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# Development of wheel-gesture control interface to prevent distracted driving

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**Extended Abstract**

**Key words:** driver distraction, gesture recognition, eye tracking, human-vehicle interaction

## 1. Introduction

This paper presents an initial investigation of a new control interface that uses original "wheel-gestures" to prevent distracted driving in a simulated driving environment. Distracted driving is one of the most dangerous and common causes of automotive crashes: distraction alone contributes to 70% of automotive crashes according to a 2003 NHTSA survey. Distractions while driving require one or more of visual, auditory, biomechanical, or cognitive attention from the driver [1].

Wheel-gestures, which are a set of finger movements to control non-driving tasks in the car while hands are attached on the steering wheel, reduce visual and biomechanical distractions while driving [2]. In the present study, we developed a wheel-gesture control interface (WGCI) to apply the modified wheel-gesture and integrated the prototype in a driving simulator, as shown in Fig. 1. Non-driving control tasks such as operating the air-conditioner, heater, radio, and MP3 player were chosen based on our pre-survey about usage frequency and were implemented in the new control interface.

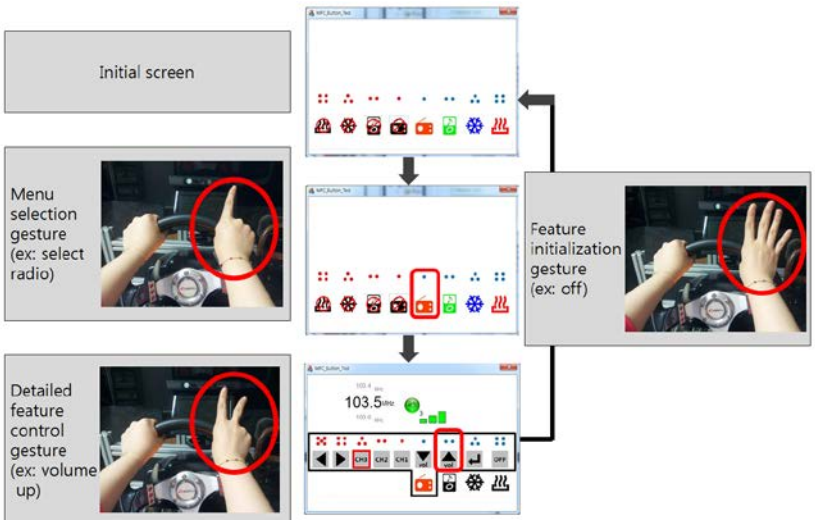


Figure 1 Examples of wheel-gesture sequence and control interface

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## 2. Experimental Methods

A human-in-the-loop experiment was conducted to compare the WGCI with a conventional button-dial control interface (BDCI). A total of 15 undergraduate/graduate students with an average driving experience of 55 months (std = 21.7 months) participated. The experiment took place in an integrated simulated driving environment incorporating UC-win/Road, SMI eye-tracking system, Kinect SDK, and Essential Reality's P5Glove. Each trial took no more than 180 min, including learning how to operate the WGCI (40 min), practicing driving (60 min), and the main experiment (30 min). Participants were told to maintain an average speed of 70 km/h and given a series of commands to operate the air-conditioner/heater/radio/MP3 player while driving.

## 3. Results

The WGCI provided 6.7% better accuracy ($p = 0.002$) and a 0.92 s higher response speed ($p = 0.001$) with regard to the execution of non-driving tasks compared to the BDCI. Driving performance such as maintaining the velocity and lane was also statistically better with the WGCI ($p = 0.002$, 0.004). Participants' heads faced more forward in the yaw, pitch, and roll directions when they used the new interface ($p = 0.001$, 0.016, and 0.006, respectively). However, the two interfaces showed no statistically significant difference in gaze direction, such as looking straight ahead or sideways.

The area of interest (AOI) was defined as the center screen of the driving simulator, and the participants' dwell time, number of fixations, number of revisits, and average fixation times were compared for the two interfaces. Analysis showed that the WGCI provided 10% more dwell time, 9% more fixations, 5% fewer revisits, and 3% longer average fixations ($p = 0.001$, 0.001, 0.006, and 0.001 respectively). Subjective measures also showed that the WGCI made it much easier to maintain the speed, maintain the lane, perform commands, confirm commands, and keep eyes on the road ($p = 0.006$, 0.001, 0.010, 0.001, and 0.001 respectively). The analysis results showed that the WGCI provides less visual distraction and better usability and is more preferred than the BDCI. Future study will include a comparison between the wheel-gesture interface and other gesture interfaces [e.g., 3,4], the development of a wheel-gesture interface without the use of gloves, and an extension of this study to field tests.

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