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Anti-Glare Headlight Safety System for Automobiles

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Abstract - *The commercial vehicles and passenger cars travelling at night times undergo fatal accidents due to the glare from the upcoming vehicles, which costs human lives and money. Thus, reducing such accidents is mandatory and thereby a solution to reduce glare at night times which can be universally applied becomes the need of the day. A system which reduces the light intensity specifically targeted towards the upcoming driver can be developed with the use of an Electrochromic film, which is a translucent material and helps in controlling the glare and ensures the adequate availability of light for visibility of the roads. By the use of a light sensor and a microcontroller the working can be automated and it can also be integrated with the Engine Control Unit. The following work provides a solution to the real-time problem existing and helps in reducing the fatal accidents at night.*

Key Words: Electrochromic film, Translucent, Micro-controller, Light sensor, Engine Control Unit

1. INTRODUCTION

Glare is a problem, because the eyes can only adjust to one level of brightness at a time. When the eyes adjust to darkness, the pupils contract to allow less light into the eyes. In this case, a brighter object anywhere in the field of vision will emit too much light for the eyes to take in such that one experiences the uncomfortable sensation of glare. Every day in India, Road accidents cost at least 400 lives. As per road accidents in India-2015 published by the Ministry of Road Transport and Highways, 39.2% of fatal road accidents have occurred in the dark between 6 pm and 6 am when traffic is relatively less. A study conducted by road safety NGO ArriveSafe on 3200 vehicles on 2500 km of single carriageway stretches of National and State highways in Punjab and Haryana has found that vehicle drivers do not care if their headlights are blinding those coming from the opposite direction and also stated that only 26.15% of drivers used dipper correctly while remaining either continued on high beam or dipped the light for a few seconds and then got back on the high beam. The ability of the eye to perceive and judge distance is severely impaired at night because it requires light to see. While the eyes are capable of seeing in limited light, the combination of headlights and road lights, along with the darkness, can cause several problems to the vision. In order to reduce the increased road accidents at night and providing drivers the ease of travelling at night, controlling the glare from headlights at night plays a vital role.

2. EXISTING SOLUTION

Generally speaking, glare can be reduced by changing the high beam to low beam whenever the high beam causes glare and lowers the visibility of the roads. But every time it is not possible for the drivers to dip the high beam in a heavy traffic or else in situations where the driver has to focus more on driving than on headlights. Thus, a system [1][2] that automatically shifts from high beam to low beam by the use of any light sensor can be implemented but ultimately it affects the life of the lamp and also causes the lowering of visibility of the roads at times which further leads to accidents.

Also there exists a system [3] which reduces the glare caused to the drivers by blocking the specific rays of light from the source using machine learning along with lane detection. It is being used in luxury and autonomous cars by the name spatio-temporal lighting system. The main drawback of this system is its high cost of implementation and it can be applied to the countries following proper lane driving which does not suit countries like India.

There also exists, the use of an Electrochromic glass called sage glass on the windshield as like polarized sun glasses. But it results in the poor visibility of road and it's not driver-friendly. Also, the use of an Electrochromic film [4] instead of sage glass is possible, but it results in the poor visibility of the roads.

3. SOLUTION

Thus, a system is required which ensures the glare reduction without hindering the visibility of the roads. In order to make the system universal to all automobiles, irrespective of the head lamp design, the solution resides in controlling the transmissivity of light rays that illuminates the opposite driver. Also, the system has to be operated at time only when glare occurs and mostly it occurs due to the upcoming vehicle rather than the preceding one. Thus, the system must be implemented in both the automobile that crosses each other. The system thus reduces the transmittance of light to the driver opposing, until both the drivers cross each other. The reduced transmittance of light rays projected towards the driver can be achieved by using a material that rapidly changes its state of transparency to translucency, then to opacity within a fraction of second. The material that serves this purpose is the Electrochromic film [4][5] which can be adhered over the headlamp. The Electrochromic film can change its state according to the voltage supplied. The translucent stage of the Electrochromic film can be able to transmit the light with 50-75% transmissivity which reduces the light intensity corresponding to the light rays projected to the opposite driver. Thus, the film reduces the glare and also ensuring the adequate availability of light rays for the visibility of roads.

The system is being automated with the help of a light sensor that senses the light intensity above the adequacy which is the main cause of the glare. The light sensor gives the signal to the microcontroller that provides signal to either switch on or off the Electrochromic film. The rapid change of state of transparency of the Electrochromic film helps the system more responsive. The light sensor in both the vehicles crossing, senses the high intensity light which causes the glare and switches the state of the film resulting in the reduced glare during the time of crossing each other, thereby helping the drivers to a greater extent.

Table -1: Technical Details of Electrochromic Film [4]

PROPERTY	CONDITION	SPECIFICATIONS
Input Voltage	On	110V, 220V
Output Voltage	On	70V
Power Consumption	On	<6W/m^2
Visible light Transmittance	On	>75%
	Off	>50%
Haze	On	<8%
	Off	>90%
Viewing angle of screen	On	>140°
Response time	On	<200ms
	Off	10ms
Service Life	On	>50,000 hours
Working temperature	On	-20°Cto 70°C

4. EXISTING PROOF

The ideology can also be compared with the modern-day LED bulbs which have been widely used for interior home designing. The modern LED bulbs have a milky white coloured glass cover which depicts the translucent state. The LED when lit, provides visibility and at the same time it doesn't cause glare. This also confirms the conceptual correctness of the ideology that translucent state can provide visibility and also reduces glare to the human eyes. The same can be applied to the modern-day lighting equipments which uses translucent glass covers.

The concept cannot be completely applied to the full headlight because it reduces the range of the visibility of the roads. If to increase the range, the power of the headlight needed to be improved which results in loss of power. Thus, the translucent state can be applied to the light rays which project towards the upcoming driver at times of glare.

5. EXPERIMENT

The main aim of the experiment is to check whether the translucency of the film that had been recommended (i.e., Electrochromic film) can be able to reduce the glare without reducing the visibility of the road to the driver. Considering the availability and cost of the Electrochromic film, numerous tests have been made with the help of a material which has the same translucency effect as that of an Electrochromic film to light rays. Before considering the parameters of the film influencing the glare, the first test relies in testing the conceptual correctness of the idea of whether the state of translucency can reduce the glare.

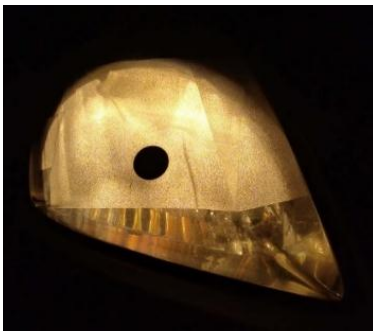

Fig -1: Equivalent translucent material adhered to the left side front headlamp

Fig -2: Difference in the glare caused between both headlamps by the use of translucent material

The material has been made to stick on the left side front headlamp glass covering from the curvature at the top to the centre focus area. The right front headlamp is kept normal and the headlamps are switched on. The experimental setup is illustrated figure 1.

From the figure 2, it is obvious that there exists a difference in the glare caused by the right and left headlamps. This confirms the feasibility of the idea that the change of state to translucency can reduce the glare.

The aim of the idea is to reduce glare by reducing the divergence of light rays exposed to the driver of the oncoming vehicle, without compromising on the visibility of roads. Thus, ensuring the visibility also plays a major role in checking the conceptual correctness. A driver is made to see the road outside with the material being adhered on the headlamp. From the figure 3, it is quite evident that the visibility of the road is not affected by the translucent film adhered on the headlight.

Fig -3: Visibility is not affected by the translucent film

Thus, from the experiment (Fig.2 and Fig.3), the conceptual correctness of using translucent film for glare reduction can be verified.

6. SIMULATION RESULTS

The ideology can also be verified through a simple analysis done using Tracepro - a light ray simulation software. A light source in the form of LED is applied at the centre point. A concave lens is used to diffract the rays coming from the source. Ahead of the concave lens, a rectangular cross-section made of small thickness resembling the film is placed.

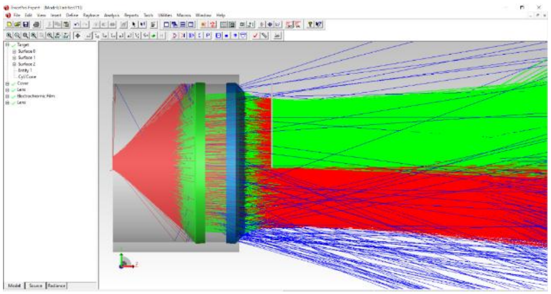

Fig -4: Effectiveness of using a translucent material (A change in the light flux before and after the translucent material)

The material is assigned with the property of transmissivity of light rays of about 0.5-0.7 indicating the translucency of the material (Figure 4). A target is made far away from the source and the light flux data has been interpreted. It has been observed that the light flux decreased at the region where the material has been used. Interestingly, not only the intensity of light in the region which has been exposed to the driver end is reduced but also the adequate light is ensured for visibility, thereby reducing glare to the opposite driver.

From the figure 5, it can be analysed that the light rays that has been directed towards the opposite vehicle driver has its intensity reduced and the region below, where those light rays which are directed towards the road and objects has their intensity unaltered, thus providing the visibility and also ensuring the reduction of glare to the opposite driver.

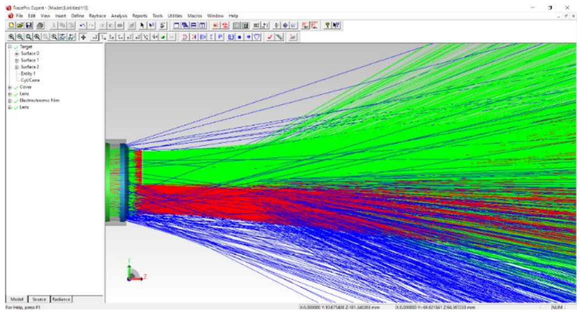

Fig -5: Final result

7. WORKING

The system consists of a light sensor (LDR), a microcontroller, a relay (switch) and an Electrochromic film to operate. The LDR is placed over the windshield at the sight corresponding to the driver's view and the Electrochromic film being adhered on both the headlights from the top of the headlight to the centre installed as layer by layer (say 4 layers). Each layer is connected through the relay to the battery. The entire automated safety system can be turned ON or OFF by the use of a lever placed near the dashboard.

The process sequence of the safety system is made as shown in the figure 6:

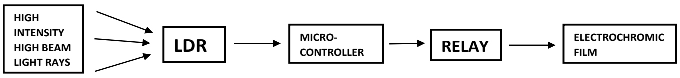

Fig -6: Operation process sequence

Headlights are most preferably used at night-time to increase the visibility of the roads and to avoid accidents. The use of headlight at day-time is not mandatory for the driver's view. To use energy efficiently, the entire operating system will be shut 'OFF' at daytime by using a specific lever available near the dashboard. Thus, the Electrochromic film will remain in the translucent state throughout the daytime. At hours of darkness, the lever is set to the position so that the entire system turns 'ON'. The voltage supply to the Electrochromic film is achieved with the help of automobile battery which discharges the required amount of power to the film making it transparent. When the headlight is operated in high beam, light from the headlamps spread throughout the road to increase the visibility just like the conventional vehicle headlights. This light has high illuminance to increase the range of visibility. Often, this light could be dangerous to the upcoming vehicle causing glare. This glare could cause the driver, discomfort and disability to view the foreground. When the upcoming vehicle approaches, it illuminates high intensity high beam light, which is sensed by the light sensor (LDR).

Now, depending upon the intensity of light received, resistance of the LDR gets reduced. [1] When the nearing vehicle is about 250-300 metres away, the high beam light from the upcoming vehicle can be recognized by the LDR. Whenever the distance between the vehicles is about 200 metres, the high beam light causes glaring sensation and thus the resistance detected by the LDR [1] will be about 100kΩ, the micro-controller then processes this signal and generates an output signal to the relay (switch). The relay then cuts-off the input voltage to the Electrochromic film layer by layer corresponding to the resistance value in LDR. On approaching, the intensity of light beam gets strengthened and the resistance also drops from 100kΩ to 30kΩ. The relay cuts-off the input voltage to all the layers of the film, when the resistance value of LDR [1] is 30kΩ, resulting in a complete translucent state of the film from the top of the glass to the centre. As a result, the Electrochromic film adhered on both the front headlight becomes translucent such that the amount of light flux emitted from the vehicle headlight decreases further providing a glare-free drive to the opposing vehicle without affecting the visibility. The anticipated design is a dependent system as it requires both the vehicles to be installed with this setup to ensure that both the drivers are glare-free.

8. LIMITATIONS

- The system consists of layers of Electrochromic film, which consists of separate bus bars that need to be integrated as a single system
- The entire system requires an additional power consumption of at most 6W per square metre
- The system cannot be applied to luxury cars employing modern headlight technologies

9. CONCLUSION

The solution proposed suits well for Indian vehicles and road conditions at night and helps in avoiding the accidents caused due to glare at night. The simplicity of the solution makes it reliable for all type of automobile users. The cost-effectiveness in a safety system significantly improves the use of it and provides the space to meet the aim for what it is developed. The futuristic development of this ideology can be used as a product development in the automotive sectors as a frugal safety system.

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