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Head up Display Techniques in Cars

S. M. Mahajan, Sudesh B. Khedkar, Sayali M. Kasav

Abstract— ***Head-up displays (HUD) are partially-transparent displays that render information in a manner that allows the viewer to comprehend it while looking into the forward scene. It is known as Head up display because while using it the operator's head position is UP means forward instead of looking down. The technology of HUD is mainly used in AVIATION industry, but now it has various applications in cars also. HUD can be fitted in place of windscreen which will give the view of road plus the required information. HUD is the outcome of GPS and compass based data about a vehicle position and the emergence of computer vision technology that can recognize objects on and around the road and the navigational information as transparent colored paths. Head up displays (HUDs) are available in aircraft industries from a long time and they are now finding way into automotive industry also. This review is an attempt to study various types of techniques in which head up display is used in cars. Because the application of HUD technology to automobiles is a relatively new idea, it is hoped that this review will serve not only an assessment of the current state of automotive HUDs but also an foundation upon which future work can be based. Many assessments of HUD location have been made but still there is not a optimal HUD location.***

Index Terms— **Head up display (HUD), Aviation, Cars, Windscreen, GPS.**

I. INTRODUCTION

The defining characteristic of an automotive HUD is that it can be monitored simultaneously with the roadway. Thus, traditional instruments could properly be called HUDs when they are mounted very high on instrument panels, or perhaps on hoods. However, the common understanding is that HUD refers to a display produced by special optics that superimposes a translucent image on the driver's view of the environment. An automotive HUD projects a virtual image on a windshield, which is usually specially treated, or on a combiner. This virtual image is often projected such that it appears near the center of the driver's visual field, approximately at the end of the automobile's hood. The image is usually fairly small, covering only a few degrees of the driver's visual field. Automotive HUDs are used to display a variety of information to drivers, typically speedometer and warning-light information. They could, however, be used to display any type of information that might facilitate better driving.

The actual components of an automotive HUD can vary a great deal, but all HUDs contain three essential elements: (I) an image source, (2) a system of lenses and mirrors that reflect, refract, focus, and magnify the HUD image, and (3) a combiner surface.

The image source is the component of a HUD that produces the initial pattern of light energy that will eventually be viewed by the driver. A variety of image sources have been proposed, and will be discussed in this review.

The reflective and refractive systems serve to transfer the HUD image from its source to the combiner. These systems vary based on the overall design of the HUD. Because the human-factors issues associated with reflective and refractive systems are seldom discussed by the designers of HUDs, they will not be discussed in this review. Combiners, the third basic component of a HUD system, serve as a final surface onto which the HUD image will be projected. The windshield of an automobile is typically used as the combiner, and it is often treated in some manner in order to allow for high image contrast and clarity for the, area in which the HUD image is projected. As the optical element that will be viewed directly by the driver, combiners are selected so that they serve the function of setting the distance of the HUD virtual image. The distance is often set so that the driver will see the HUD image at or near the end of the hood of the automobile.

II. LOW VISIBILITY CONDITION OF DRIVING

Low visibility is one of the major reason leading to accidents in recent days. The problem of low visibility occurs mostly in winter and rainy season [1].It can also happen in areas or countries affected by heavy ice fall. In fig1 the visibility of the road is very low; to overcome this problem HUDs can be used. In fig 1 we can see that with the help of the HUDs we get the required information on the screen itself. The information provided by the HUD seems to be sufficient for driving the car in low visibility areas also.

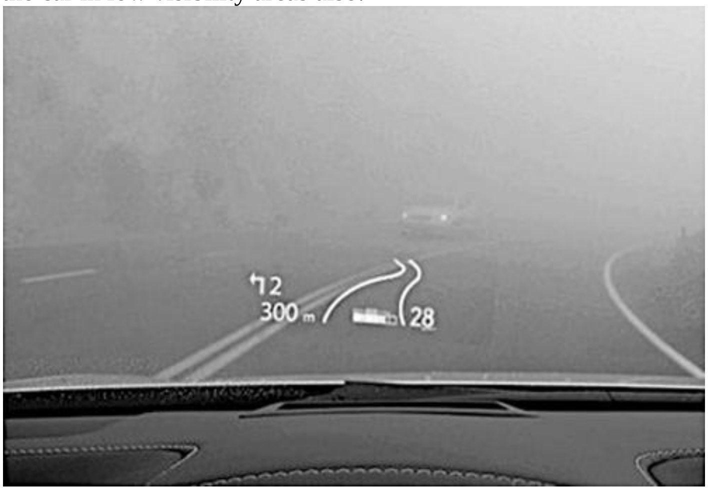

Fig. 1 HUD in low visibility environment

III. DRIVING AT NIGHT

Driving at night is difficult task for every driver because of limited information about the road, directions and conditions [2]. Fig 2 shows an example of night driving condition without HUDs and shows the benefit of the HUDs. In fig 3 the HUD shows us the information about the turns, directions, distance to travel, curves etc.

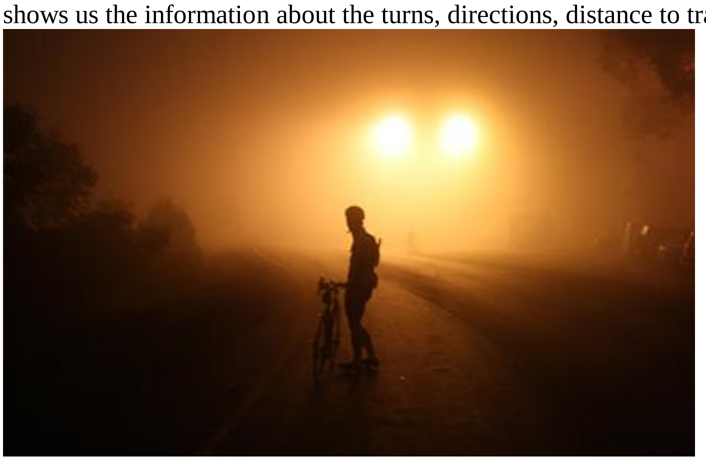

Fig. 2 driving at night without HUD

Fig. 3 driving at night with the help of HUDs

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IV. DISTANCE TO NEXT TURN

Many times in actual driving conditions we get confused about where exactly to turn the car for reaching destination we want. As shown in fig 4 the HUD indicates the actual distance after which car is to be turned [3].The map moves to show your progress along the route. If you move, rotate, tilt, or zoom the map, you can see your progress. When you approach an intersection or exit with multiple lanes, Navigation can help. Quickly see the estimated time remaining of your route on the bottom of your screen.

Fig. 4 HUD indicating distance to the next turn

V. NAVIGATION

Fig. 5 shows the turn by turn navigation features of modern HUDs are so good they've almost entirely replaced standalone GPS units. But in actual use, many drivers take their eyes off the road to check the map, which can be extremely unsafe. Even if you have a car mount to keep your phone in your field of vision, using it for navigation can still result in diverting your attention from the road, however briefly[4]. The built-in navigation systems in many cars have the same problem. The distance and direction of the next turn, your current speed and the road's speed limit. It also shows whether you're near any of the speed cameras in the company's database and your estimated time of arrival.

Fig. 5 Navigation

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VI. SPEEDO METER

This GPS Speed Heads Up Display projects your vehicles speed up onto the windscreen, in your line of sign in bright, large, white numbers as shown in fig 6.These easy to read numbers allow you see at a glance what speed you're travelling, without the need to look down at your dashboard. Project GPS speed onto the windscreen in driver's line of sight, so you don't have to take your eyes off the road to check your speed. Avoid speeding fines with audible over speed alerts. The simple plug and play setup makes it quick and easy to begin using the device. Simply plug it into the cigarette lighter in your vehicle and as soon as the device has picked up satellite reception, you're good to go. Great for cars, vans, trucks or vintage/custom vehicles that don't have a speedometer. Can also be calibrated to match your cars speedometer [5].

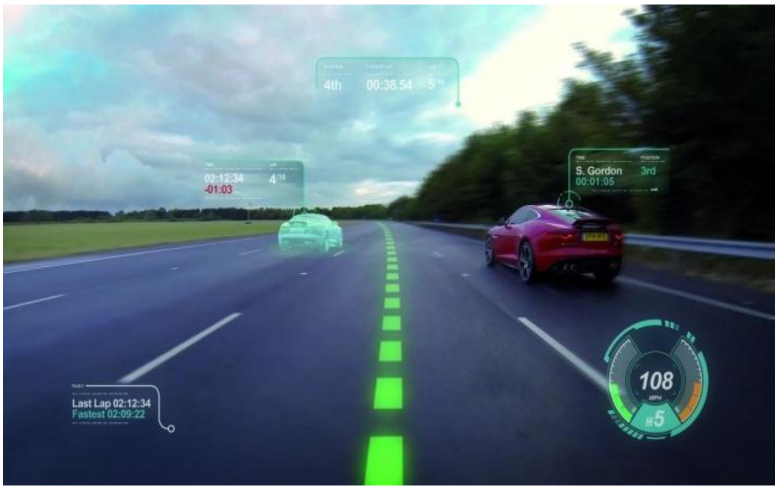

Fig. 6 SPEEDOMETER on HUD

VII. GHOST CAR NAVIGATION

Most modern navigation systems instruct drivers using a series of arrows or at best a pictographic representation of a highway exit. However, Jaguar's new experimental system abandons the arrows and instead projects an image of a "Ghost Car" for the driver to follow. Officially known as "Follow-Me Ghost Car Navigation," the system uses the heads-up-display technology to project an illuminated "ghost car" that looks to be driving right in front of the actual vehicle as shown in fig 7,"Driving on city streets can be a stressful experience, but imagine being able to drive across town without having look at road signs, or be distracted trying to locate a parking space as you drive by," said Jaguar Land Rover's director of research and technology, Dr. Wolfgang Epple , in a statement. This technology is used in jaguar & land rover till now.

Fig. 7 Ghost car navigation

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VIII. FUTURE SCOPE

Jaguar Virtual Windscreen concept looks to the future of HUDs Looking to add a touch of *Gran Turismo* or *Forza* to your daily commute? Jaguar Land Rover is developing a Virtual Windscreen concept that aims to do just that with a slew of driver assistance technologies designed to keep your eyes on the road, including a head-up display (HUD) that overlays the driving line featured in many virtual racers. As well as projecting key information onto the windscreen like speed and navigation, the Jaguar Virtual Windscreen concept would also overlay the driving line and even a "ghost" car, which acts as a reference point from previous laps. Although this may seem like a bit of fun for track-day warriors, HUD systems offer some obvious safety benefits for having key information at the driver's eye-level.

Jaguar's concept also extends to replacing rear view and external mirrors with cameras and virtual displays. This system would incorporate a of a "3D instrument cluster" linked to head-tracking technology that could deliver key information unobtrusively as well as giving drivers a clear picture of their surroundings. Finally, the system would include gesture-based control for functions like sun blinds, rear windscreen wipers and maps. Rather than having to search for buttons on the dash, the idea is that drivers could simply wave at the gesture-sensor with a range of 15 cm (5.9 in) to operate particular functions. Of the three tech concepts in development, this is the one most likely to appear in production models in the near term, with Jaguar claiming it could be on sale "within the next few years." Below is Jaguar's video detailing how the Virtual Windscreen concept would work. Source: Jaguar Land Rover is testing a new 360-degree virtual urban windshield which gives drivers a full view of the environment around the car and eliminates blind spots that often lead to accidents. Video screens embedded in the A pillars make them virtually invisible and augmented reality software identifies and selects pedestrians, cars and important signs the driver should be aware of on the windshield. The new technology is a broader take on the head-up display that many automakers already use.

HUDs typically project speed, rpm and other useful information on the windshield. With the Jaguar Land Rover system, pedestrians, cyclists and other vehicles would all be visible from inside the vehicle, with small video cameras watching blind spots.

Jaguar Land Rover says the technology could also be used to project a virtual ghost car in front of a driver. Unlike the Ghost Dash, however, it’s not for improving a driver's track times -- it's meant to be followed like a navigation assistant. The system could also enhance navigation by advising the driver to turn at easy-to-see landmarks, as opposed to unfamiliar streets.

“Our ultimate aim is to reduce the potential for accidents and enhance the urban driving experience,” said Wolfgang Epple, director of research and technology. “If we can keep the driver’s eyes on the road ahead and present information in a non-distracting way, we can help drivers make better decisions in the most demanding and congested driving environments.” Jaguar Land Rover says that eventually the technology would be connected with an Internet-based data cloud, which could add things like fuel prices, upcoming road and weather problems, open business and number of spots available in a parking lot. Though some of the technology appears far in the future, the capability for augmented reality, cloud connectivity and adding screens to roof pillars is already here -- it’s just a matter of getting the new technology down to the right price point so it can be installed on every car and truck that comes down the line.

IX. CONCLUSION

This review has covered a variety of ways in which a Head up display can be used. The application of HUD in automobiles is very easy but costly. The current state of automotive HUDs suggest that we have fully characterized the benefits that might be achieved by displaying information with HUDs. The most important benefit that HUDs have demonstrated is that they keep drivers attention directed towards the road. Because of HUD the driver is able to give quicker reactions and fewer errors in detecting obstacles.

This benefit could be applied towards improving driver safety, and HUDs could be used to display information that would normally require long glance time away from the road. HUDs can be used to display more complex sources of information that drivers normally access while driving such as navigation information, cellular phone status or RPM of engine. By displaying these sources of information at a head up location, some of the long glance time away from the roadway that drivers would normally make could be eliminated. Future work should address how to display more complex information with HUDs and whether doing so will result in safety benefits to drivers The work will require an assessment of the effects of HUD complexity on environmental monitoring performance, because locating complex HUDs close to roadway objects might cause drivers to be distracted from monitoring those roadway objects.

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AUTHOR BIOGRAPHY

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S. B. Khedkar, B.E Mechanical SITRC, SANDIP FOUNDATION, Department of Mechanical Engineering, Member of Mechanical engineering students association.

S. M. Kasav, B.E Mechanical SITRC, SANDIP FOUNDATION, Department of Mechanical Engineering, Member of Mechanical engineering students association.