A Study on Methods of Multimodal Interaction in Vehicle Based on Wheel Gestures and Voices

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Abstract. This study was aimed to investigate the multimodal interaction providing wheel gesture and voice inputs together- that is suitable for car driers in the driving environment, and to define it by function. The structure was defined first of the wheel gesture-voice multimodal interaction, followed by discussion on the resulting wheel gesture and voice interaction respectively. Next, multimodal interaction set was extracted to practically use after mapping the two interactions with the in-vehicle functions, and verify it through interviews with experts. This allowed the deriving of a specific set for multimodal interaction based on the wheel gesture and voice in the vehicle, which is expected to be used as a basis for future research on the multi interaction interface that can take advantage of the gesture and voice in a driving environment.

Keywords: Vehicle, Multimodal interaction, Gesture, Voice.

1 Introduction

1.1 Research Background and Objectives

The most important thing while driving is the level of competitive tasks that take away driver's visual attention from the driver's front lobe, or Primary Visual Attention Lobe (PVAL) [5]. The competing tasks with PVAL for visual attention include reading a map or tuning the radio dial while driving [1].

Currently, motor companies are running the projects to find a new way to solve these problems, among which they are actively studying on the interaction utilizing the gesture and voice in driving environment. Currently, motor companies are running the projects to find a new way to solve these problems, among which they are actively studying on the interaction utilizing the gesture and voice in driving environment. Previous studies have confirmed that the multimodal interaction combined with gesture and voice is the most appropriate interaction method for the driving environment. However, there are limitations that disturbance factors are found in the gesture due to the driving, device operation and hand movements during conversation, and that disturbance factors are found in the voice due to the in-vehicle noise or conversation with passengers. In addition, multimodal interaction is required that can be flexibly used depending on circumstances because cases occur when a variety of input methods may be necessary depending on the changing conditions within the vehicle from

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time to time. Therefore, the purpose of this study was to propose the wheel gesture-voice multimodal interaction set bases on the mapping of wheel gesture and voice interaction that can be used while operating specific functions in the vehicle.

1.2 Previous Research

Previous studies have performed experiments to find out the best combination of non-contact gesture and voice recognition for interaction of vehicle information systems operations; according to the results, the way of voice commands to operate and gesture to maneuver amounts showed the highest satisfaction and efficient in terms of time or error [2].

Other studies have defined the functions to be able to manipulate using wheel gesture and one hand space gesture in the vehicle and proposed, among those, the suitable interaction schemes utilizing wheel gesture for the operation of the functions. Wheel gesture refers to the ability to operate the functions not directly related to the driving by the operator in the vehicle with his two hands holding the steering wheel. Of these, audio, radio, heater and air conditioner were selected as the objects of functional operation, and underwent mapping with the gesture to derive the final wheel gesture interaction set [3].

2 Structure of Wheel Gesture-Voice Multimodal Interaction

Input interaction is defined as the type of the input other than input devices, and is divided by five interactions of instruction word, four-way, cursor, touch and intelligent interaction [4]. This study has defined the multimodal interaction as the input method for the instruction words.

Figure 1 shows the structure of the multimodal interaction set utilizing the voice and gesture in the vehicle. It is the structure that the user commands the functional operation using the gesture and the voice and accordingly the car outputs the command by operating the function.

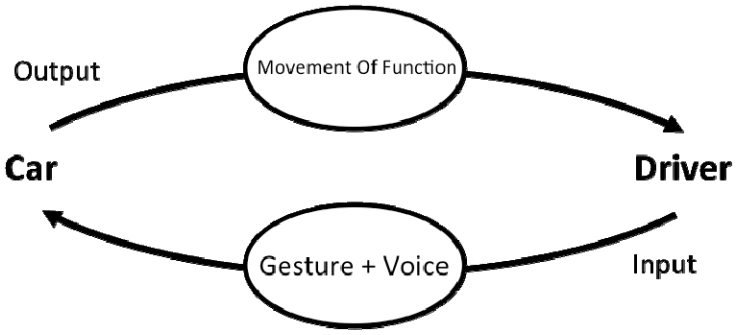

Fig. 1. Structure of Wheel gesture-Voice Multimodal Interaction

All possibilities will be open without precluding limited use assuming that easy-to-use input method may vary depending on the situation of the driver in the vehicle environment.

Therefore, the user may use gesture and voice separately or together in the functional operation through the Wheel gesture-Voice multimodal Interaction. These two can operate each function independently by respective interaction alone without interdependence.

3 Classification of Wheel Gesture-Voice Multimodal Interaction

As shown in Figure 2, the functional operation process in the vehicle is composed of function selection (ON), detailed function selection (Adjustment of Level), after a certain period of time, and function selection (OFF), with each structure that the result being recognized by the user through feedback in each phase [3].

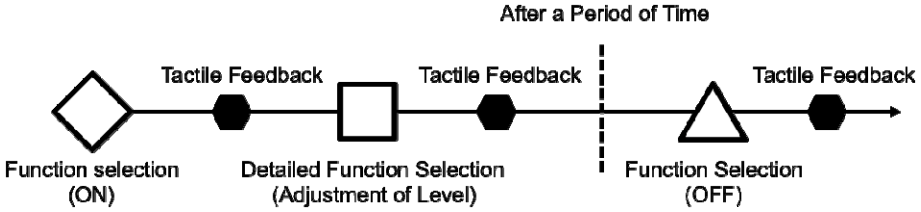

Fig. 2. TASK analysis of operation of ordinary function of the driver (Source : Kang, 2012, p.50)

Among these, what require the input interaction are the function selection (on), detailed function selection (numeric control), and function selection (off). This study has mapped and defined the wheel gesture and voice interaction that can be used each individual stage, has limited the range of functions that can be operated to radio, audio, heater and air conditioner which are not directly related to the driving, and have premises to receive voice feedback step by step to prevent the interference with the forward visual conditions.

3.1 Wheel Gesture Interaction

The selection of the function via wheel gesture comprises of the repetitive input of Left Hand Index Raise as shown in Table 1 and the confirmation of the selected function by voice feedback. Next, fine adjustment of the numerical quantity such as the strength of the heater and air-conditioner and volume of the radio and audio can be made using Right Hand Index Raise and the change of the radio and audio channels and the temperature control of the heater and air-conditioner can be made by Left Hand Index Raise and Left Hand Thumb Twist. In addition, the function could be finished by using Hand Spread [3].

Table 1. Wheel gestures (Source : Kang, 2012, p.59)

WHEEL GESTURES					
					
Left hand Index raise (Selection)	Left hand Index raise	Left hand Thumb twist	Right hand Index raise	Right hand Thumb twist	Hand spread

3.2 Voice Interaction

The voice interaction was defined based on the classification criteria for the gesture interaction. The function can be operated by the voice operation using instruction words intuitively recognizable when the function required is definite. For example, the radio is turned on by the user intuitively with the combination of words 'Radio' and 'on.' When compared with the wheel gesture interaction, voice interaction can be executed in one step thanks to the direct select ion of the desired function

3.3 Wheel Gesture-Voice Multimodal Interaction Set

Table 2. Wheel gesture-Voice Multimodal Interaction Set

FUNCTION	INTERACTION	COMMANDS					
Radio	Name	Turn on	Channel Up	Channel down	Volume up	Volume down	Turn off
	Gesture						
	Voice	"radio on"	"channel up"	"channel down"	"volume up"	"volume down"	"radio off"
Audio	Name	Turn on	Channel Up	Channel down	Volume up	Volume down	Turn off
	Gesture						
	Voice	"audio on"	"channel up"	"channel down"	"volume up"	"volume down"	"audio off"
Heater	Name	Turn on	Temperature up	Temperature down	Strength up	Strength down	Turn off
	Gesture						
	Voice	"heater on"	"temp up"	"temp down"	"strength up"	"strength down"	"heater off"
Air conditioning	Name	Turn on	Temperature up	Temperature down	Strength up	Strength down	Turn off
	Gesture						
	Voice	"aircon on"	"temp up"	"temp down"	"strength up"	"strength down"	"aircon off"

Wheel gesture-Voice Multimodal Interaction Set includes both wheel gesture and voice interaction, which have the same goal of operating specific functions. Therefore, the operation of the function can be performed by the two ways independently or interchangeably. For example, the radio can be turned on by using voice interaction "radio on," turned up by the input of Left Hand Index Raise, and turned down by the input of Right Hand Thumb twist.

4 Expert Interview

4.1 Method and System

Expert interview was conducted to verify for the effectiveness to the users of the function operation of the four tasks (radio, audio, heaters, air conditioners) using Wheel gesture-Voice Multimodal Interaction Set as discussed in this study.

Experts were composed of a total five people including two ordinary drivers (1 male / 1 female each) of 10 or more years of driving experience and three UX design majors (2 males / 1 female) of 5 or more years of driving experience; Full instruction was given to them on the vehicle function operation process and defined Wheel gesture-Voice Multimodal Interaction Set, for their sequential assessment according to the operation process and collection of qualitative results.

4.2 Findings

Results were derived from interviews with experts that Wheel gesture-Voice Multimodal Interaction Set provides higher driver's forward vision concentration compared to the existing traditional button or touch interaction thanks to no interference with driver's vision. On the other hand, it was confirmed that increased kinds of functions accordingly makes it difficult to learn and remember the gesture or voice instruction words.

5 Conclusion

This study has defined a Wheel gesture-Voice multimodal interaction that can flexibly use tasks because a variety of input methods are required that do not interfere with the driver's field of view according to the ever-changing driving situation. The interaction includes a concrete Set that can be used independently or together depending on the intended use and situation of the driver.

Further research is necessary to expand the four limited functionality discussed in this study up to the different areas of the vehicle, and additional research is needed about the output methods for the input interaction.

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