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Smart Headlight System

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ABSTRACT

Artificial Intelligence has revolutionized the world making the lives of people simple and better than anytime before. Gadgets that we use in day-to-day life have become smart. One such field that has seen a tremendous change-over due to the introduction of artificial intelligence in the automotive field. Autonomous cars will form a major part of mobility in the future. The automotive headlights are a support system for the cameras mounted in the autonomous car, making the captured frames visually better so that the car can steer through properly. Though it is helpful for the autonomous steering system it has some demerits like glaring which is a major cause for accidents during night times. This journal will discuss a smart way of avoiding the glaring effect in the headlights making the roads safer.

Keywords— *Smart headlights, Electrochromic glass, Anti-glare system, Lane detection*

1. INTRODUCTION

Artificial Intelligence is a broad area that aims in minimizing the human intervention in decision making thereby making the work simple for humans. Narrowing down the application of AI in the field of automobiles, this paper will discuss making the headlamps smart by using a biomimetic [1]. A survey says that most of the people in urban areas suffer from eye problems because people use high beams during driving in the night time this has also caused many fatal accidents when the road becomes unclear due to the glaring effect of high beams. This problem can be solved by taking influence from the human eyes. When the eye is exposed to the light of very high intensity the iris, which is an annular structure responsible for controlling the diameter of the pupil, expands itself thereby reducing the diameter of the pupil so that only a few light rays enter the pupil and the eye is unaffected. This principle can be incorporated in the headlights to reduce the number of light rays leaving the system.

2. BIOMIMETIC - IRIS

The term biomimetic refers to the process of taking influence from nature to solve engineering problems. The iris in the human eyes is responsible for the amount of light that can enter the eyes, it protects the eyes from severe damages caused due to exposure to high-intensity lights. This principle can be incorporated into headlights with the help of an electrochromic glass.

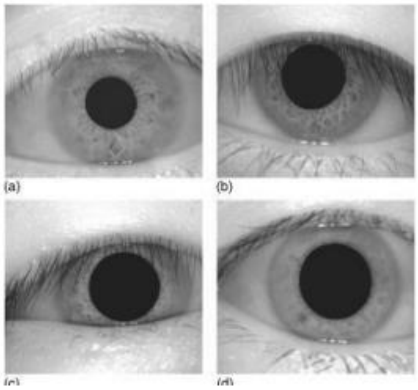

Fig. 1: Iris position with variation in intensity of light

3. ELECTROCHROMIC GLASS

As the name signifies, electrochromic glass can change from transparent to opaque or translucent with the application of voltage [2]. The principle of operation can be explained based on Fig. 2. When the voltage is applied to the electrochromic glass the ions orient themselves thereby allowing the light to pass through it. When the voltage is cut down due to the random orientation of the ions the light gets scattered and does not pass through the glass. The voltage applied will be in the order of 5 V for lithium ion-based systems.

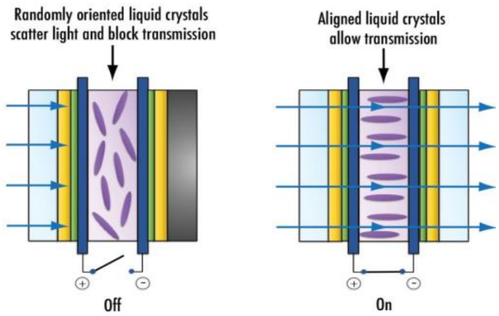

Fig. 2: Electrochromic glass – Working principle.

Combining the iris biomimetic with the electrochromic glass the existing design of the headlamps is altered as shown in Figure 3.

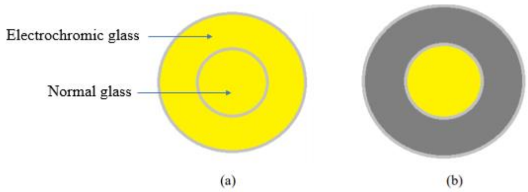

Fig. 3: Headlight design (Front view)
(a) Low beam mode (b) High beam mode

The new headlamp will have a combination of electrochromic glass and normal glass. When the vehicle is operating in normal low beam mode the complete lamp will be transparent thereby allowing all the light beams to pass through. The problem of glaring occurs only during high beam operation, when the driver switches to high beam the electrochromic glass also gets triggered and turns opaque thereby allowing only a few light beams to pass through. The light rays coming out from the headlight can be approximated to have a shape of a frustum of a cone, with this principle in action the radius of the frustum of the cone would decrease and thereby decrease the glaring effect for the vehicles in the opposite direction. But if we use the switching to high beam, as the trigger for the electrochromic glass it will not be effective as in certain applications in rural roads with no one on the road there may be a need for using high beam. In such cases a lane detection mechanism can be used to trigger the electrochromic glass.

4. LANE DETECTION

To avoid the operation of electrochromic glass in rural areas a lane detection algorithm can be used that detects lanes and triggers the electrochromic glass. It is written in python using the OpenCV library which is used for image detection and processing. The lane detection is as shown in Figure 4.

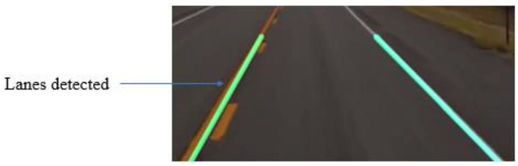

Fig. 4: Lane detection

This lane detection algorithm ensures that the electrochromic glass is operated only inroads with lanes. If the road does not have any lanes and if the driver switches to a high beam nothing would happen and all the light beams would leave the light lamps. The complete operation can be explained with the help of Figure 5.

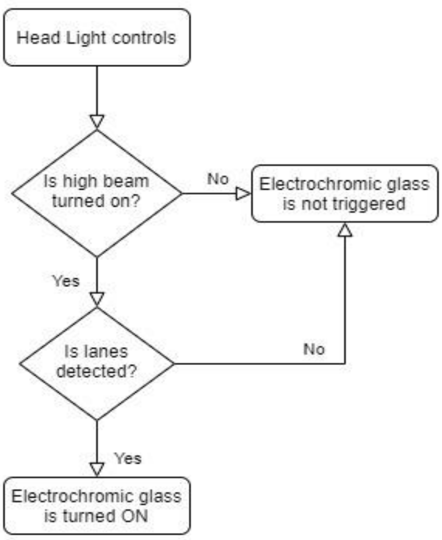

Fig. 5: Operating principle

When both high beam is turned on and the lanes are detected by the lane detecting algorithm the electrochromic glass is triggered else the headlight will be in its normal state of operation as shown in Figure 3(a).

5. SIMULATION

To validate the above-discussed phenomenon, the simulation was done using TracePro. The model used for simulation is as shown in Figure 6. The model is an elliptical reflector that is found in most of the headlight systems and the screen is placed to infer the light intensity [3].

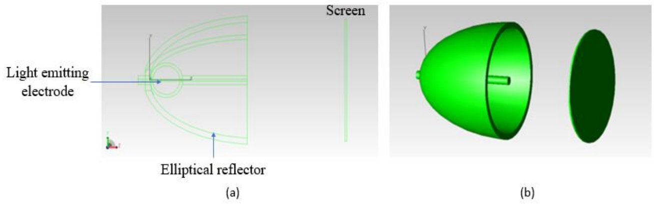

Fig. 6: Elliptical Reflector
(a) Silhouette view (b) Render

Initial trials were made for the normal operation and the results are as shown in Figure 7. The rays were sorted in such a way that rays' incident on the screen alone is displayed.

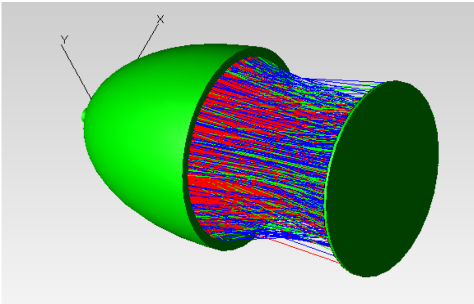

Fig. 7: Normal mode – Simulation

For the simulation of electrochromic glass, a baffle vane was introduced and it was simulated for 10,000 rays from the source.

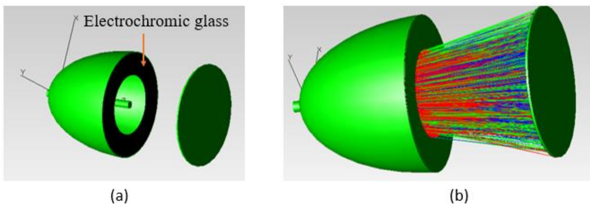

Fig. 8: Elliptical Reflector.
(a) Electrochromic glass (b)Simulation

To make a comparison between with and without electrochromic glass the total irradiance map can be compared.

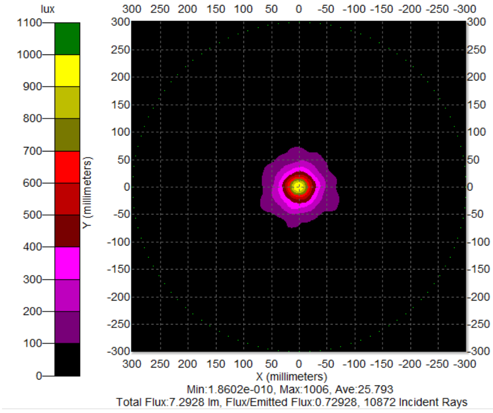

Fig. 9: Total Illuminance map without electrochromic glass

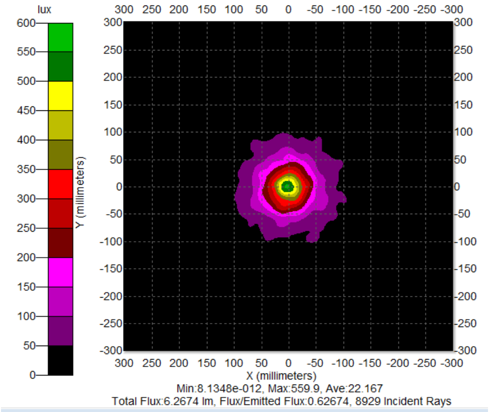

Fig. 10: Total Illuminance map with electrochromic glass

On comparing the Figure 9 and 10, the total flux received on the screen is lower in the case of design with electrochromic glass when compared to design without electrochromic glass. Since there is a drop-in intensity and the diameter of incidence on the screen, the design with electrochromic glass performs better than the present design.

6. CONCLUSION

This paper provides a comparison between the existing headlamp design and a headlamp with electrochromic glass to reduce the glaring effect. From the simulation bench it is clear that the design with electrochromic glass, there is a drop in the lux value and the diameter of incidence on the screen. This method of using electrochromic glass is thus an effective way of reducing the glaring effect.

7. REFERENCES

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