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Design and Fabrication of Adaptive Headlight System with Fog Detection

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ABSTRACT: Curved roadways have the highest fatal accident rate during the evening hours. In most circumstances, late detection of items in the traffic zone is critical. These findings highlight the significance of automotive forward-lighting systems. To improve nighttime safety, the goal of this project is to develop and construct a prototype of steerable headlights. This will be achieved by modifying a conventional static headlamp, enabling the headlights to be adjustable and adaptable based on the driving conditions. The primary focus is on enhancing visibility and safety during nighttime driving. The primary focus is on maintaining cost-effectiveness and reliability throughout the design and implementation process. A steerable headlamp system was developed using readily accessible market components. Multiple types of testing were conducted on crucial components of the system to assess accuracy, response time, and overall system impact. The results obtained from these extensive tests will be thoroughly analyzed and discussed in the subsequent sections. Any discoveries or adjustments that should be implemented are discussed and may be valuable for future development.

I. INTRODUCTION

To enhance road safety and driving comfort, advanced front-lighting systems (AFS) with swiveling headlamps are being developed. These intelligent lighting systems aim to improve driver visibility, particularly on curved roads and at intersections. With over 80% of traffic accidents occurring in dark and inclement weather conditions, the need for these advanced lighting solutions is evident. By boosting illumination coverage, these systems contribute to reducing accidents and increasing road safety.

Swivel-beam headlamps have undergone numerous tests, which have shown that they can increase the illumination at the driver's gaze point by up to 300% when the car turns a corner. This significant improvement in visibility enhances safety during driving. Adaptive headlights are an active safety feature that improves visibility around curves and over hills to make nighttime or low-light driving safer. Normal headlights illuminate the side of the road while leaving the road in front of you in the dark as you drive around a bend in the road. On the other hand, adaptive headlights adjust their beams in accordance with your steering input to illuminate the vehicle's actual path. Similar to this, when a car with normal headlights crests a hill, the beams of light briefly aim upwards towards the sky. Due to this, it is challenging for both drivers and oncoming drivers to see the road ahead and the approaching driver. As opposed to conventional headlights, adaptive headlights employ a self-leveling system that adjusts the direction of the light beam based on the position of the vehicle.

Active headlights and adaptable front-lighting systems are

other names for adaptive headlights. The rate of accidents is substantially higher at night than during the day, hence these notions are highly important for automobiles in order to avoid

Accidents. The emphasis on car safety is driven by statistical data highlighting the severe consequences of accidents. In 2014 alone, out of 698,451 individuals involved in accidents in India, a staggering 4,882 people lost their lives, while the remaining suffered injuries, resulting in significant financial losses. These statistics underscore the urgent need to address car safety concerns and implement effective measures to mitigate the impact of accidents.

The adaptive headlight system turns the car by using the steering to shift the headlights. As a result of adding light, vision at the cornering improved. The current invention pertains to automobile headlights, more specifically, to a device that allows the vehicle's headlights to switch direction synchronously with steering rotation, improving safety while driving at night or in low light. In the known previous art, a vehicle's headlight has a fixed line of emission that is parallel to the vehicle's front direction. Although the headlamp's elevation angle can be changed to provide "high beam" or "low beam" effects, the direction of emission cannot be changed. Driving on curved or turning roads can create a blind spot in the illumination, leading to reduced visibility and potential hazards during nighttime



or in dark conditions. Consequently, there is a pressing need for a device that effectively addresses this issue and improves visibility in such situations. The development of such a device holds significant value and utility in enhancing driving safety.

II. OBJECTIVES

1. To study the working of conventional head light systems.
2. To develop a head light system that can adjust itself according to the need of road.
3. Development low cost budget fog detection & prevention system that prevent accident during winter

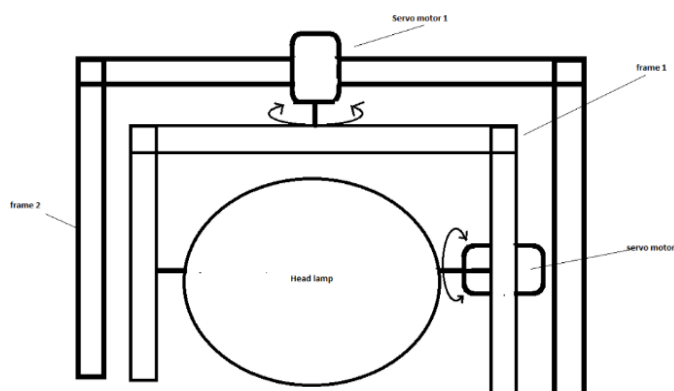
III. METHODOLOGY

The gravity sensor detects the impact of Earth's gravitational force on the device containing the sensor. It is typically derived from the accelerometer, with the assistance of other sensors such as the magnetometer and gyroscope, to eliminate linear acceleration from the recorded data. The gravity measurements, expressed in m/s^2 similar to the accelerometer, are taken along the X, Y, and Z axes.

When a device equipped with a gravity sensor is held upright, the Earth's gravity acts as the primary source of acceleration. Consequently, by analyzing the X, Y, and Z components of the detected gravity, one can determine the device's tilt relative to the Earth's surface. In the past, primitive gravity sensors for measuring tilt employed a small object (e.g., a sphere) suspended by a wire connected to the device. Basic angular scales were utilized to ascertain the wire's inclination in relation to a vertical reference line aligned with the Earth.

In contemporary mobile devices, the accelerometer serves as the physical sensor for measuring acceleration. However, the accelerometer captures all the accelerations that impact the device, encompassing both the gravitational acceleration and the actual linear acceleration associated with its movement. To approximate the gravity specifically on a handheld device, a low-pass filter can be applied to the accelerometer data, minimizing the influence of linear acceleration. It's important to note that a handheld device is typically stationary for most of the time and doesn't experience sustained acceleration in a single direction (unless the user is inside a vehicle subject to sudden changes in acceleration). As a result, the linear acceleration components in the accelerometer readings are transient in nature, tending to revert back to zero.

CAD Model-



The entire model has been designed with the help of designing software CATI A V5 R20.

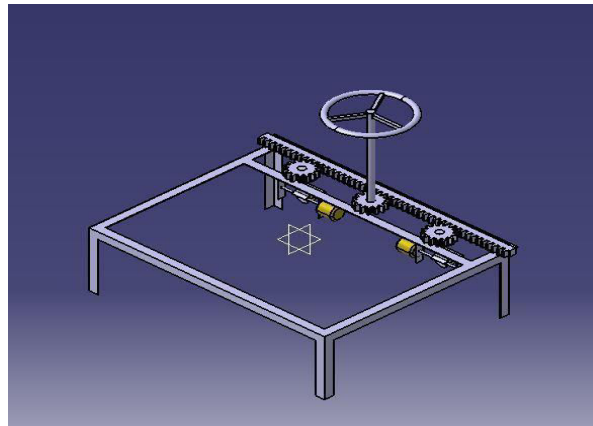


Fig: CATIA MODEL

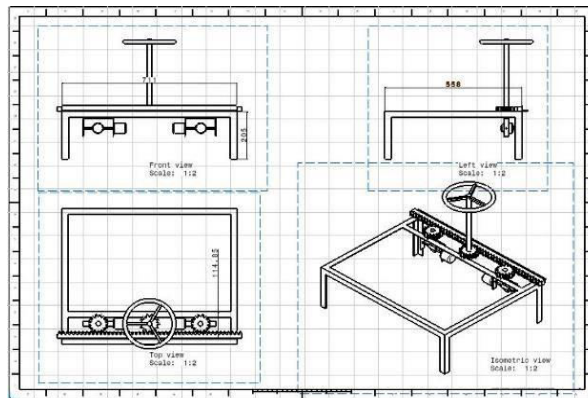


Fig: Drafting of Model

Working methodology-

Two sensors, namely the gravity sensor and the fog sensor (DTH22), are utilized to control the headlights. The gravity sensor is responsible for adjusting two degrees of freedom (DOF) of the headlights. When the vehicle is ascending, the headlights will dip to provide appropriate illumination. Similarly, if the vehicle is traveling upside down, the headlights will adjust accordingly to focus on the road. The headlights also respond to the vehicle's turning motion. When the vehicle turns right, the focus of the headlights will shift to the right, and vice versa.

In addition to the gravity sensor, the fog sensor plays a role in the automatic control of the headlights. When the fog sensor detects the presence of fog, it triggers an automatic change in the color of the headlights to adapt to the foggy conditions.

Design and calculations

Calculation –

Rack and pinion:

Data:

- Number of teeth on Rack T1=50
- Number of teeth on Pinion T2=25
- Diameter =40
- Radius=20



Length=250mm
 Pitch=5mm
 Addendum=m=2
 Module=pitch/π=5/π=1.59=2

Least pressure angle to avoid interference, Let,
 Φ=least pressure angle to avoid interference
 Addendum= r sin2φ
 2= 20sin2φ Φ=18.434

Length of the arc of contact,
 Length of the path of contact= $\sqrt{((r + addendum)^2 - (r \cos\phi)^2)}$
 $=\sqrt{((20 + 2)^2 - (20 \cos 18.434)^2)}$
 =11.13 mm

Minimum no.of teeth
 Circular pitch=Pc=πd/T
 =π*40/25
 = 5.0265 mm
 Therefore length of the arc of contact=(Length of path of contact)/(cosφ)
 =(11.13/cos18.434)
 =11.73

The no.of pairs of teeth in contact,
 = (Length of the arc of contact)/(circular pitch)
 = 11.73/6.28
 =1.78

Therefore, minimum no.of teeth in contact=2 or 1 pair Addendum=m=2mm

Dedendum =1.25*m=2.5mm

Clearance=0.25m=0.5mm Working depth=2m=4mm Whole depth=2.25m=4.5mm
 Tooth thickness=1.5708*m=3.1416mm Tooth space=1.5708m=3.1416mm Fillet
 radius=0.4m=0.8mm

Components Used-

SR. NO	NAME OF THE COMPONENT	MATERIAL	QTY	SPECIFICATION
1	Gyro Sensor	-	1	BMG 250
2	Arduino	-	1	-
3	Fog Detection Sensor	-	1	DHT22 Model
4	Servo Motor	-	2	DC Motor 180 Degree
5	Frame and other Supporting Material	MS	-	1- inch Pipe
6	Rack and Pinion	MS	1	-
7	Steering	-	1	Maruti 800



IV. RESULT

The Adaptive Front Lighting System (AFS) is an automated lighting distribution system implemented in vehicles. It incorporates a specific control algorithm designed to adapt the light distribution according to various driving conditions, such as curved roads and oncoming vehicles. AFS aims to maintain an optimal light distribution suited for the specific road environment. To achieve this, the system takes into account input from in-vehicle parameters such as steering wheel angle and the distance between the subject vehicle and oncoming vehicles.

The AFS system architecture enables horizontal movement of the headlights through the steering shaft's motion and vertical movement of the headlamp based on the distance between the two vehicles. During the system's initial design phase, critical factors considered were the availability, affordability, and reliability of the components used. Furthermore, it has been observed that the AFS system can be implemented in current low-cost vehicle models with minimal modifications.

AFS holds the potential to enhance night driving behavior and reduce the risk of accidents by providing more favorable lighting conditions compared to standard headlights. It offers an automated solution that improves visibility and adapts to the surrounding road conditions.

V. CONCLUSION

The model can detect the fog and slope using inputs from the fog sensor and gravity sensor, it then does arithmetic calculations to give output signal to servo motor for adapting headlight. On increasing the fog and humidity in the atmosphere, the fog gives input to the headlight system, thereby increasing the brightness of the lamp for high range visibility. The gravity sensor on other hand detects the slope there by changing the slope of the headlight based on the same slope of the vehicle. This will help driver to easily drive under foggy climate. This system helps in reducing the fatality and accidents during the journey usually on the highways. On the other hand, the force analysis on the model shows required dimensions needed to be required for the model of automobile, thus the model can be used safely for the road journey. This mechanism can easily bear the stress generated during the working of automobile and sustain fluctuations occur during raw road drive.

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