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Touch Screen vs. Rotary Controller: How Usable are the Two Major In-Vehicle Information System Technologies?

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1. INTRODUCTION

In-Vehicle Information Systems (IVISs) are menu-based systems that integrate secondary functions into a single screen-based interface [1]. Today, there are two major IVIS technologies used in vehicles: touch screen and rotary controller. These currently represent the best solutions to the challenge of integrating a large number of functions into one system; however, both IVISs have usability issues. In order to develop the next generation of usable IVISs, designers need to evaluate and understand these usability issues. Although previous studies have attempted to measure the effects of IVISs on driving, none have directly compared the two main technologies with a range of natural secondary functions. This study aims to evaluate the usability of these systems, in order to inform the design of more usable IVISs, to enhance driving.

2. METHOD

Driving performance was measured for a sample of 20 participants interacting with the two IVISs whilst driving in the University of Southampton's driving simulator. The study used a repeated measures design and participants also took part in a control condition of driving with no IVIS. Participants were instructed to perform secondary tasks, relating to infotainment, comfort, navigation and communication, via each IVIS.

3. RESULTS

3.1 Primary driving performance

A reduction in vehicle speed was expected as a result of increased secondary task demand. Drivers recorded the highest mean speed in the control condition and the lowest with the rotary controller. Lateral control was measured as the number of centreline crossings made by the driver. The experimental conditions both produced more centreline crossings than the control condition, with the rotary controller performing worst of all. With less attention to the forward road scene, as a result of interaction with IVISs, drivers are less likely to detect significant events, such as pedestrians crossing the road. This increases the probability of collisions. In both experimental conditions, drivers were involved in more collisions than in the control condition. The highest mean number of collisions occurred with the rotary controller. These results indicate that the interaction with IVISs degrades primary driving performance, due to reduced attention to road ahead.

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3.2 Visual behavior

When interacting with an IVIS, drivers must time-share visual attention between the system and the road scene. In this study, eyes-on-road time was compared to the time spent looking at the IVIS LCD. In both IVIS conditions, drivers spent significantly less time looking at the road and more time looking at the LCD, compared with the control condition. This is evidence that visual attention is diverted away from primary driving when interacting with secondary tasks. Visual distraction was worse with the rotary controller.

3.3 Secondary task performance

Secondary task performance measures reflect the effectiveness and efficiency of IVIS interaction. The touch screen produced consistently shorter task times than the rotary controller for the tasks evaluated in this study. The touch screen also produced a lower error rate. This indicates that the touch screen enabled superior secondary task performance, compared with the rotary device. This is consistent with the primary driving performance results because the IVIS which is more difficult to successfully interact with is likely to produce worse driving performance.

4. DISCUSSION AND CONCLUSIONS

The results have shown that of the two major IVIS technologies currently used in vehicles, the rotary controller caused more visual distraction and produced lower levels of driving performance, compared with the touch screen. Both systems produced significantly reduced performance compared with driving with no IVIS interaction. The touch screen is a direct input device, which means that there is a direct relationship between what the eyes see and what the hands do. This may simplify the interaction between driver and system, possibly creating less impact on driving. The rotary controller is an example of an indirect device, involving translation between a user's inputs and system outputs. Users adapt more slowly to indirect devices, requiring practice in order to understand this translation. This could explain the differences observed between the two IVISs. Further evaluation of users' subjective perceptions of the IVIS interaction is needed to produce a comprehensive picture of the usability of these systems.

5. REFERENCES

[1] Harvey, C., Stanton, N. A., Pickering, C. A., McDonald, M. and Zheng, P. 2010. Context of use as a factor in determining the usability of in-vehicle devices. *Theor. Issues Ergonomics Sci*. In press.