CSU EcoCAR 2: Introduces the UI Team

Background

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(Responsible for the history and similar applications: Items 1 and 2)

The history behind CSU’s Vehicle Innovation Team (CSU VIT) is characterized by its involvement with the Department of Energy’s Advanced Vehicle Technology Competitions (AVTC). The DOE has sponsored more than 45 AVTC’s running over the span of 26 years; 10 of which have been run through the Argonne National Laboratory (ANL). The current competition, EcoCAR 2: Plugging into the Future, started in 2011 and is set to wrap up in May 2014. The competition is extremely challenging: a Chevrolet Malibu must be redesigned to reduce environmental impact while maintaining factors such as safety, performance, functionality, and consumer acceptability. In order to do this one must have a good understanding of the underlying history and nature that goes along with the problem, as well as looking into what technology is currently available and its ability to satisfy these needs. One area of study in the realm of vehicle User Interfaces (UI) is analyzing what types of interfaces out there are most suitable to tasks being performed by drivers and the safety concerns involved with such interfaces. This paper explores the role that rotary pads, touchscreens, touchpads, haptic feedback and head-up-displays play in vehicle safety.

As designers of a system user interface it important that we first must understand the physical and mental impairments that go along with using such systems integrated into vehicles. A driver must be visually aware of what interactions are happening around them but
also must be mentally aware in order to have good reaction times if a situation does occur.

Introducing systems into the car that require visual recognition such as tiled menus or that require cognitive thinking such as entering addresses on a touch screen greatly impact driver awareness [1]. Every time a driver glances away from the road there are lateral deviations of the car away from its path and reductions in the amount of time the driver has to react to their surroundings. The designer needs to consider not only the safety of such systems but also how well they are laid out so that the driver feels safe and comfortable while using them.

In G. Burnett’s study [1] 18 participants, half left handed and half right handed, operated a driving simulator with three controlled input modes: a rotary pad, a prototype touchpad (like on a laptop but with incorporated handwriting detection software), and a touchscreen. As they drove 3 routes following another vehicle at a safe distance, they were given 7 different tasks at specific times to complete using each of the interfaces [1]. In terms of preference and performance the study concludes that the rotary pad was negative in both, the touchscreen was better in performance than the touchpad but the preference was for the latter [1]. The mean amount of time for using each device to navigate to certain parts of the menu can be found in Figure 1 [1]. As you can see the touchscreen has very good response times and a lower standard deviation than the other two interfaces. The study [1] reported that out of the participants, 10 said they overall preferred the touchpad and 7 had preference for the touchscreen (one participant couldn’t decide and was dropped from the study). In his concluding remarks he notes that some of the participants mentioned integration between the
two in order to utilize the combined advantages of both [1]. Most car systems today used the combined advantage of quick touch buttons with an integrated touchscreen display.

![Graph showing mean task times for each task/input device with standard deviation bars given.](image)

**Figure 1: Mean task times for each task/input device (standard deviation bars given)**

There are limitations to this study, as noted by the author, because the test vehicle’s actual touch screen is much smaller than the provided 12 inch one. It is predicted that had the smaller one been used there would have been a decrease in performance [1]. The second limitation was that, if indeed a system was designed to incorporate either a touch pad or rotary controller with an optimized interface, there would be an increase in performance [1]. Tesla which produced its Model S back in 2012 is an electric car which makes full use of a 17 inch touchscreen dashboard (see Figure 2). The most common commands are kept at the bottom of the screen for quick access and users can navigate up to 4 different commands on their front
dashboard (just behind the steering wheel) using scrolling buttons on the steering wheel. Incorporating this feature helps reduce the distraction from glancing at the car’s center display when changing settings which in return improves the driver’s safety. Also, a well incorporated design aspect is that instead of using the center display for navigation, it is possible to load the map navigation just below the window for quick glance ability and improved safety. The comparison of touchscreens to touchpads for the average number of glances is located below on Figure 3 [1]. Another common method of displaying information in front of the driver is by the use of a Heads up Display (HUD) which uses a source of broad band radiation to produce holograms creating visible numbers on the driver’s window [2]. This allows the driver to see things like vehicle speed without looking down at the odometer. Having HUD integrated in vehicles is considerably safer than glancing away from the road such as is done in all other display types.

Figure 2: Tesla Model S with User Interface Panel
Although a little outdated G. Burnett discusses the results of voice recognition software taken from several other sources. Tsimhoni did a study comparing 3 different types of inputs; touchscreen, word based and character based speech recognition for navigation to a specified address [2]. Participants must use all three during 4 different driving conditions: parked, straight, and driving around moderate turns as well as sharp turns. While driving during the hardest work load (sharp turns) it took on average 15.3 seconds for the word based recognition software as compared to the 41 seconds for character based and 86 seconds for the touchscreen [2]. Although speech based recognition clearly has the upper hand in the shortest task time generally speech recognition software is not accurate enough to be used for navigation in vehicles [1]. The most important aspect of speech recognition is that it entirely eliminates the
visual distractions. It may at first take a bit of cognitive thinking but as users get more used to speech to text capabilities usability will increase. Many companies are realizing the importance of technology with speech based functionality such as Tesla, who was previously mentioned, and their incorporation of it into the Model S. There is however still difficulties because there will always be variability in speech signals depending on who is speaking and what kind of background noise there is.

Recently haptic sensors have been researched to see how they affect drivers and if they could improve the user interface interaction experience. What haptic sensors do is that as the user touches parts of the screen vibrations of varying frequency will respond to let the user know what they are touching. A new study made to report on and extend the findings of a 2009 study for haptic feedback touchscreens brings new insight to the potential of this type of sensory feedback. The 2009 study was conducted before the official publication of ISO 26022:2010 which is a standardized method for conducting a Line Change Test (LCT) for the evaluation of vehicle technology [4]. This in turn caused misleading results [4]. M. J. Pitts revised the study in accordance with ISO 26022:2010 and instead concludes that visual + haptic feedback has no effect on the touchscreen task completion or the cars deviation from the course [4]. It is reported that users most liked when the three different feedback signals were used: audio, haptic and visual [4]. However, there is no benefit to using them to increase driver safety. See Figure 4 below for results of feedback on lateral deviation. Cadillac just released its 2013 XTS which features a haptic feedback user interface dubbed CUE (Cadillac User Experience) which is an 8” monitor laid out like a smartphone or tablet is with a stationary top and bottom row. The goal for newer systems is to replicate the smart phone or computer interfaces so that the UI is easier to
use. Unfortunately the CUE is receiving really bad reviews from customers because it is too slow to start up and there is not enough touch precision.

Figure 4: Effect of feedback time on mean Deviation (Mdev).

After looking at the many types of different system user interfaces it looks like a perfect system has not yet come along. There are still major safety concerns and improvements to be made to these systems considering that: “Large-scale studies have found that up to 60% of crashes, near-crashes, and incidents can be attributed to visual distraction from the primary driving task” [4]. Data points to touchscreens as being the new best UI and with advances in speech recognition a combination of the two will hopefully decrease the visual demand. It is our task as the EcoCAR 2 User Interface team to come up with an innovative and creative solution to these problems.
Bibliography:


