Effect of automotive head-up display (HUD) imagery location on driver preference associated with use of scrolling list while driving

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1. Objective
The objective of this study was to empirically investigate the effect of head-up display (HUD) imagery location on driver preference during item search and selection while driving. A simulated HUD system was employed to display a single-line scrolling list at different locations outside the vehicle; and, the study participants performed an item search and selection task while driving.

2. Background
An automotive HUD system must be designed to help the driver focus on the road ahead and at the same time quickly process the information it presents. The location of the HUD imagery is one of many design variables that would significantly affect driving as well as HUD information processing performance. The recent technological advances enable presenting HUD imagery at various locations outside the vehicle; and, such capability greatly expands the range of design possibilities.

Multiple studies have examined the effects of HUD imagery location on driving performance and driver preference (Tretten et al., 2011; Chao et al., 2009; Morita et al., 2007; Yoo et al., 1999; Flannagan et al., 1994). The existing studies mostly considered displaying a simple, non-interactive visual object (e.g., a warning symbol); and, few seem to have examined more complex visual objects that the driver can manipulate interactively - for example, a scrolling list. Consequently, how HUD imagery location affects driver preference and performance is not well understood for such interactive visual objects. This lack of understanding hampers optimizing the design of HUD imagery and fully capitalizing on the advantages of HUD. As an effort towards addressing this problem, the current study investigated the effect of HUD imagery location on driver preference associated with performing item search and selection with a single-line scrolling list while driving.

3. Method
In this pilot study, one female and four male subjects participated. Their average age and years of driving experience were 26 and 6 years, respectively.

A simulated HUD system implemented in a driving simulator was employed to display a single-line scrolling list at different locations through the windshield during simulated driving. A total of nine HUD imagery locations shown in Figure 1 were considered.

In each experiment trial, the primary task was to follow a lead vehicle. The lead vehicle occasionally changed its speed and lanes, and the participants were instructed not to collide with the lead vehicle. The secondary task was to search the scrolling list and select a target item. An auditory cue signalled the onset of scrolling list manipulation. The name of the target item was auditorily provided to the participants immediately after the auditory cue.

Each participant performed a single experiment trial for each of the nine HUD imagery locations. In each trial, the scrolling list appeared at the HUD imagery location four times. The total driving distance was about 2km. After each experiment trial, the participants were asked to fill in the NASA-TLX questionnaire and subjectively rate perceived preference level on a seven point scale. In addition, the primary and secondary performance data were collected during each experiment trial. The order of the nine experiment trials was randomized for each subject. For each subject, training sessions for practicing the primary and secondary tasks were provided prior to the experiment trials.

The study hypothesis was that HUD imagery location significantly affects driver preference as well as workload.
4. Results

An examination of the preference ratings data revealed that the mean preference ratings varied greatly across the nine HUD imagery positions, and, the participants preferred the bottom- and middle-left positions the most (Figure 2). Overall, the participants preferred the HUD imagery to be located on the left side of the full-windshield and not at the top positions.

5. Conclusion and future directions

This study investigated the effect of the HUD imagery location on driver preference associated with a scrolling list manipulation task while driving. The study results indicated that HUD imagery location greatly affects driver preference rating and the participants preferred the area enclosing the bottom- and middle-left parts of the windshield. We are currently analysing the primary and secondary task performance data. The effects of driving condition and driver age will be examined in our future research studies.

References

Chao, C. W., Huang, C. H., & Doong, J. L. 2009. “See-through head-up display of in-vehicle information systems for vision enhancement.” In The International Association of Societies of Design Research Conference.