

Advanced Vision System for Drivers in Foggy Roads

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Abstract - The accident data of India reveals that many of the accidents occur due to poor visibility in foggy weather. Besides that, fog also slows down normal traffic speed, which has an adverse effect on economy in our country. To overcome these adverse situations, it has been tried to develop two vision systems using monochromatic semiconductor lights, which can be effective in foggy conditions. In the first system IR LEDs of 850nm and IR Camera with display are being used to increase the visibility. The second system comprises of Amber (600nm) monochromatic LED with normal camera and display. Any of these system being installed in vehicle, drivers will get clear image of the object present on the road at night in fog. The experiment proves that use of these system clearly show the image of the object or person present in dense fog at different distances, be it 15m or 20m or 50 m. Use of the second system will make the driver of opposite road side vehicles also aware of incoming vehicles from a sufficient distance, even 80 meters through dense fog because of the visible Amber light source installed in front of the coming vehicle.

Keywords - Fog light; Fog Vision; IR light; Amber Light.

INTRODUCTION

In winter season fog forms on regular basis in Indo-Gangetic plane, density of the fog is increasing day by day as air pollution is increasing and there is an enormous rise in road crashes due to low visibility due to dense fog. According to the Times of India report dated January 8, 2018, New Delhi, "Road accidents and fatalities due to fog and mist have increased significantly over the past three years. While 16 people were killed daily in such accidents in 2014, it increased to 21 in 2015 while in 2016, more than 25 people died in similar crashes every day, according to the latest report of road transport ministry". According to the report of the Government of India, Ministry of Road Transport & Highways Transport Research Wing in 2017, "26982 road crashes took place as a result of bad weather conditions, especially fog, killing 11,090 people". Due to fog there is a slowdown in traffic speed, as a result of this more time is taken compared to clear weather, which implies a slowdown in economic activities. From these it can be said that the total loss related to fog is comparable with that of other hazards like tornados, hurricane etc. So, efficient vision system for drivers of different type of vehicles

have been designed and developed in laboratory and tested to overcome these adverse situations occurring in fog. As per Beer-Lambert law, if the wavelength increases the scattering and dispersion phenomena [1] decreases. The white light becomes dispersed in fog droplet and divides in VIBGYOR color but the monochromatic light does not break in fog droplet and the dispersion never occurs [2-7]. So, on the basis of this theory we have proposed a system where a monochromatic light would pass through fog and the camera suitable for that wavelength would capture the image of the object in fog. Two light sources have been developed with two types of monochromatic LEDs. One with IR LEDs (peak at 850nm) and another with Amber LEDs (peak at 600nm). The peak of IR luminaire is 850nm which is beyond the range of human eye sensitivity, but there are some cameras available in the market which is sensitive to 850nm IR lights and the image output is black and white. The sensitivity of eye is maximum at 555 nm (Green) which is very close to Amber (600nm). There are some cameras available which is sensitive in the range between 400-700nm and have a peak response at 555nm.

A. Proposed System I & Experiments:

The first proposal is a combination of monochromatic Infrared LED (850nm) luminaire [8] with IR sensing camera (Sensitivity range from 800nm to 900nm and peak at 850nm). The experiment was done in the Illumination Engineering Laboratory, Department of Electrical Engineering, Jadavpur University. This experiment was a subjective measurement as the LUX meter was not capable of taking reading of the IR light as the sensing range of those instruments was limited to the visible range only.

Experiment 1: OBJECT DETECTION IN INDOOR WITH IR LIGHT

The system consists of an IR luminaire, an IR sensing camera [9], a battery (12V), a dc-dc driver (12V to 24V, 1 amp. Constant current) to drive the luminaire from the battery, a display connected with the camera with co axial cable. Firstly, the whole laboratory was made foggy by using artificial fog machine (model-Super Star, 1500watt). An IR luminaire of wavelength peak at 850nm, 24 watt was placed at a

height of 1 meter from ground and the camera was placed beside the luminaire. The image of the object was observed in the display. Fig 1. Shows the experimental setup which includes the IR LED light source, Camera and Display.

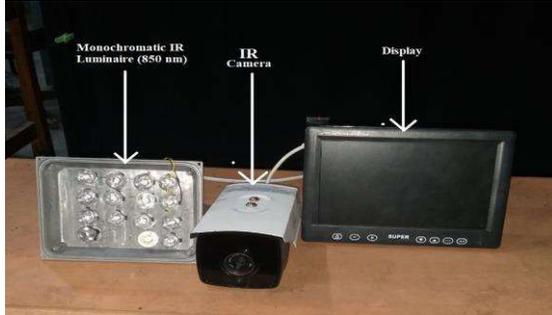


Fig.1 Experimental setup for experiment 1

Experimental result:



Fig 2(A) Image in the display with IR lights off.



Fig. 2(B) Image in the display of the system with IR lights on at a distance of 15 meter from the light source.

Fig 2(A) and 2(B) show the images in the screen captured by the IR camera without and with the IR light illuminating the object respectively. The distance of the object was 15 meters from the light source and camera. So, from this image it is clear that this system can capture a good image in the foggy weather with the IR light.

Experiment 2: OBJECT DETECTION IN OUTDOOR WITH IR LIGHT

The second experiment was conducted at Gangtok , Sikkim in open field. The instruments were fitted on

a table at the balcony of the 4th floor of the hotel room at Gangtok. The IR light was focused to downwards.

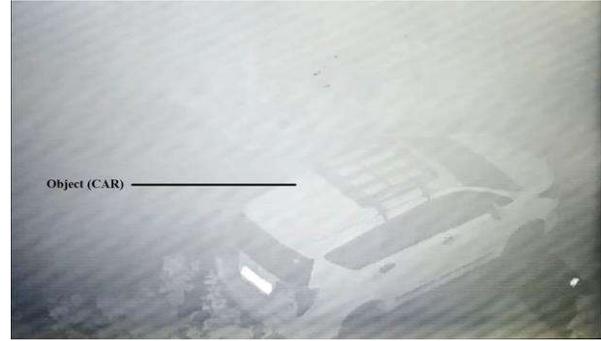


Fig.3 Image taken from the balcony of the 4th floor of the hotel room at a distance of 20 meter with IR System at Sikkim, Gangtok in dense fog.

Experimental result:

Fig.3 shows the image taken from the display of the system. The distance of the object (a car) was 20 meters from the camera and luminaire. So, it can be concluded that the system works well in the real fog.

B. Proposed System II & Experiments:

The second system was a monochromatic light source (Amber) with a normal camera whose sensitivity lies in the visible range. The spectrum of amber light is a single monochromatic spectrum with a peak at 600nm which had a less chance of dispersion in fog and a better frontal visibility was found than viewed in clear eyes. An experiment had been conducted to test this and experimental results are given below.

Experiment 3: OBJECT DETECTION IN INDOOR WITH AMBER LIGHT

The experiment was set up to check the illuminance level on an object from the Monochromatic light source in foggy weather.



Fig.4 Experimental setup for experiment 2

The image of the experimental setup has shown in Fig. 4 which contains a monochromatic Amber light (28 watt), a camera (sensitivity range 400nm to 700nm and peak at 555nm), a 12V DC battery, a 12volt to 32-volt DC-DC constant current (1A) driver

and a Display. The experiment was conducted in the KCR hall in the Department of Electrical Engineering, Jadavpur University. Firstly, artificial foggy condition was created in the hall by fog machine. The experiment was done in two densities of fog, medium dense fog and very dense fog. The luminaire i.e. the Amber light was kept in a fixed position, 1.5 meter from the ground. A mark had been created in each meter distance straight from the source from 1 meter to 20 meter and all other lights were put off. The Amber light was kept in a fixed position, 1.5 meter from the ground and measured the illuminance level by a LUX meter in each meter distance from the source from 1 to 20 meter.

Experimental Results:

After the experiment, different illuminance values were found on objects in three type of foggy conditions - a) No fog, b) Mid fog c) Dense fog were plotted. A graphical representation of the data compiled is given in Fig.5.

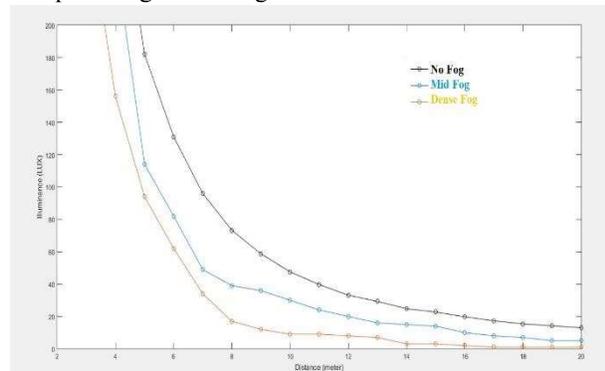


Fig.5 Illuminance values with distance in no fog, mid fog and dense fog condition.



Fig.6 objects can be seen in foggy condition with Amber light in the KCR hall, Dept. of EE, Jadavpur University

The available illuminance (measured in LUX) data with increasing distance from the source. It can be concluded that a minimum amount of illuminance which is sufficient to see an object can be found up to

20 meter distance. So we can see the object from a distance of 20 meter. The deterioration of the LUX level increased as the fog density increased due to more dispersion in the fog. Fig.6 shows the image taken from the display of the system 2 which shows a clear image of the object in the dense foggy condition illuminated by Amber light at a distance of 20m.

Experiment 4: OBJECT DETECTION IN OUTDOOR WITH AMBER LIGHT

Another experiment was conducted in Gangtok, Sikkim. The instruments were fitted on a table at the balcony of the 4th floor of the hotel room at Gangtok. The weather condition was dense foggy at that time.

Experimental Results:

Fig.7 shows the image taken by the camera and the display of the system. The distance of the object was 20 meters from the camera and luminaire. So, it can be concluded that the system works well in the dense fog.

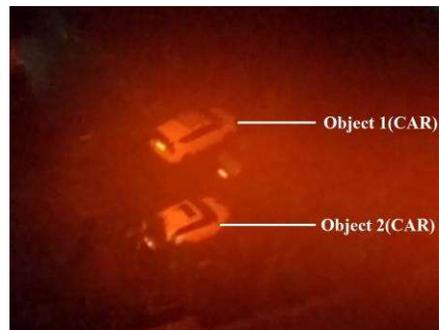


Fig.7 Image taken from the balcony of the 4th floor of the hotel room with Amber system at a distance of 20 meter at Sikkim, Ganktok in dense fog.

Experiment 5: LIGHT SOURCE DETECTION IN OUTDOOR IN FOG WITH AMBER

The experiment was conducted in the open field of Gangtok, Sikkim and it was a subjective experiment to check whether the light source could be seen from a certain distance or not in a dense foggy weather condition. In hilly areas dense fog is generally available in roadways or in open field. So we choose an open field in Hanuman Tak, Sikkim, Gangtok, to conduct the experiment. This experiment was conducted in daytime. No illuminance data was taken due to the fact that the Illuminance meter doesn't have any arrangements to differ between the daylight and the monochromatic amber light. The place was a parking lot with a dimension of 100 X 20 sq. meter area. The fog level was very dense as no object was visible from a distance of 80 meter from the observer. The Amber light source was fitted over the bonnet of

a car at a height of 1 meter from the ground level and checked the distance up to which the light could be seen and detected properly and was being checked every 5 meters apart.

Experimental Result:

Fig. 8 shows the yellow amber light could be seen clearly from a distance of 80 meters from the camera with which the image was being captured but the vehicle on which the light was mounted could not be seen.

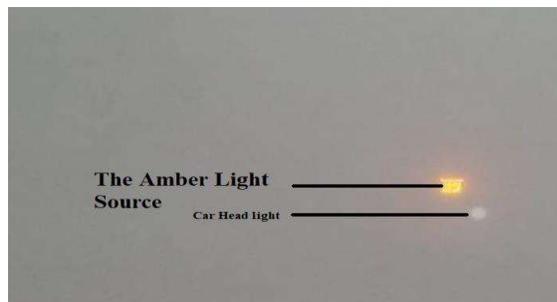


Fig.8 The visible amber light at a distance of 80 meters in dense fog at HANUMAN TAK, GANKTOK, SIKKIM taken by a mobile camera.

C. Conclusion:

In dense fog, when an object is invisible with naked eyes of human being, this system shows the image of the static or dynamic objects clearly through the camera and a display. In day time, IR system is not suitable because huge amount of Infrared Radiation present in sunlight, which saturates the camera in outdoor ambience and the captured image in display become blurry. In daytime the system II with Amber light makes it possible to see and recognize the object better than human eyes up to 20-meter distance. The light source can be detected at outdoor from a distance of 80 meter. Thus, the vehicles with Amber light in front, can be located from far by the other drivers, as well as the drivers having this system in his car get clear pictures of road in front of him up to approximately 20 meters from the display. The distance may be increased by increasing the wattage of the LED luminaire increasing its brightness. In the night time this Amber light system with its camera and display as well as IR system with the IR camera and display works very well. The resultant images can be much better if we use better quality camera and better-quality display like Super Amoled display. The whole system consumes very low power around 40 watt which is less than the power of single headlight (approx. 55watt) of a car. So, the total power consumption of the whole vehicle will also

decrease & thus road transport system will lead to a path of Sustainable Development. So, in future it may replace the headlight of the vehicle also. If this low power system is installed in vehicle, then road accidents will decrease as a result of it death rate will also decrease which will indirectly improve Human Development Index.

ACKNOWLEDGMENT

We would like to thank Mr. Rajib Malik, PhD fellow, Department of Electrical Engineering, Jadavpur University, Kolkata for his great help in conducting the experiments.

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