An Experimental Study of In-vehicle Displays

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Application of In-vehicle display systems

In-vehicle display systems, with the integration of computer and embedded information system technology, have been increasingly adopted in vehicles.

Advantages

+ navigation
+ entertainment functions
+ driving safety and convenience

Disadvantage

distraction-related safety issues resulting from drivers' interactions with such multi-function systems

Study Objectives

- Report on distraction associated with in-vehicle displays.
- compare different driving behaviors by setting different tasks and using different in-vehicle display systems.
- Compare 3 different in-vehicle displays.

Experimental Design

Hypothesis

➢Driver's attention on the primary task (driving) will be affected by secondary tasks (e.g., operating an in-vehicle display system)
➢Lack of consideration of the human factors in design can lead to impaired driving performance and increased risk of collision

Study Considerations

➢Test results while using a real car in real driving environments have high validity. However, results are not repeatable because of various uncertainties in the real driving environment.
➢Virtual environment simulation (Driving Simulator) allows good control of the driving environments and ensures test repeatability.

Virtual Environment Lab

What we do?

➢Build Virtual Environments - Using OpenGL we construct 3D models of driving environments (city streets, rural roads, and Interstate highways).

➢Develop and Implement Scenarios - Scenarios are specifically designed events for different driving environments. A pedestrian walking in the crosswalk ahead of the driver is a simple example.

➢Measure Driver Performance - Each scenario may lead to unique driver performance. These performance measurements will be analyzed and compared with respect to the driving environments.

Method

Participants

➢ 24 participants between 25-32 years old
➢ Staff or students at NU with valid driving licenses
➢ 3 groups, each group has 8 participants
➢ between group design.

Apparatus

➢Three In-vehicle display devices (A-Drive, MyGIG, I-Drive).

Adrive A variety of buttons and two knobs

MyGiG A touch-screen LCD with control buttons

Idrive A controller knob was mounted in the center console

➢Real vehicles placed in driving simulator.

➢Curve screen and 3 projectors to get a 180 degree view.
➢ASL eye movement camera.

Scene including Curves,Traffic lights,Vehicles

ASL eye movement camera
• Provide real time visual feedback and data for future analyses.

Specifically Designed Tasks For the Distraction Study

Tasks to study the navigation, music, and radio sub-systems

1. Switch to the cd player and play the song, true confessions (track 7).
2. Go to Satellite radio. Choose the Sports category and listen to ESPN .
3. Turn to FM 96.9, WTKK.
4. Switch to the navigation guidance system and get directions to the previous/recent destination of "33 State Street, Boston, MA".
5. Cancel the navigation directions you just sought.
6. Switch to the Library and in the album, the Bonnie Raitt Collection, play the Sugar mama(track12).

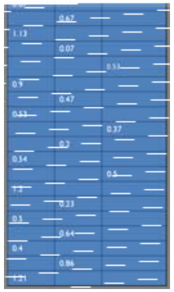
Experiment Procedure

Training Procedure
5 minute training video
3 mijutes of guided instruction using the system
Experimental Trial
Listen to the instruction tape, do a task. Task time>120s means failure.

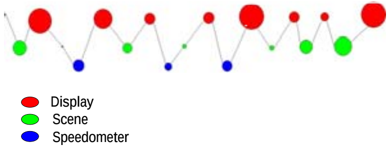
Results and Conclusions

Results focus on whether, based on different tasks and different systems, in-vehicle systems distract the driver and affect their driving performance. Of particular interests is the distraction levels corresponding to different design characters of the systems.

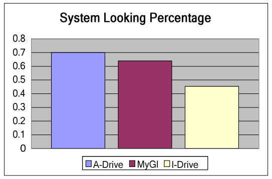
Scan Path



scan path of one participant from one system at one task, based on the fixation data
Green circles represent driver's looking time on the scene.
Red circles represent driver's looking time on the display.
Blue circles represent driver's looking time on speedometer.



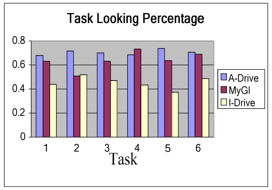
Distraction time percentage on three systems



Distraction between different systems

For all three in-vehicle systems used, the distraction time percentage are all above 40%, indicating that drivers were distracted a lot by using the in-vehicle display systems.
For different systems, A-Drive had the highest percentage, around 70%, and I-Drive has the lowest percentage, below 50%. The significant difference(25%) between them could be attributed to the hand controller of the I-drive .

Distraction time percentage of six tasks



The differences in percentages for 6 tasks on one system could be attributed to the functional and menu design between the systems. For I-Drive, the distraction time percentage for each task is fairly low compared to A-Drive and MyGIG. For the I-Drive, completing any task only required the operation of the controller located in the console, no additional looking time at the display were needed.

Conclusion

➢In-vehicle display systems distract drivers by reducing the time drivers spent on looking at the forward scene. Drivers frequently switched their attention between the display and scene.
➢Designs with more consideration of the human machine interface can significantly reduce distraction time. What is needed is a simple and classified function menu with buttons that are easy to use.

Future work

A mental workload measurement can be added to the experiment, such as NASA-TLI, RSME.
Human machine interface standards and principles could be applied to the analysis of the design.
A more automatic method of collecting experimental data could be designed.

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