

# Developing a Car Gesture Interface For Use as a Secondary Task

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## ABSTRACT

Existing gesture-interface research has centered on controlling the user's primary task. This paper explores the use of gestures to control secondary tasks while user is focused is driving. Through contextual inquiry, ten iterative prototypes and a Wizard of Oz experiment, we show that a gesture interface is a viable alternative for completing secondary tasks in the car.

## KEYWORDS

gesture interfaces, divided attention, secondary task, glance, telematics

## INTRODUCTION

When a person is engaged in a cognitively demanding task, like driving, any secondary activity that demands their attention is potentially dangerous. In these circumstances, a more usable system is a safer system, by requiring less attention, demanding less time, or causing less confusion.

Gesture interfaces have been built for a variety of tasks, including running a vacuum, training robots in a factory [6]. Car information and communication systems, known as telematics, have explored innovative interaction styles, including pointing [5], and haptics [3].

By exploring the possibilities of gestures, the limitations of current telematics and the human factors guidelines for in-car entertainment systems [1], we addressed the use of gesture interfaces for secondary tasks.

## PART I: METHOD

For this study, gestures were limited to distinct one-handed motions completed in front of the center console. This meant the driver could operate the interface with their right hand while keeping their left hand on the wheel.

Based on observations from seven contextual inquiries, we identified key entertainment and navigation tasks (e.g. 'go to favorite station', 'get directions to an intersection') that our system had to support.

We then completed ten iterative cycles of prototyping and

think aloud testing to refine the interface. [5] The prototypes, made on screen or on paper, tested a variety of presentation and navigation ideas. In order to simulate the driving environment, the interface was displayed out of arms reach and users were given a paper plate to represent the steering wheel. During think aloud testing, Seventy-five users completed the critical tasks identified during the contextual inquiries.

## PART I: RESULTS

In early iterations, we designed the interface as a series of virtual objects which could be manipulated by gestures. The objects themselves serve as visual cues for the interaction: wheels that could be "spun" or tabs that could be "pulled". We also worked with Marking Menus [2]; users could select from a hierarchical menu through a sequence of pointing gestures which collapse into a single motion with practice.

While these interfaces required only a few steps to complete each task, each step required the extended visual attention of the user, to focus on the object and manipulate it precisely. Users said there was "too much information" presented; another asked, "I'm supposed to do this while I'm driving?" The interactions presented were useful for an onscreen task or a primary task, but were not useable in the context of a vehicle.

Since driving required the user's constant visual attention, the gesture interface needed to accommodate a series of short glances [1]. To solve this problem, we limited the library of gestures to eight symbolic gestures, and used simple directional gestures (up, down, left and right) and numeric gestures (one through five) for navigating the interface. Each gesture was represented visually by an arrow icon (Figure 1) which would call a certain action. Although this created a longer task flow, it limited the number of actions available at each step. This allowed the users to make choices quickly in a series of glances, thus allowing them to keep attention on the road.

In the initial prototype 89% of users pointed rather than gestured; In later prototypes, when arrow cues were added, no users reverted to pointing.



**Figure 2.** Gesture interface & heads up display in the simulator.

The think aloud tests informed our design process, but had limited external validity because users weren't actually driving during the test.

## PART II: METHOD

In order to emulate real driving, we constructed a driving simulator (Figure 2) to test our final two iterations with 18 users. It included seat, steering wheel, pedals, stereo, windshield, and dashboard. The windshield was built of a film-coated, transparent Plexiglas that could emulate a heads-up display through projection. One projector was mounted above the user to project the gesture interface onto the windshield; a second projector showed the driving simulation at a large scale in front of the user.

The driving simulation provided a first-person view of downtown San Francisco with minimal traffic. The user controlled the driving simulation directly through the wheel and pedals. For the gesture interface, users made gestures with their right hand; an unseen experimenter controlled the interface from their gestures using a "Wizard of Oz" technique. Qualitative post-test data was collected for each user in the last two iterations.

The final iteration of the interface was tested in the simulator using a counterbalanced, within-subject design ( $n = 8$ ). Drivers performed the same entertainment tasks, (e.g. find a song, search presets, adjust volume) with both the gesture interface on the windshield and the standard radio installed in the simulator. Users were given five minutes of practice in the driving simulator, to acclimate them to the sensitivity of the pedals and wheel. Users were also shown a sample gesture, not used in the interface, as an example. Experimenters counted driver errors while completing the tasks, including the number of missed red lights, missed green lights, and occurrences of speeding, swerving, and crashes.

## PART II: RESULTS

Drivers in the gesture condition made less total errors than with the physical interface but the difference was not



**Figure 1.** Gesture navigation & entertainment interface.

significant. In qualitative interviews after the experiment, users preferred the gesture interface:

- “[The gesture interface] helped me keep my attention on the driving more because I didn’t have to take my eyes off the road.”
- “[I ] don’t have to reach and touch anything. I could be less precise [with the gestures].”

While these results are not conclusive, they suggest gesture interfaces could be used safely in a vehicle.

## CONCLUSIONS

Our qualitative findings have shown that in a gesture interface used for secondary tasks, the interface must accommodate quick glances of user attention. The key usability features were the visibility of options and ease of navigation. Through our initial quantitative findings, we’ve shown that gesture interfaces are a viable option for secondary tasks.

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