ICVs). It begins by exploring key challenges that arise during the three main phases of cooperative communication: before, during, and after data exchange. The study presents various strategies and ideas aimed at overcoming these challenges. It also examines different communication scenarios and techniques, evaluating how effective and practical they are in real-world applications. A detailed analysis of several datasets is included, focusing on their unique features and how well they support different communication tasks.In addition, the paper reviews the platforms and frameworks used in experimental setups, offering insights into their performance and limitations. After reviewing current approaches and datasets, the paper identifies

promising research directions and unresolved challenges that need further investigation. Overall, this comprehensive study helps build a clearer understanding of V2X communication and lays the groundwork for future advancements in the field of intelligent transportation.

[3]. Wireless communication among road users plays a crucial role in helping autonomous vehicles understand their surroundings, make decisions, and plan routes—ultimately improving road safety and traffic efficiency. To support this collaborative driving approach, the concept of Vehicle-to-Everything (V2X) communication was introduced and has since become a key area of development in the automotive industry.Over the past two decades, several communication standards have emerged, including IEEE 802.11p-based protocols like Dedicated Short-Range Communication (DSRC) and ITS-G5, as well as cellular-based technologies such as C-V2X and the more recent NRV2X. While there's a wealth of research on V2X technologies and their performance, there are surprisingly few surveys that bring all this information together. Even fewer explore future trends or challenges related to the global rollout of V2X systems.This paper aims to fill that gap by offering a comprehensive overview of current V2X communication standards, their effectiveness, practical applications, and the challenges they face. It also highlights areas where further research is needed and presents a vision of where the V2X field may be heading in the coming years.

[4]. This paper introduces the development of an Autonomous Dynamic Braking System (ADBS) designed to enhance road safety and improve ride comfort by helping prevent vehicle collisions. The system monitors driving conditions in real time and automatically applies the brakes when there's a risk of collision, using a Time to Collision (TTC) calculation based on relative speed, distance, and acceleration between vehicles.The braking algorithm is designed to avoid sudden stops unless absolutely necessary, ensuring that braking is smooth and controlled. This not only maintains safety but also prioritizes the comfort of both the driver and passengers.Initial results show that the system significantly boosts vehicle safety and provides a more comfortable driving experience. However, further real-world testing and validation are needed to fully assess its reliability and performance. Overall, ADBS shows strong potential as a solution for reducing accidents and saving lives by minimizing the impact of human error on the road.

[5]. Automatic Emergency Braking (AEB) has become a common feature in modern passenger vehicles and plays a key role in improving driving safety as part of intelligent driver assistance systems. To address potential safety concerns that arise from interactions with the surrounding environment, the new ISO/PAS 26448 standard has been introduced.This paper begins by explaining how AEB systems work and what components they include. It then uses a systematic approach to assess the risks associated with AEB, identifying possible hazards and setting appropriate safety goals, especially related to the system's reaction timing.The study also explores how road surface conditions can impact AEB performance, highlighting some of the system's limitations. By applying the System-Theoretic Process Analysis (STPA) method, the paper identifies new design constraints and safety requirements that can help improve AEB products.Overall, the analysis supports the development of safer, more reliable AEB systems and can be integrated into any stage of the system's design and development.

[6]. This article highlights the importance of thoroughly testing modern electronic driver assistance systems. It presents the results of an experimental study evaluating the performance of an Automatic Emergency Braking System (AEBS), specifically its ability to prevent collisions with pedestrians.The study involved a realistic, movable model representing an adult pedestrian to simulate a scenario where a person crosses the road in front of a moving vehicle. The vehicle under test was equipped with an AEBS that uses radar and a video camera to detect pedestrians and initiate emergency braking.Tests were carried out under both daytime and nighttime conditions on wet asphalt roads to mimic real-world driving environments. The study also examined how the pedestrian model behaved during impact to better understand the dynamics of such collisions.Detailed data from the test runs were recorded and analyzed to assess the AEBS's response and functionality. The findings provide valuable insights into how well AEBS performs in critical situations and underscore the need for continued testing and refinement of these systems.

[7]. Ensuring the safety of all road users, including cyclists and pedestrians, is crucial in the era of autonomous driving. Autonomous Emergency Braking (AEB) systems have proven effective in helping self-driving cars avoid collisions, particularly with non- motorized vehicles that are harder to detect. A new approach, called Automatic Preventive Braking (APB), developed by Mobileye, aims to reduce crashes without slowing down traffic. However, the effectiveness of APB hasn't been fully evaluated yet.This study compares the performance of APB with two types of AEB systems—one-stage and three-stage braking—in critical driving situations involving both motorized and nonmotorized vehicles. The tests used real-world data from the Shanghai Naturalistic Driving Study, which were then simulated using MATLAB's Simulink.The results show that:The one-stage AEB system, with a deceleration rate of 5.5 m/s^2 and a time-to-collision threshold of 1.6 seconds, successfully prevents all safety- critical events from turning into crashes.APB provides the best driving stability, but its safety performance is not as strong as that of the AEB systems.APB's braking performance is highly sensitive to its pre-set parameters and changing vehicle speeds, which could explain some of the crashes.In comparison, the time-triggered braking of AEB systems is more reliable and consistent than the distance-based triggering used by APB.

[8] The increasing use of Advanced Driver Assistance Systems (ADAS) in cars marks a major step toward creating safer roads and more comfortable driving experiences. This paper provides a detailed review of ADAS in both internal combustion engine (ICE) vehicles and electric vehicles (EVs), with a focus on understanding how these systems operate in each type of vehicle. It highlights the differences in how ADAS functions in terms of energy efficiency, sensor technologies, and overall performance, as well as how these systems integrate with the vehicle's control mechanisms.Additionally, the paper addresses the challenges faced when implementing ADAS in both ICE and EVs and looks at the future prospects for these technologies. It also explores the evolution of autonomous driving technology and what we can expect from this rapidly advancing field in the near future.

[9]. Spending long hours in front of screens—whether on a computer, tablet, or phone—can be harmful to your eyes. These devices emit blue light, which has been shown in various studies to negatively impact human health. One common condition related to screen use is computer vision syndrome, which is linked to a decrease in the number of times a person blinks. This condition can cause headaches, eye strain, back pain, stress, and irritability.While some solutions, like adjusting screen light, have been proposed to minimize these effects, real-time monitoring of a person's blinking remains a challenge. This paper presents a solution using the Viola-Jones algorithm to detect eye blinks in real-time. By processing images, the system analyzes the iris and eyelids to determine whether a blink has occurred. The results show an impressive accuracy of over 90%, tested using a webcam operating at 10 frames per second.

[10]. With the rise in digital device usage, Computer Vision Syndrome (CVS) has become more common, with symptoms like eye strain, irritation, and reduced blink rates. Most existing systems designed to prevent CVS mainly focus on blink rates, which limits their ability to detect the full range of symptoms. This paper introduces a real-time system for identifying CVS that combines multiple visual indicators—such as pupil dilation, red-eye detection, and blink rate—to provide a more accurate and comprehensive diagnosis.The system uses eye and iris landmark detection, relying on a pre-trained convolutional neural network (CNN) to track the eye region. The method was tested with data from five different racial groups, including 50 images evenly split between male and female subjects. The fastest detection was achieved for Caucasian males, while the slowest was for East Asian males. However, detection time remained under one second for all subjects.When detecting pupil dilation, the method achieved an accuracy of 78%, based on videos showing both normal and dilated pupils. Overall, the system, which was trained on diverse demographic data, scored 84% for performance, demonstrating high precision in detection and the ability to cover a wide range of CVS symptoms.

[11] In recent years, the number of vehicles on the road has skyrocketed, increasing the chances of traffic collisions. As a result, concerns about the safety of drivers, passengers, and other road users have become more pressing. The proposed system offers a practical solution to improve safety by focusing on key features like distance warnings, automatic emergency braking, blind spot detection using radar, and data storage through IoT. Radar is particularly valuable because it works well in low light and adverse weather conditions, making it an ideal tool to assist drivers in these challenging situations.

[12]. This research introduces a regenerative braking cooperative control system designed for hybrid electric vehicles (HEVs) with automatic transmissions. The braking system of the HEV combines regenerative braking and electronic wedge brake (EWB) friction braking for the front wheels, along with hydraulic friction braking for the rear wheels. A new cooperative control algorithm is proposed to manage the regenerative and friction braking systems, adjusting the braking torque based on the driver's input. A vehicle test was conducted to assess the performance of the proposed braking system and the control algorithm.

[13]. This project aims to make driving safer by automatically detecting and reacting to obstacles. Using ultrasonic sensors, the system continuously monitors the distance between the car and any nearby objects. When an obstacle is detected within a pre-set safe distance, the system automatically engages the brakes, either slowing down or stopping the vehicle to prevent accidents. The intelligent braking system processes real-time data to make quick decisions, ensuring overall road safety. This technology is designed to reduce road accidents and improve safety by responding to potential hazards in real-time.

III. PROBLEM IDENTIFICATION

- Ultrasonic sensors for better front object detection.
- Automatically adjust the headlights to low beam for safer driving at night.

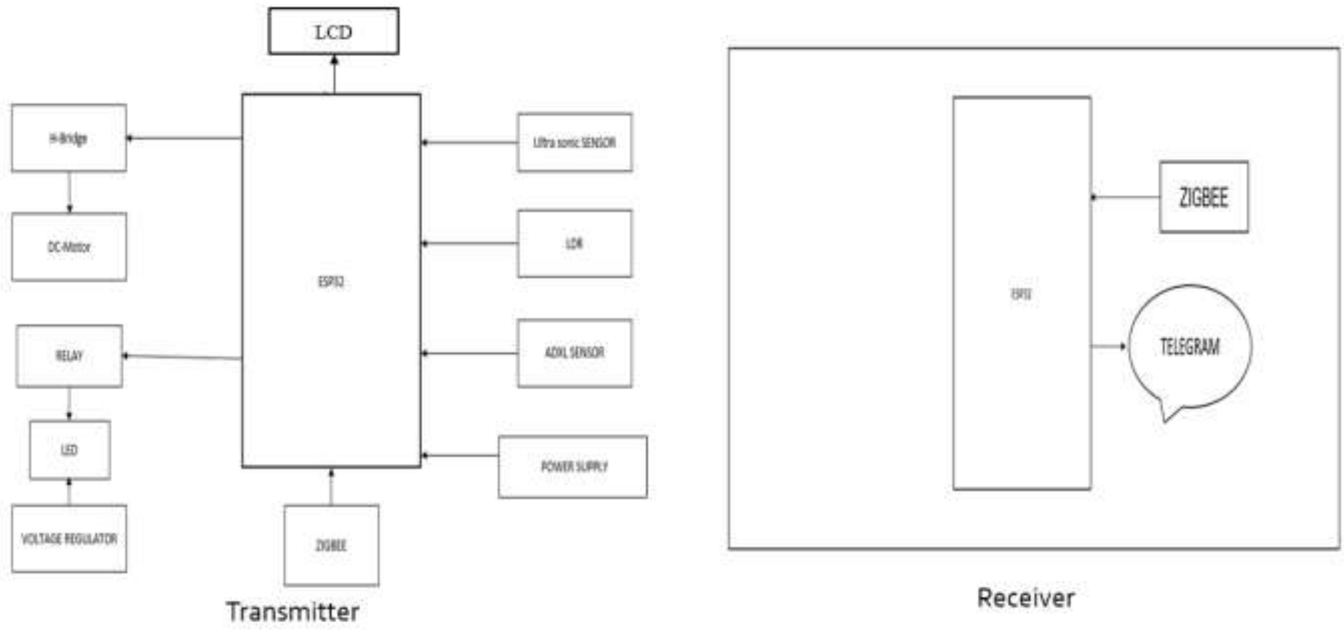
IV. OBJECTIVES

- To utilize Ultrasonic sensors for effective front object detection.
- To employ ADXL sensors for accurate accident detection and automatic vehicle stopping.
- To integrate Zigbee communication for low-latency alerts to nearby vehicles.
- To establish automatic braking systems triggered by collision warnings.
- To create a hub for emergency contact notifications via Telegram.
- To incorporate LDR sensors for detecting high beam headlights from oncoming vehicles.
- To ensure automatic adjustment of headlights to low beam for safer nighttime driving.

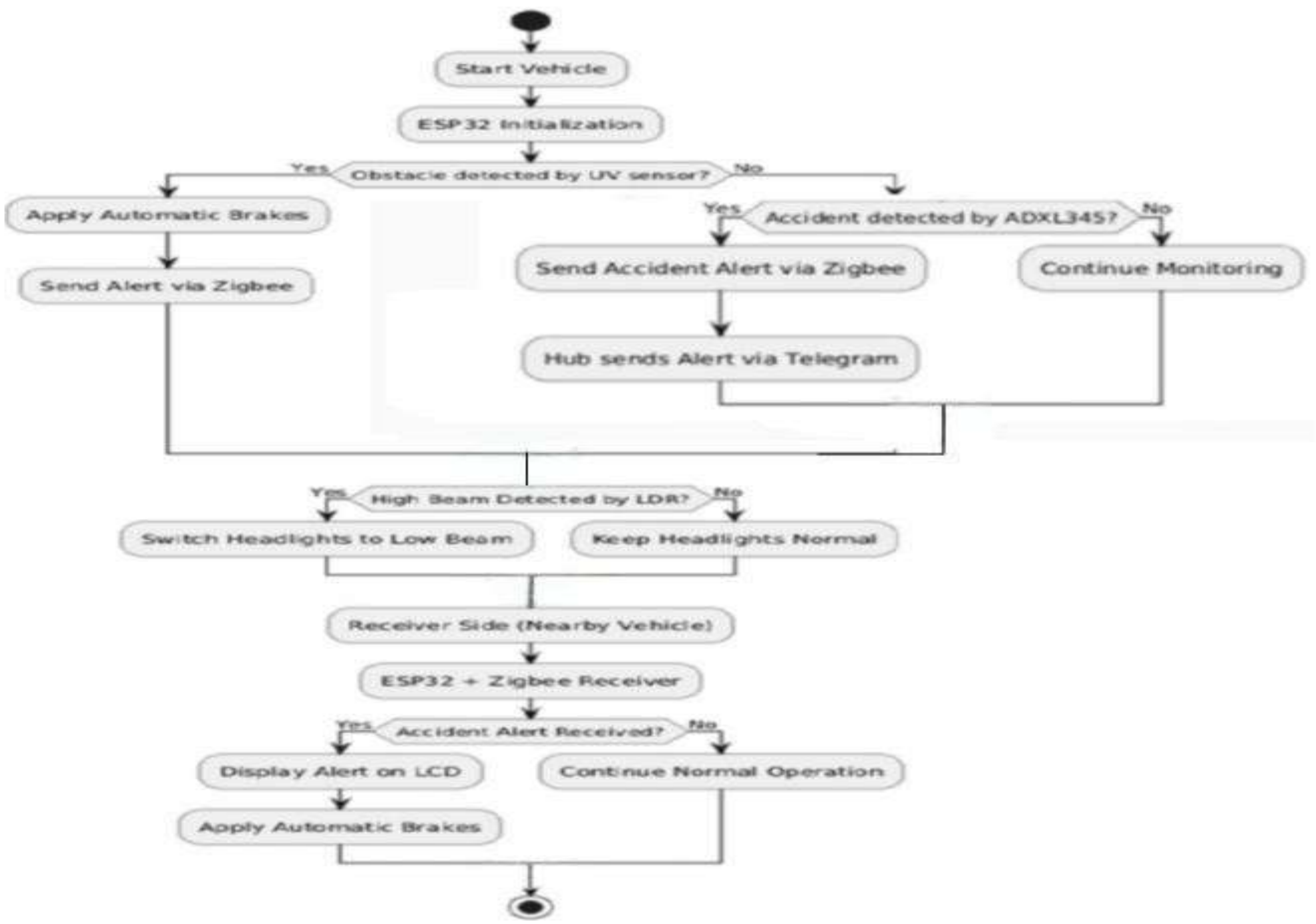
V. METHODOLOGY

- Utilize the ESP32 microcontroller to manage sensor data and communication between vehicles.
- Integrate Ultrasonic sensors for front and rear object detection and ADXL accelerometers for accident detection.
- Implement Zigbee communication for real-time data sharing and alerts between vehicles.
- Develop algorithms to trigger automatic braking in response to collision threats.
- Establish a hub for consolidating data and notifying emergency contacts via Telegram.
- Test the system in real-world scenarios to assess effectiveness and optimize performance.

VI. BLOCK DIAGRAM

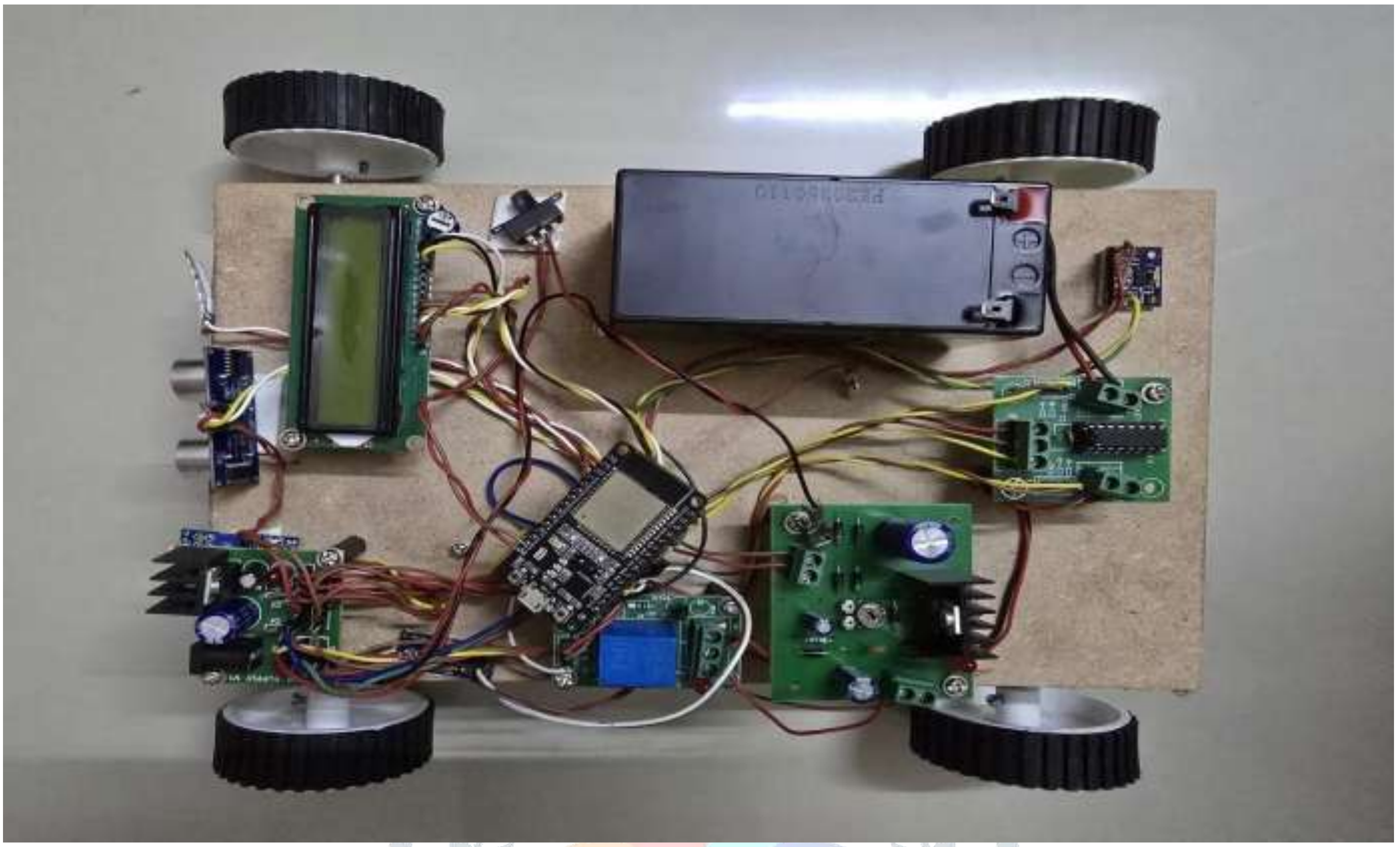


FLOW CHART

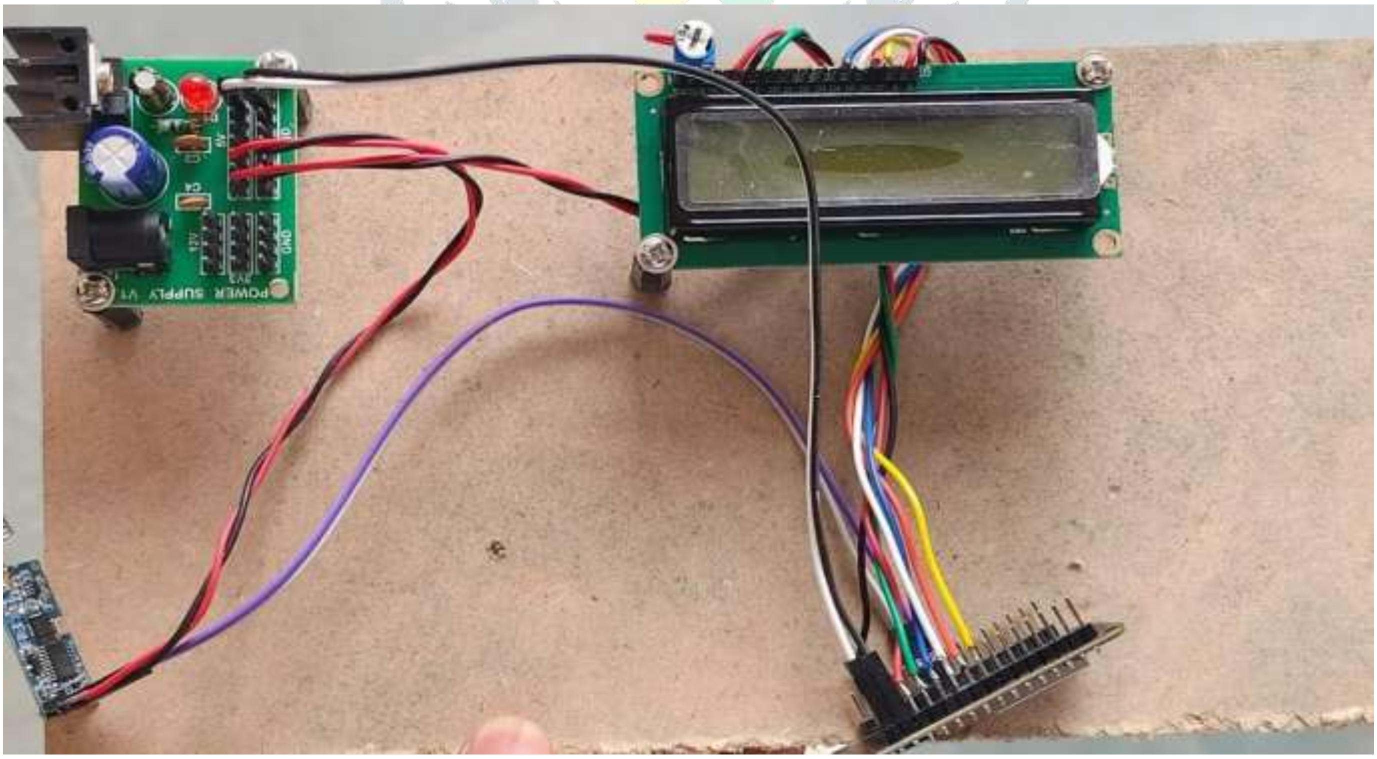


VII. RESULT

Model



Hub



VIII. APPLICATIONS

- Implement vehicle-to-vehicle communication to improve road safety.
- Ultrasonic sensors for better front object detection.
- Accurately detect accidents and automatically stop the vehicle if needed.
- LDR sensors to detect high beam headlights from on coming vehicles.
- Ensure automatic adjustment of headlights to low beam for safer nighttime driving.

IX. FUTURE SCOPE

- Complete Accident Response Loop: Successfully established an automated, end-to-end accident response loop using ADXL impact detection and an immediate Telegram-based emergency notification system.

- Foundational Active Safety: Created a crucial Collision Warning and Mitigation capability through the integration of Ultrasonic front object detection and the trigger for the automatic braking system.

- Enhanced Nighttime Visibility: Successfully addressed the issue of high-beam glare using the LDR sensor and automatic headlight adjustment, significantly improving nighttime safety for both the driver and oncoming traffic.

- Proof-of-Concept for Next-Gen ADAS: The project serves as a strong Proof-of-Concept (PoC), demonstrating the effective integration of IoT sensors and communication (Zigbee) to provide genuine active safety, forming a robust foundation for a full-scale, intelligent Next-Generation Advanced Driver Assistance System (ADAS).

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