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Advanced Driver Assist System for Automobiles

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Abstract – A group of technologies known as advanced driver assistance systems (ADAS) aid in keeping drivers safe and preventing collisions. These systems monitor the area surrounding the car using a range of sensors, including cameras, radar, and lidar, and if required, send out alerts or make necessary corrections. The primary area of comfort for the driver is the driver assistance system. This study identifies, investigates, and puts into practice the issues of reduced visibility in curves, particularly in ghats, and visual impairment brought on by fog and abrupt approaching light. The suggested approach seeks to address these challenges by automatically implementing features like headlamp rotation, which addresses concerns with curves, automated dimming of headlights, and fog detection.

Key Words: Advanced Driver Assist System, Sensors, Motors, Communication module

1. INTRODUCTION

Advanced Driver Assistance Systems (ADAS) stand as a pinnacle in automotive innovation, revolutionizing driving safety and efficiency. By amalgamating a sophisticated array of sensors, cameras, and cutting-edge technologies, ADAS aims to redefine the driving experience. This comprehensive system goes beyond mere assistance, empowering drivers with an arsenal of active and passive safety features. From lane-keeping assistance to adaptive cruise control, collision warnings, and blind-spot detection, ADAS operates on dual fronts: actively aiding drivers in maintaining control and vigilantly alerting them to potential hazards.

With a primary focus on mitigating distractions that endanger safety, ADAS seamlessly integrates essential information into the dashboard, fostering a safer environment by curbing driver distractions like phone use or texting. Moreover, it fosters inter-vehicle communication, fortifying safety measures. Managed by the car's sophisticated computer, this technology employs a symphony of sensors, cameras, and supplementary technologies to ensure comprehensive safety.

ADAS, a cornerstone in vehicle safety, leverages state-of-the-art technology to provide critical alerts to fleet drivers, pre-empting potential dangers. Notably, these driver-assist systems, encompassing various models beyond Tesla, operate autonomously, relying on a network of cameras and sensors to provide a panoramic view, eliminate blind spots, aid in parking, and employ high-resolution imaging radar. To counter network congestion, these systems incorporate inter-sensor communication.

However, despite their advanced capabilities, it's essential to recognize that no driver-assist system is designed to detect disengaged drivers. Nevertheless, ADAS integration in vehicles plays an indispensable role in not only reducing the frequency of accidents but also mitigating their severity, a crucial endeavor for overall vehicle safety.

2. PROPOSED SYSTEM

Sudden flash of light leading to increasing number of accidents in night time. The project is intended to automate the procedure of dim and dip of light as manual dim and dip of light as it affects the reliability of the automobile and also does not affect the driver in case of any visual impairment.

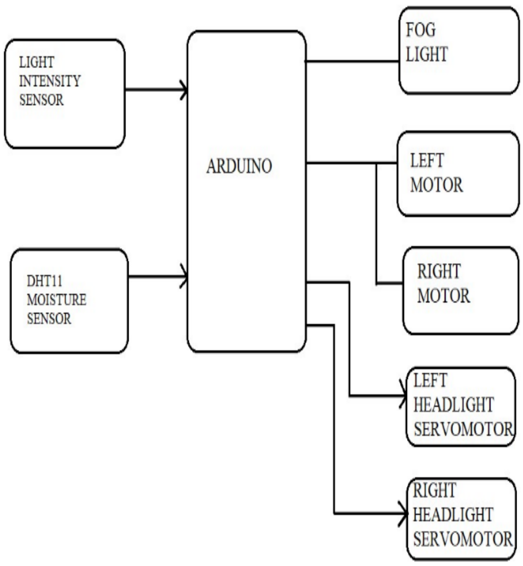

Fig 2.1: Block diagram of proposed system

Headlights play a vital role in night driving, serving as active safety features that enhance visibility around bends and over hills. The proposed system focuses on two key variables: the angle of the headlight and its intensity. Traditional headlights maintain a fixed direction, illuminating the roadside while leaving the road ahead in darkness during curve traversal. Conversely, adaptive headlights adjust their beams based on steering input to light up the actual path of the vehicle. Steering input is gauged using a single-turn potentiometer that tracks the steering wheel's position.

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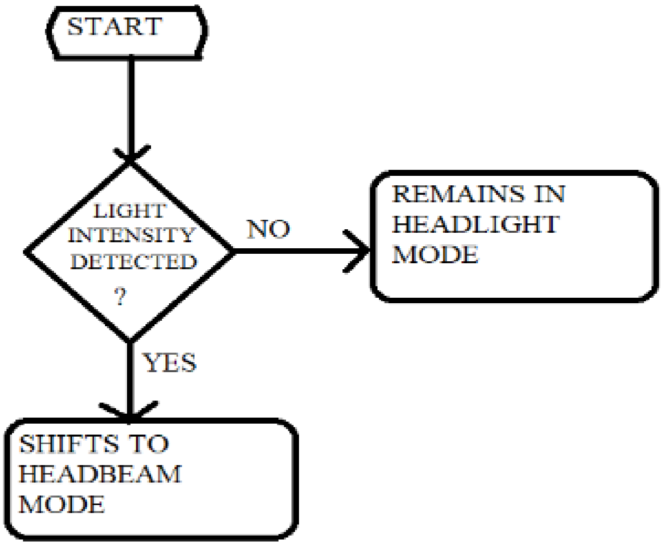
Nighttime driving on a one-way highway poses challenges due to glare from oncoming cars. This sudden flash of light can impair the driver's vision, leading to an increase in accidents during nighttime. The project aims to automate the dimming and dipping of headlights, as manual adjustments compromise vehicle reliability and driver safety during visual impairment incidents.

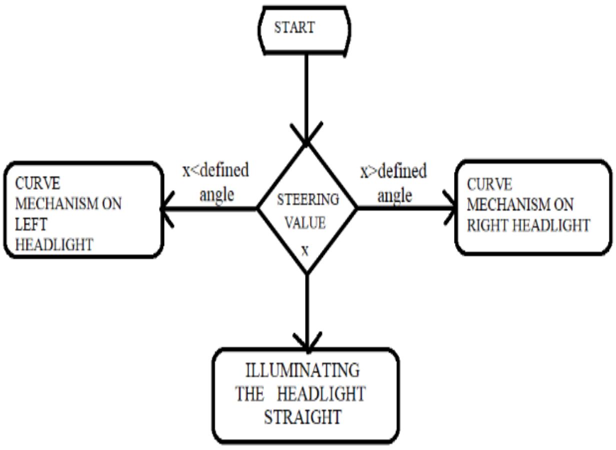
Regions characterized by poor air quality and hilly terrains with smog often experience accidents due to reduced visibility. While fog lights exist, their manual control hampers efficiency. The proposed system automates fog light switching. The overall implementation is outlined in Figure 2.1.

The system employs a photodiode to detect light intensity. Arduino UNO processes this data, comparing it with a preset value to determine whether the headlights should switch to high beam mode or remain in headlight mode, as illustrated in Flowchart 2.1a



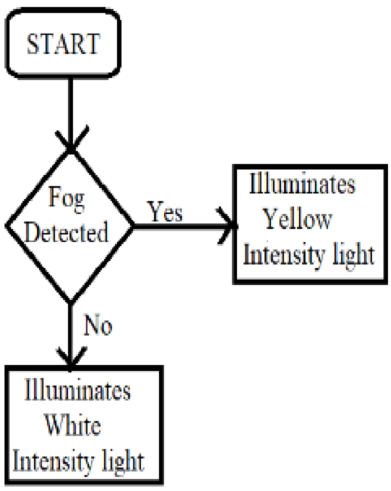
Flowchart 2.1a: Light intensity detection

Servomotor mechanism is used to provide this feature to headlights. Angle of curvature x is predetermined and is used as decision-making factor to rotate the headlights with required degrees of rotations. The servomotor mechanism provides a steering value, which is further sent to the microcontroller unit where the value is compared with a defined angle which determines whether the rotation of the headlight takes place in left direction. As shown in Figure 2.1b



Flowchart 2.1b: Steering wheel mechanism

Fog sensor DHT11 is used to detect the fog, the signal is further processed by the microcontroller unit. This determines the illumination of fog light if fog is detected at a humidity value less than predetermined Value. It is depicted in the Flowchart 2.1C



Flowchart 2.1c: Fog detection and Illumination of fog light

This section provides an intricate breakdown of the project's workflow, supported by flowcharts. It delves into the mechanisms governing light intensity detection, steering wheel action, and fog detection with subsequent fog light illumination.

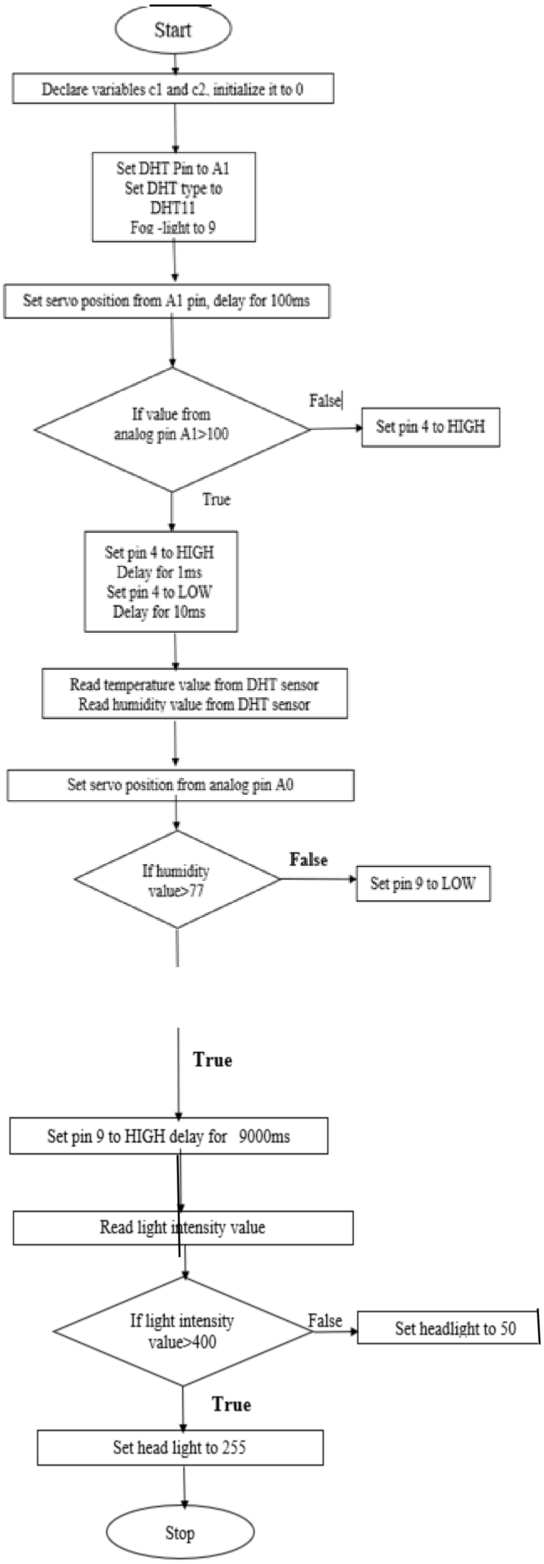
3. SOFTWARE IMPLEMENTATION

It covers the software implementation of the project using Arduino ide platform with the aid of embedded c language.

3.1 Code environment

The Arduino IDE (Integrated Development Environment) is a software platform used for programming and developing applications for Arduino boards. It provides a user-friendly interface that simplifies the process of writing, compiling, and uploading code to Arduino microcontrollers. The code is dumped in the Arduino by making use of the Arduino IDE platform using embedded C language.

This part of the thesis describes the code for the Arduino uno microcontroller with the aid of flowchart of algorithm as shown in the flowchart. 3.1.



Flowchart 3.1: ADAS workflow

4. HARDWARE IMPLEMENTATION

This section details the hardware implementation, incorporating components like Arduino UNO, Stepper Motor, LDR Sensors, Fog Sensors, and related accessories—integral to the system's core. Each component's individual functionality and its role within the system are elucidated.

4.1 Mechanical approach.

The mechanical aspect begins with SolidWorks, defining the model's dimensions: 80 cm length, 48 cm width (Figure 4.3A). The side view sets the model's height at 18 cm (Figure 4.3B). A three-dimensional representation follows, utilizing 5 mm wide, 2 cm long mechanical bars (Figure 4.3C). Additionally, the steering mechanism design is showcased (Figure 3.3.3), featuring a 15 cm height and 10 mm radius.

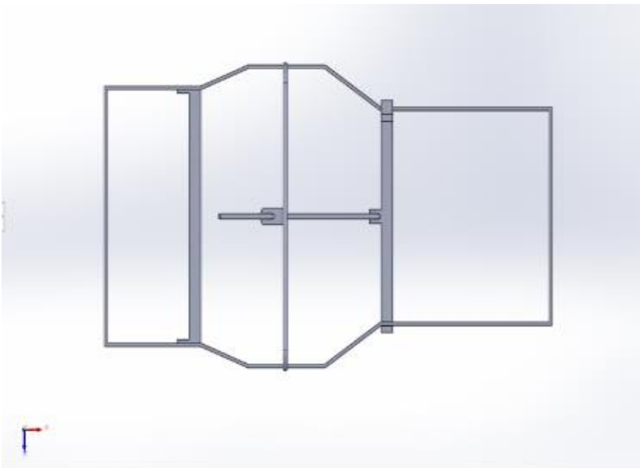


Fig 4.1a: Top view of mechanical design

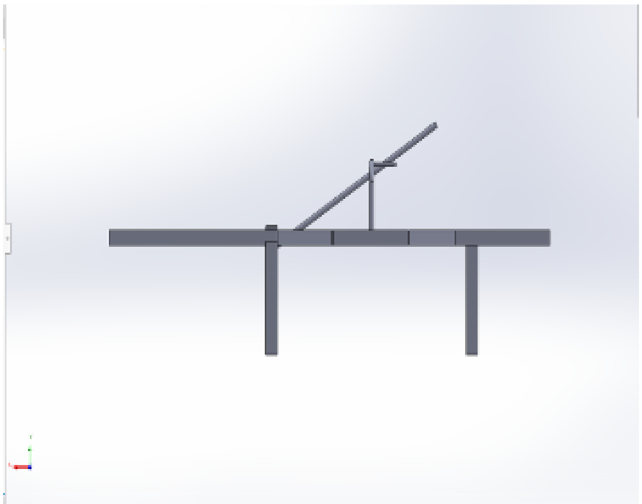


Fig 4.1b: Side view of mechanical design

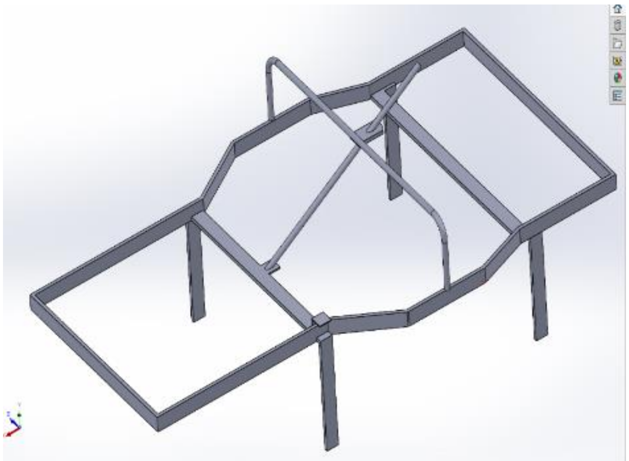


Fig 4.1c: Three dimensional view of mechanical design

4.2 Hardware output module

The following case has been analyzed and the output obtained has been recorded.

CASE 1: ROTATION OF HEADLIGHT ACCORDING TO THE STEERING WHEELS

Case 1 focused on synchronizing headlight rotation with steering wheel movements. Using a steering angle sensor potentiometer (10k range) attached to one of the front wheels, the microcontroller measures steering angle variations. This data prompts the servo motor, positioned from 0° to 180°, aligning the headlight accordingly. Refer to Figure 4.2.1a and Figure 4.2.1b for visual representations

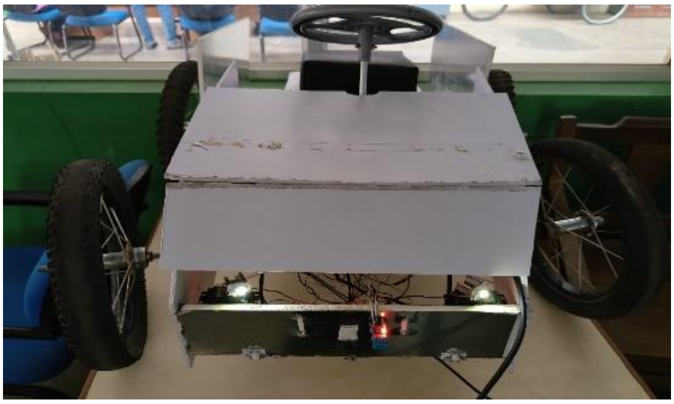


Fig 4.2.1a: Rotation of headlight towards vehicle's left side.

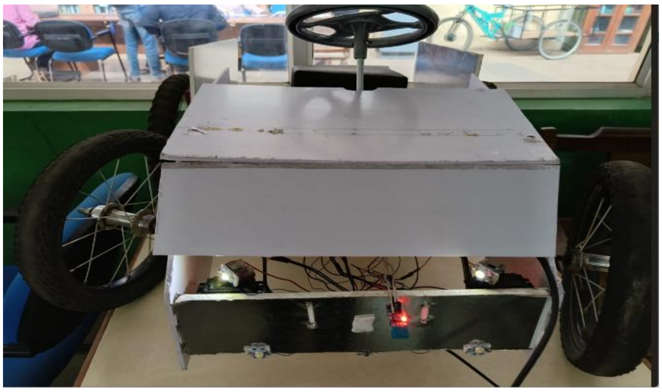


Fig 4.2.1b: Rotation of headlight towards vehicle's Right side

CASE 2: AUTOMATIC DIMMER AND DIPPER

In Case 2, an LDR (light-dependent resistor) acts as a light sensor, detecting oncoming vehicle headlights. The microcontroller monitors light intensity against a set threshold. If the intensity exceeds this value, headlights dim gradually over a 0.45m distance after a 1-second delay. If not, the headlights switch to dipper mode. Refer to Figure 4.2.2A and Figure 4.2.2B for illustrations of dim and dip modes.

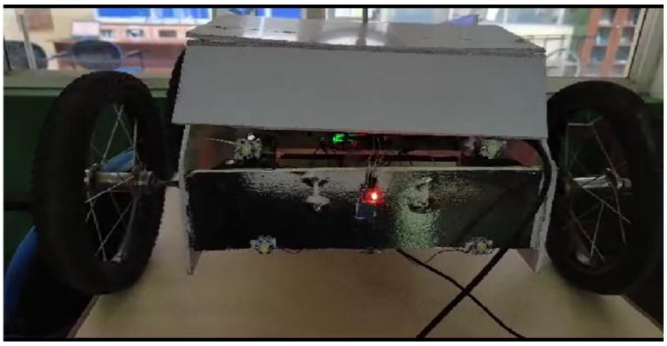


Fig 4.2.2a: Automatic dimmer

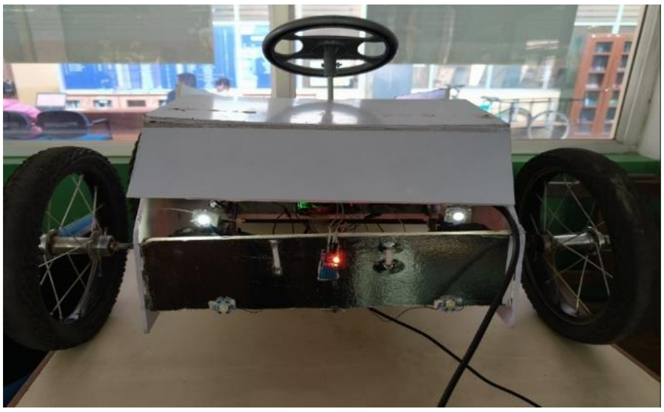


Fig 4.2.2b: Automatic dipper

CASE 3: AUTOMATIC FOG DETECTION AND ILLUMINATION OF FOG LIGHT

Case 3 employs a DHT11 as a fog sensor, detecting fog within a temperature range of -100°C to +300°C. When the sensor value surpasses a predetermined threshold, the microcontroller activates the fog light (yellow) after a 15-second delay. This feature aids drivers by mitigating the human eye effect in foggy conditions. Refer to Figure 4.2.3 for visualization**.**

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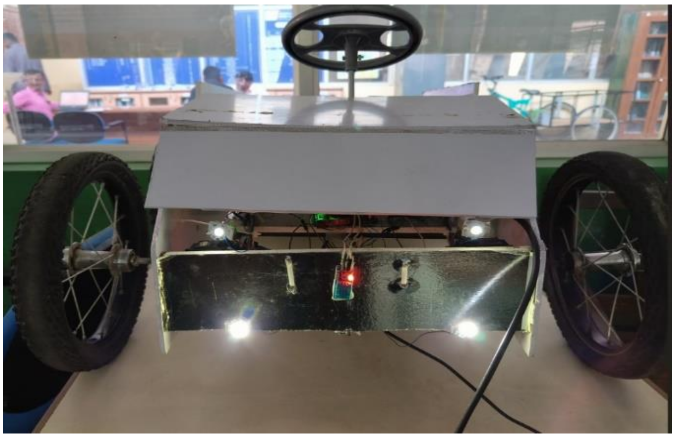

Fig 4.2.3: Detection of fog and illumination of yellow light

FABRICATION AND ASSEMBLY OF FRAME

To accommodate the various parts firmly to the frame, some adjustments has been made in order to get sufficient weight balance.

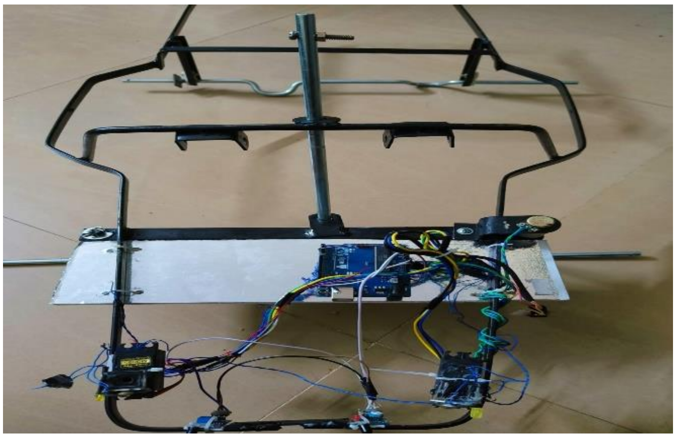

Fig 4.2.4: Assembly of mechanical design

MOUNTING OF STEERING MECHANISM AND STEERING WHEELS

The steering wheel is mounted on the frame and the Tie-rods are attached to the wheel drums. The steering wheel is supported by a rod, which is welded to the base.

Fig 4.2.5: Steering wheel

ARRANGEMENT OF HEAD LIGHT MECHANISM

The headlights are mounted on a bar whose one end is fixed to a board and the other end is connected to a moving bar, which is fixed to a special linkage connected to a rack and pinion.

Fig 4.2.6. Headlight of ADAS

FINAL ASSEMBLED VIEW

Figure 4.2.7. Final Assembled View

The Final Assembled view is shown in Figure 4.2.7. The steering wheel is mounted on the frame and it is connected to the headlight and the prototype is assembled.

5. RESULTS

The Rotation of headlights where the individual headlight is in the same alignment of that of the respective wheels is achieved. Detection of the incoming light and automatic dim and dip of the headlights are also achieved. Detection of the fog with the specified parameters and automatic illumination of fog light is also achieved.

Table 5.1: Analogy of prototype with real time model

Parameters	Prototype model	Real time model
Control unit	Arduino uno Atmega328p microcontroller	Mips 32-bit microcontroller
Steering angle sensor	Potentiometer	Giant magnetoresistance technology
Light sensor	LDR	Ambient light sensor
Fog sensor	DHT11 sensor	DHT22 sensor
Headlight	Light emitting diode	Halogen bulbs

The project's real-time design is an innovative approach, creating a working model. Comparing it with standard models requires understanding its real-time functionality. Table 5.1 outlines how the prototype and real-time models differ in various parameters. The control unit's power remains consistent, but the real-time model utilizes high-powered, sensitive sensors for enhanced performance.

Table 5.2: Comparative analysis of prototype model with real time implementation

Parameters	Prototype model	Real time implementation in Benz
Microcontroller board Voltage	3-5 V	3.3-5 V
Headlight Voltage	3.3-5 V	12-15 V
Microcontroller board Current	0.3 mA	12 mA
Mist thickness	1.5 cm	2.5 cm
Fog Sensor (Temperature)	-10 to 40 ˚ C	-30 to 70 ˚ C
Humidity sensor Response Time	1 s	16 ms
Light sensor Response Time	15 s	8 ms
Light senor distance range	0.45m	12.192m

Table 5.2 compares the proposed Arduino Uno-based module with Benz's IoT-based module using Node MCU. The Arduino Uno shows superior current handling and relies solely on power supply, while the Node MCU depends on both network and power supply. Enhancing other parameters in the proposed system can be achieved by upgrading sensors for better real-time performance.

The adaptive headlight system tilts headlights 0-20 degrees based on steering wheel movement, shown in Figures 5.1 and 5.2. Experimentation on headlight yawing angle revealed close alignment between theoretical and experimental values, obtained through three trials for accuracy despite slight variations due to factors like weight and speed.

Table 5.4 depicts experimental values for inside lock angle, showing slightly more fluctuations across three trials compared to outside lock angle. The primary static friction on the steering wheel causes this variation, resulting in a slightly lower accuracy percentage for inside lock angle. However, this difference is generally negligible due to their close proximity.

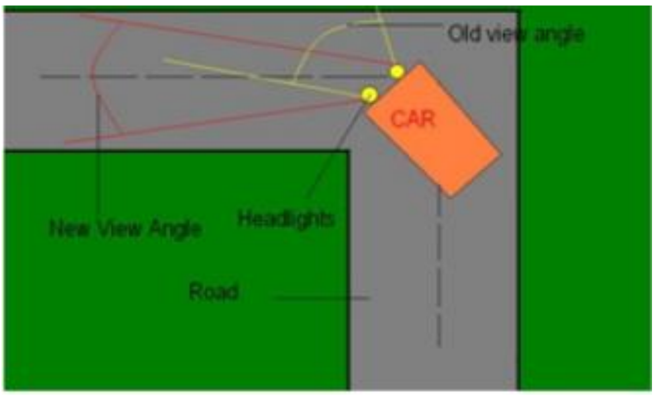

Fig 5.1: Before installation of mechanism

Figure 5.2. Representation of vehicle in motion with mechanism installed

Table 5.4: Accuracy percentage : 91.11%

Sl . NO.	Theoretical value of inside lock angle in degrees	Experiment value of inside lock angle in degrees
1	45	41
2	45	45
3	45	39

The automatic fog light system experiences a slight delay of 20-40 milliseconds compared to manual activation. This delay, akin to the human brain's response time, occurs as the control unit detects fog through sensors before activating the fog lights, similar to how the brain detects fog through the eyes before manual activation. The automatic mechanism, while slightly delayed, is more reliable than continuous manual switching, reducing mechanical failure risks and enhancing the car's overall reliability.

6. CONCLUSION

Through the innovative use of the Arduino IDE, the development of an Advanced Driver Assistance System (ADAS) catering to nighttime driving challenges is an impressive feat. This technology's capability to offer road tracking headlights, minimizing unnecessary movements and prioritizing essential actions, marks a significant stride in driving safety and experience. However, while this model presents cost-effectiveness, it's imperative to address and fortify its vulnerabilities. Ensuring robustness against potential risks remains pivotal in upholding its promise of enhanced safety and convenience for drivers on the road.

7. Future scope

The potential for ADAS to progress and integrate new technology to increase efficiency and safety on the road is quite encouraging.

Here are a few probable ADAS breakthroughs for the future:

1. Fully automated driving is possible with ADAS as a first stage. Future ADAS systems will keep developing and progressively include more autonomous capabilities. This entails cutting-edge sensors, machine learning techniques, and computer vision tools to allow self-driving capabilities in circumstances like parking or highway driving.

2.V2X Communication: Vehicles may communicate with infrastructure, people, and other vehicles via Vehicle-to-Everything (V2X) communication. Real-time information sharing made possible by this technology can improve the safety of the road by issuing alerts about potential dangers, traffic jams, and road conditions.

3. Improved Sensor Technologies: Enhanced sensor technologies will help ADAS. For instance, advances in radar and LiDAR (light detection and ranging) systems will improve the ability to identify objects and calculate distance. In addition, improvements in camera technology and image processing algorithms will improve item, sign, and pedestrian identification.

4. Artificial Intelligence and Machine Learning: ADAS will be better equipped to comprehend and react to complicated driving conditions as a result of the combination of artificial intelligence (AI) and machine learning (ML) algorithms. Systems using artificial intelligence (AI) may learn from massive volumes of data to make better decisions, anticipate possible dangers, and adjust to different driving styles.

5. High speed alert system: If the vehicle's brakes fail while being driven at a high speed, whether intentionally or unintentionally, the system will send an alarm to the driver.

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