Augmented Reality vs. Street Views: A Driving Simulator Study Comparing Two Emerging Navigation Aids

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Introduction

In several countries, the primary mode of commuting is through driving. Acc. to Census Bureau, an average American spends around 100 hours in a year, commuting to work. Since the number of people spending time behind the wheels is increasing, the number of computational resources that can now operate inside a vehicle is also increasing. Companies have been introducing various such functionalities in the market. Few examples are hands free voice dialing, live traffic reports, automated directory assistance, infotainment systems, and personal navigation devices (PNDs). How these in-car services affect the driving performance is unknown. This paper focuses on the impact of PNDs on visual attention and driving performance.

Existing Solutions

Studies show that there are two PNDs that affect the visual attention and driving performance. One was the standard PND that displays a map and provides voice instruction. And the other PND only provided voice instruction. It was found out that drivers paid more attention on the road with the latter type of PND. But, drivers prefer standard PND. So, the question aroused, on how to create a PND that would allow driver to maintain the visual attention on the road for good driving but also generate high user satisfaction.

Suggested Solution

The authors believed that this could be accomplished with augmented reality (AR) PND. AR PNDs integrate a virtual navigation route in the real world by displaying it directly on the windshield with a head up display (HUD). An in-car display where you don't have to glance through is required. The benefit of HUD is that it takes shorter time to react to sudden events as compared to head-down displays (HDD). The authors expect to have HUD technology in the market soon, but for now all we have are HDD technologies. One such HDD technology is street view PND.

SV PNDs use sequence of images of the streets and their surroundings, augmented with a virtual navigation route, to help users navigate themselves with respect to their location. This kind of PND is helpful for pedestrians or passenger-side navigators. It is inappropriate for the drivers, as they need to focus on the road. The paper explores the impact of AR and SV PNDs on visual attention, driving performance and user satisfaction. The baseline is the standard PND. The exploration is done on the city roads, especially the ones the driver is not familiar to, that is when timely decisions are made, while heeding both traffic and pedestrians in the challenging streets of the city. The authors propose three hypotheses.

1. With standard PNDs as a baseline, AR PNDs allow driver to spend more time looking at the road ahead that SV PNDs.
2. The differences in visual attention between the PNDs are associated with differences in driving performance, with AR PNDs allowing for the best driving performance.
3. When comparing different characteristics of AR and SV PNDs, users will express a preference for AR PNDs.

Evaluation

This paper discusses the importance and need for a better personal navigation device. The

importance of a new one has been highlighted throughout the introduction. As increasing number of people are becoming completely dependent on PNDs, this becomes very dangerous when a person is driving a vehicle by himself and is distracted by their PND.

They have pointed out that measuring a user's driving performance over a long duration as averages over a long duration doesn't paint the correct picture as it doesn't take into account the short glances where the user is glances onto the PND. These variances can be calculated by changes in the lane position or movements in the steering wheel. The author has mainly focused on these aspects while comparing the HUD and HDD displays.
They ran an experiment on two commonly used PNDs i.e. Street View PND (SV PND) and Standard PND (SPND) and compared with Augmented Reality PND (AR PND). There were a total of 18 university students aged between 18 to 37 years of age. The participants were given an overview of the simulator and description of the three driving PNDs. They ran the driving simulator with each PND individually and before each trial they were provided a 5 mins training on how to use that PND. The order of the PNDs were changed arbitrarily for different participants. Each user was given a different route for each type of PND. At the end of each PND test the participants were given a NASA-TLX sheet to rate the PND. Apart from the NASA-TLX sheet the participants were rated on another five metrics by the researchers. The metrics were:

1. Percent dwell time (PDT) on the road ahead: measures percent of time driver spends on looking ahead
2. Cross-correlation peaks: to detect the short periods of deterioration in driving performance following glances.
3. Average driving performance measures: which included the absolute values of first difference and variances of lane position, steering wheel angle and velocity.
4. Number of collisions
5. Level of agreement with preferential statements

They were able to measure the above metrics using an eye tracker, lane position, steering wheel angle, vehicle speed and number of collisions. As per the metrics it was observed that the PDT had drastically improved in the Augmented Reality PDT. The results were as per the hypothesis the driving performance was more improved in PDTs where the participant does not have to glance too many times away from the road. In segments of the road where there were unexpected occurrences, the augmented PDT had the least number of collisions. As hypothesized by the researchers these differences really do not affect the average driving performance and the choice of PND comes into play during these small moments.

The NASA-TLX filled up by the participants provides a subjective view on the different PNDs used by them during the course of the experiment. The AR PND received the best rating while the other two got a detrimental score. Most of the participants felt that the AR PND was the least intrusive.

Limitations

AR PNDs are expensive compared to standard PND's with HDD.
If we are using our mobile as PND it is easy to use in any car, where as AR PND needs the full setup before using it any car.

Conclusion

Given the limitation, it has been accepted as the future technology with many company such as Garmin, Navdy providing similar solution.