IJTRET

International Journal of Trendy Research in Engineering and Technology
Volume 4 Issue 3 June 2020
ISSN NO 2582-0958

DRIVER ASSISTANCE FOR HEARING IMPAIRED PEOPLE USING AUGMENTED REALITY

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ABSTRACT

Taking into consideration the drivers' state might be a serious challenge for designing new advanced driver assistance systems. During this paper we present a driver assistance system strongly coupled to the user. Driver Assistance by Augmented Reality for Intelligent Automotive is an augmented reality interface informed by a several sensors. Communicating the presence of pedestrians or bicyclists to vehicle drivers may end up in safer interactions with these vulnerable road users. Advanced knowledge about the presence of these users on the roadway is particularly important when their presence isn't expected or when these users are out of range of the advanced safety systems that are becoming a daily feature in vehicles today. For example, having advanced knowledge of a pedestrian walking along a rural roadway is important to increasing driver awareness through in-vehicle warning messages that provide an augmented version of the roadway ahead. Voice recognition system through an android platform adds some good flavour during this project. The strategy of voice recognition through this platform is achieved by converting the input voice signal into text of string and subsequently it's transmitted to embedded system which contains an arduino atmega328 microcontroller through Bluetooth as a technique of serial communication between an android application and a control system. The received text string on an arduino is also displayed on the AR Glass. As connected vehicles start to enter the market, it's conceivable that when the vehicle sensors detect a pedestrian on a rural roadway, the pedestrian presence is also communicated to vehicles upstream of the pedestrian location that haven't reached the destination. This paper presents a survey of studies related to perception and cognitive attention of drivers when this information is presented on Augmented Reality.

Keywords— Augmented Reality (AR), Advanced Driver Assistance Systems, Road Safety

I. INTRODUCTION

Driver Assistance Systems within the automotive industry are developing for several years, with a final goal to boost the security of the driving force and also the passengers, but also to enhance the performance, efficiency and luxury through ICT. The activity of operating a car is very complex. Partially, that's and therefore the the time limitations needed for the human to note, percept, process information before making to enhance, and act appropriately. This activity is occurring in an environment of traffic crammed with unpredictable situations. In such an environment, displaying appropriate information, like step-by-step navigation instructions, information about the road conditions, accidents or work on road, distance to the vehicle ahead, danger from rockslides and similar information is highly useful as information in support of the choice making and preparation for appropriate action. problems with the ergonomic design aspect for these solutions are focused on determining the foremost appropriate ways for ensuring efficient and effective cooperation between human and also the system in context of that that the driving activity is of primary importance. The efficiency, or on the contrary, the negative effects of the aspect of road safety while using these systems is especially depended of the compatibility of their interfaces, the way of dialog, surrounding and functional ability of the drivers [1].

The European Commission in its document the European Statement of Principles on Human Machine Interface for In-Vehicle Information and Communication Systems presents the framework recommendations and principles that require to be fulfilled when developing these components, further because the basic safety aspects that require to be followed. The document lists the key European directives and international standards that provide the framework for the manufacturers and suppliers of such equipment to be able to plan their development and implementation [2]. Geham (2005) states that so as to extend safety of the driving force and passengers it's more important for the vehicles through the systems for active safety to avoid accidents compared to the minimizing effects of the accidents through the systems for passive safety. The systems for driver assistance aim to extend the security and/or comfort and to help the driving force to specialize in the driving activity.

Regarding the perception, it's been concluded almost immediately time that the driving performance are in tight correlation with the flexibility for seeing and visual strategy. Lot of authors comply with the actual fact that the perceptive visual channel is of paramount importance for the driving activity [3,4]. it's estimated that up to 90% of the needed information for seamless completion of this task are communicated through the visual channel. the present systems in vehicles are mainly presenting visual messages: in a very variety of text messages, pictograms and/or graphic maps on displays integrated within the dashboard. When the driving force must operate these systems, he should move his view from the road for several seconds. The probability for an accident increases with the duration of the time the driving force isn't watching on the road [3, 4, 5]. Studies determine that the key duration of sight of the road while driving is 2 seconds [6]. In wider perspective, any integrated display within the vehicle is assessed as visual cost which will be quantified in a very number of occurrences and duration so as to induce an information from the system.

Because there's a void or distance between the physical spaces (for example the road and also the vehicle interior) and also the virtual ICT spaces (for example the integrated display within the vehicle), the user should spend time and cognitive effort to regulate from one space to the opposite. This void is referred as cognitive distance between the physical and also the computer world [6]. Two separate components exist that consist the cognitive distance. the primary component is that the cognitive effort needed so as for the driving force to maneuver his/her attention from the physical to the pc environment and to locate the acceptable information therein space: moving the view from the road to the display. The second component is that the needed effort to return back from the pc environment to the physical world and to implement the gained information within the current activity like using the systems for GPS navigation, glance from the ICT map to the road and also the real environment and making a choice regarding the maneuvering and driving of the vehicle. The increased effort for completion of every of the components that make the cognitive distance lead to increased total results of the cognitive distance. Going into details, if the user should switch between spaces often the effect of the cognitive distance is even bigger. this is often significant for people with cognitive disabilities, those who complete activities that are in tight relation to the time duration, or activities that have big cognitive load. this is often especially important for older drivers that usually have weak cognitive system as results of their age.

In this regard, the priority of the human factor is the way to define criteria for efficient recommendations for support within the design of the systems for driver assistance in vehicles with displaying visual messages without the necessity to distract the eye of the driving force from the driving activity [8]. this could also take into consideration the most important road questions of safety knowing that the amount of systems implemented in vehicles is getting bigger annually [9, 10].

II. Related Work

In recent decades, humans have relied on the car because the primary mode of transportation. Driving has become ubiquitous and is sort of use to most adults. However, the truth is that driving may be a complex task that needs processing large amounts of roadway and environmental information under tight time and pressure constraints. These constraints force drivers to prioritize information and to only process alittle percentage of visual auditory information without delay. Most of the time, drivers are able to handle the complexities of the driving process without mishaps. However, when drivers fail to react appropriately to a situation, or fail to acknowledge a dangerous scenario, the results of such an occurrence can range from a straightforward near-miss to a roadway fatality. Scenarios that involve a pedestrian fatality caused by drivers are often among those where the failure to acknowledge a dangerous situation is exemplified.

A.Driver Behavior

Drivers are liable to making mistakes thanks to inherent human physical, perceptual, and cognitive limitations. In fact, driver error has been identified to be the most cause in 75 to 95% of roadway crashes [5, 6]. Human error has been the topic of research for a protracted time, resulting in several taxonomies that designate the speculation behind errors and supply a novel analysis perspective. However, three perspectives dominate: Norman’s [7] error categorization, Reason’s [8] slips, lapses, mistakes, and violations classification, and Rasmussen’s [9] skill, rule, and knowledge error classification [6]. These three perspectives categorize major driving errors into errors of recognition, errors of decision, and errors of performance. Perception and interpretation are often identified as recognition. Situations that may result in recognition errors include inattention, distraction, and looked-but-failed-to-see errors. Planning and intention are often identified as decision. Decision errors include misjudgment, false assumption, improper maneuver, excessive speed, inadequate signaling, and driving too near other vehicles. Action execution are often identified as performance. Performance errors include overcompensation, panic, freezing, and inadequate directional control .

B. Augmented Reality Technology

Augmented reality differs from virtual environments (VE), or video game because it is more commonly called. With VE technologies, users are completely immersed in an exceedingly synthetic environment and can't see the $64000 world around them. In contrast, AR allows the users to work out the $64000 world with additional virtual objects overlaid on the $64000 world. Hence, instead of completely replacing reality, AR supplements it; virtual and real objects appear to coexist within the same space. the foremost commonly accepted definition of AR states that it's any system that has the subsequent three characteristics:

1. It combines real and virtual;
2. it's interactive in real time; and,
3. it's registered in three dimensions

Augmented reality is an example of intelligence amplification during which a computer is employed as a tool to create a task easier for somebody's to perform by providing additional information about the environment. It can provide drivers with a range of knowledge in an exceedingly discrete manner and may be as simple as a further piece of knowledge or as complex as an entire environment makeover. Augmented reality relieves the burden on drivers by projecting what they see with informative details. It also improves the user's perception and interaction with the $64000 world. Information that the user cannot easily or directly detect together with his or her own senses are indicated or emphasized by the virtual objects. This information helps the user better perform the real-world tasks

With enhancements in special effects and also the increase in processing power of computers, AR technology has achieved a big jump. it's permeated several areas, like medical visualization and training, manufacturing and assembling, maintenance and construction, design and modeling, grooming and warfare, commercial applications, various kinds of entertainment, navigation, and data guidance. one in every of the foremost computationally intensive challenges that each one AR applications have in common is that the requirement to exactly align virtual images with objects within the world

C.Testing In-Vehicle Technologies

As the marketplace for in-vehicle technology continues to grow, there are several studies that involved in-vehicle technology. In-vehicle technology includes Bluetooth to voice command systems and data display systems. Although in-vehicle systems are useful in one or more ways, avoiding distraction and a spotlight deficits while driving may be a challenge in in-vehicle systems. Bach et al. [32] checked out 100 papers and classified them into two categories: evaluation of settings for in-vehicle systems and measure of driver attention relevant to invehicle systems. The classification showed that the majority studies were conducted in driving simulators and real traffic driving. Lateral and longitudinal control and eye behavior were the most-used measures for driver attention. The studies also showed that in-vehicle systems interaction can increase safety while driving if minimal or no interaction induced visual demands.

Using a driving simulator, Boyle and Mannering [30] evaluated driving behavior using in-vehicle and out-of-vehicle traffic advisory systems. Four different advisory-information conditions were analyzed: in-vehicle messages, out-of-vehicle messages, both kinds of messages, and no messages. Two weather scenarios were also considered, fog and no fog, also as two kinds of incidents, snowplows and no snowplows. Study results showed no significant difference in mean speed and variance speed over long segments. The study also found that when the knowledge message had either passed or become out of range, drivers would speed up to atone for the lost time incurred from being warned to abate.

III. PROPOSED APPROACH

Our objective is to integrate the visualization metaphor within the design process of driving assistance system. so as to propose a visualization metaphor adapted to the driving situation, it's necessary to grasp what's the present situation and what the driving force looks at. So we propose the coupling of an obstacle detection module with a system monitoring the driving force so as to develop a display module for an application of Augmented Reality (AR).

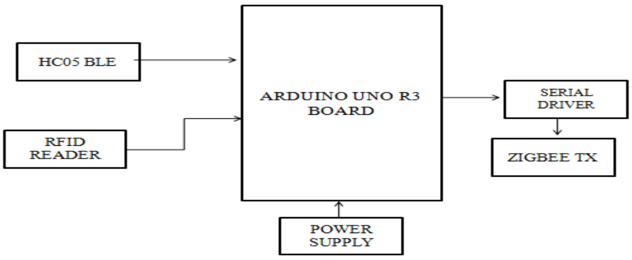


Fig 1:Block Diagram of Vehicle Unit

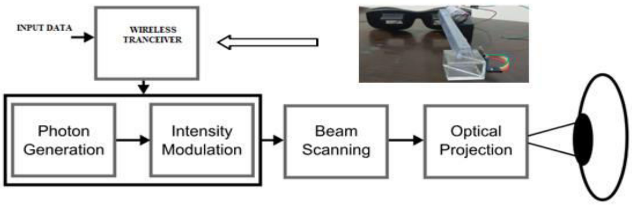


Fig 2:Block Diagram of Vehicle Unit

Having in mind the benefits of the systems and so as to check the consequences, differing types of HUD-AR displays are analyzed from the aspect of several of their functions for driver assistance.

A. Lane Departure

While testing the AR systems that present safe corridor for lane departure when driving so as to supply the motive force with the power to securely overtake a vehicle before of, the researchers have noticed a major improvement in two positive aspects: bigger number of the drivers used the braking pedal to lower the speed, which generally could be a positive indicator from the aspect of safety; all drivers operated the vehicle and braked in an exceedingly similar way, according the instructions of the required path. Nevertheless, the behavior of the drivers in adverse situations haven't been investigated, that's when the vehicle is within the dead spot or when overtaken by a faster vehicle. Furthermore, this study shows that in situations of lane departure, AAR systems have the tendency to form the drivers glance at the side rear view mirror later compared to the drivers not using such a system, because the visual attention of the motive force is firstly occupied by the AR display on the road (Figure 1.). After they interpret this AR information, the drivers checked the side mirror to organize for lane departure.

ISSN NO 2582-0958

Fig 3: Driver Assistance System for lane departure

Keeping the specified path of the vehicle while driving is especially difficult for unexperienced drivers and/or in atmospheric condition conditions when the visibility is lower. The concept of augmented reality enables outlining of the road edge with a virtual element assisting the driving force within the task of maneuvering the vehicle (Figure 2, Figure 3). By displaying a path for driving in augmented reality, the maintaining of the vehicle within the desired path of motion is achieved while lowering the deviations from the specified trajectory

B. Detection of critical events on the road

Drivers must use caution on the vehicles around them, the risks on the road, the specified path, pedestrians and traffic signs and every one of that while driving the vehicle, controlling its speed and direction. of these tasks increase the physical and therefore the mental workload, which is particularly dangerous for older drivers and drivers with lower reflexes. Hence, an alarm that might warn the driving force for an eminent danger on the road can assist in minimizing the workload of the driving force and reduce the quantity of accidents. the actual fact that a critical event is presented on the windshield can assist the driving force in detecting the damaging events (Figure 4, Figure 5). Compared to traditional systems for driver assistance, HUD-AR systems lower the time needed for detection of a happening up to 100ms.

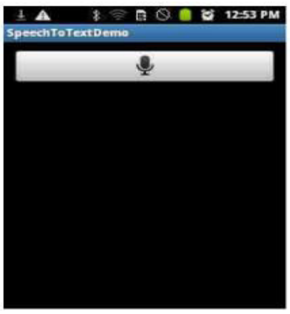
Fig. 4 Driver Assistance System for critical events detection

C. Night Vision

The systems for displaying information with AR can significantly improve the visualization in dark, emphasizing the situation of pedestrians and other obstacles on the road, enabling drivers to efficiently transfer information that's instantly understandable. Night vision systems are known from time ago and for the primary time were employed in the military industry. within the automotive industry, this sort of systems was introduced for the primary time in a very serial production model by Mercedes-Benz in 2011. this method shows a picture on display placed within the electrical device of the vehicle. meaning that the driving force must move the eyes from the road, to interpret the image on the display, to return the view on the road and to implement the knowledge gained from the system. The systems for visual sense using AR present the exact same information but now directly on the windshield and therewith significantly lowering the workload of the driving force and decreasing the time needed for processing of the knowledge and taking action.

D. Android Application

Voice Control is an android application which recognize the speech of human then convert it into text format and this text as a string are often further proceed and transmitted from smart phone through Bluetooth as a wireless channel to an arduino Uno circuit where Bluetooth module HC-05 is installed for serial communication. during this communication system data is transferred one bit at a time. An arduino will receive the serial data and check the received string with predefined string and if it's equal then the corresponding operations are performed through digital pins of an arduino. MIT app inventor 2 is employed to develop this android application, which allows easy creation via drag and drop block programming. This platform is very beneficial to people who don't seem to be expert in java, android additionally as python coding. When the system Bluetooth is connected with android application then it displays the status "Connected" on the screen, then clicking the microphone button exposes the speech recognizer. It allows a straightforward and reliable reference to the Google speech Processing Libraries for smooth and accurate speech recognition. First we've to put in this application in our smart phone and connect the Bluetooth of our smart phone with system (HC-05 module) and switch on the mobile data then press the microphone button of an android application and speak something which convert immediately into text within the screen.



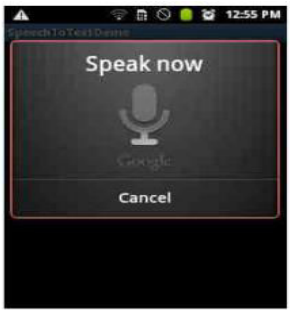


Fig 5: .Output for voice to text conversion

IV. RESULTS EVALUATION

Questionnaires were wont to gather subjective ratings as how they perceived the AR-HUD and the way they felt during the experiment. Out of 23 subjects in total, 15 persons had a preference for AR-HUD with tracking conditions (65.5%), 4 of them had a preference for the none-tracked system and also the last 4 didn’t have any preference. The ARHUD with tracking conditions had 15 as median grade with a typical deviation of 6.5 (average = ~13), and also the none-tracked system 10 median grade with a typical deviation of two.5 (average= ~11).

Let’s start by looking further into the 15 people who had a preference for the AR-HUD with Tracking Conditions. the primary question that rises, is whether or not they need seen the difference all the way or only in specific situations. The histogram below shows the share of persons that have seen/ haven't seen the difference between the 2 systems in numerous road situations.

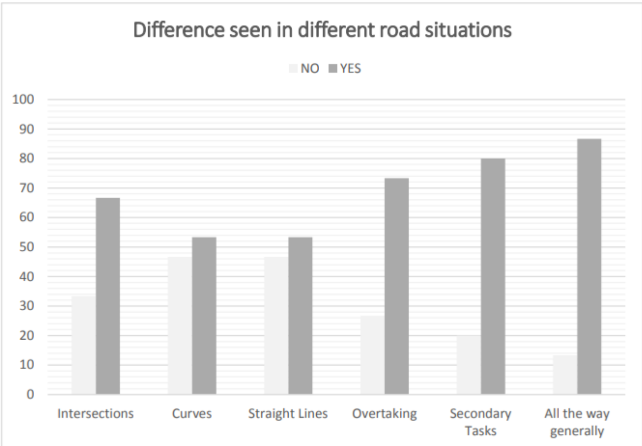


Fig 6:Different Road Situation

After that, we wanted to look further into the scale factor in the case where the difference was seen between the two systems. In the graph below, we can see the number of persons with respective ranks for each specific road situation. The grades go from 5 (weak difference) to 20 (strong difference).

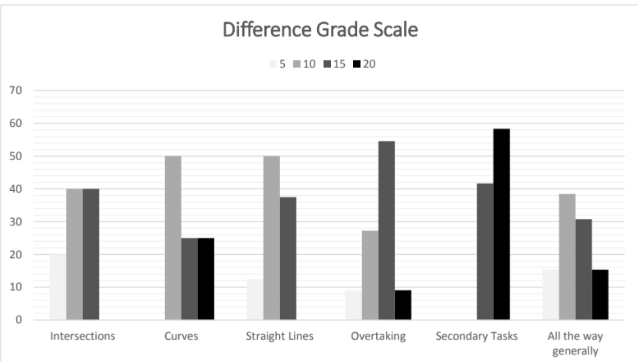


Fig 7:Different Grade Scale

For the 65.5% people that preferred the HUD with Tracking, our initial hypothesis was that the precision difference would be significant between the two systems and that imprecision ranks would be different in all of the following situations: intersections, curves, straight lines, overtaking manoeuvers, secondary tasks, and all the way in general . In order to measure this difference we used “Wilcoxon Statistical Test”, which is a non-parametric statistical test. In our case, we used the matched data for two tasks (driving session with tracking and driving session without tracking).
As mentioned above, a large majority preferred the AR-HUD with tracking conditions, and those participants evaluated the system to be more precise in all different road situations than the other system. It was surprising that some persons (8 of them) didn’t manage to see the difference between the two systems. On closer examination, it was found that the majority of these drivers left a significant gap with the front vehicle, so they either had no preference or preferred the second configuration system.

V. CONCLUSION

Besides the actual fact that the HUD systems are present since the 80s, they're still not a usual way of displaying visual information within the automotive industry. Studies have shown that HUD displays have bigger potential, but they need lower acceptance level from drivers. one in every of the possible reasons for that why HUD systems are still not well established is that the incontrovertible fact that to this point the main target was on their development as technology, and not on adjusting to the requirements of their use by drivers. we introduce the event of supported Android Bluetooth Chatting for Smart Home Application. this technique is employed to regulate the electrical devices by low cost Bluetooth wireless technology without human intervention. the look principals of the classic 2D displays aren't applicable any further fully for this manner of presentation, due to the various habits of movement of the visualized objects. Further research is required within the area of determining the mixture of design principals that provide best results for a particular driving activity especially for HUD and AR.

Based on that perspective, the review presented during this paper shows that HUD-AR visual displays have great potential from the aspect of driver assistance within the way of skyrocketing the perception and decreasing the work load, but with caution to the look principles and implementation of knowledge to the windshield. additionally, it's necessary to create additional studies in real conditions and not with the employment of driving simulator so as to induce better understanding of the acceptance level of the driving force for the HUD systems and to induce understanding of that where drivers wish to receive the data.

Further research should be conducted on the aspect of human factors so as to totally understand the ways of optimization of the massive technological advantages of the HUD-AR concept within the automotive industry with a final goal to extend the road safety. Understanding the challenges that these systems are bringing and their effect to the road safety within the everyday use in traffic should become a part of the capacities of the opposite stakeholders (police, departments for motorized vehicles, insurance experts, prosecutors and others) involved within the process of keeping the roads safe.

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