Multi-touch Based Standard UI Design of Car Navigation System for Providing Information of Surrounding Areas

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Abstract. Recognizing current location and surrounding areas is one of the default tasks to utilize car navigation systems. Due to the information and communication technologies, features in in-vehicle navigation systems are getting complicated and require more drivers' visual attention. This research aims to develop UI design for enhancing drivers' performance in the situation of recognizing and exploring surrounding areas with car navigation systems. In order to make drivers' eyes on the road, a standard feature definition and efficient operation methods are required. First of all, standard features are defined by analyzing top-selling navigation systems in Korean market. Drivers' can get route guidance from their in-vehicle system and personal handheld devices. However, the differences amongst the systems make drivers confused and waste time. The development of standard features of car navigation systems can reduce drivers' cognition load. Secondly, multi-touch interaction methods and drivers' behaviors are investigated in order to develop basic rationale to introduce multi-touch operation to a car navigation system. Current systems in market except smart applications adopt tactile and single-touch based interaction methods. These methods require more visual workload than multi-touch based methods in certain cases. User research has been conducted in tandem with researches of standard features and multi-touch interaction to figure out problems and their needs regarding to exploring surrounding areas in relation to current location. As results of this research, TF (Task Flows) of a multi-touch based standard UI design is suggested. The UI design can offer more values to drivers in terms of the amount of information with efficient and less eyes-on-the-system operations.

Keywords: in-vehicle information system, touch-based interaction, location-based service, interaction design.

1 Introduction

1.1 Background and Goal

Nowadays, IVIS (In-Vehicle Information System) offers an increasing number of information and functions for enhancing drivers' experience. Sometime, those features require drivers' visual attention and decrease their driving performance. When

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using a navigation system in IVIS, it is very critical to recognize current location and surrounding areas for route guidance features. Current location of a person works as a reference point to search the location of a target in relation to current location by forming a spatial mental model of a target space. The clear overview of current location and other spots from the current location is important for other situations when people navigating in indoor spaces, public and outdoor spaces, and even cyber spaces such as an internet space. In driving situation, the failure of figuring out driving route would make a driver distracted and cause an accident in the worst case. The poor quality of information delivery and complicated operation procedure of using IVIS make drivers' are the sources of the accident. Nowadays, IVIS (In-Vehicle Information System) comes into wide use more and more, thus a driver-oriented UI for navigation systems is required. This research aims to develop UI design for enhancing drivers' performance in the situation of recognizing and exploring surrounding areas with car navigation systems. In order to make drivers' eyes on the road, a standard UI is developed by defining standard features and efficient operation methods.

1.2 Process and Methods

The process of design a standard UI of car navigation system consists of four phases: In phase 1, Understanding issues in visualization of current location, existing problems are investigated in order to elicit drivers' needs with Nethnography and FGI.

In phase 2, Function definitions, comparing with commonly used IVIS in Korean market, the main features are summarized with three different modes: map view mode, route view (driving direction) mode, neighborhood searching mode.

Phase 3, Investigation of multi-touch interaction, multi-touch interaction methods have been collected from many digital artifacts and applications. With this data, a reference table is developed by filtering feasible methods in driving context.

In phase 4, Multi-touch UI proposal, the proposal is designed by developing simplified UI and mapping multi-touch interactions onto the corresponding-behaviors-triggered features. A new UI design of a car navigation system is developed to demonstrate the concept of this research, and is discussed, compared with an existing design. In addition, the possible results of applying this standard UI to other systems in IVIS are discussed by reviewing use case scenarios.

2 Understanding Driving Experience

2.1 Nethnography

To capture issues in the use of car navigation systems, users' comments on car navigation systems on internet sites such as dcinside.com, and power blogs have been collected [1]. The common postings on this research topic are as below: 1) occasionally, my eyes are one screen to figure out that images on the screen indicate to which one around me. If I fail to do that, I cannot start to use route guidance system. 2) I am very familiar with multi-touch operation due to my smartphone, so sometimes I try to manipulate my IVIS as I do to my smartphone. 3) Sometimes, I want to stop by

restaurants, rest areas, and/or attraction points nearby. However, it is not easy to explore surrounding areas around my current location. 4) It is very hard to click the right button on the screen because the size of a button is relatively small and a car swayed usually.

2.2 FGI

FGI method is also used to capture users' driving experience with details [2]. Twenty four interviewees were participated in the discussion, and the interviewees are divided into two sub-groups. Sixteen are general user group who utilize default and general features in products. Other eight expert user group who are a kind of early adaptors and/or lead users. Each sub-group is divided into two sub groups for effective and in-depth discussion. Basic questions in proceeding scenarios are as follows: 1) which features in IVIS are not comfortable, and when, 2) why certain features do not work and how to improve the issues, and 3) which future features will be available for enhancing driving performance with the use of IVIS. Figure 1 shows the summary of Nethnography and FGI at the first phase.

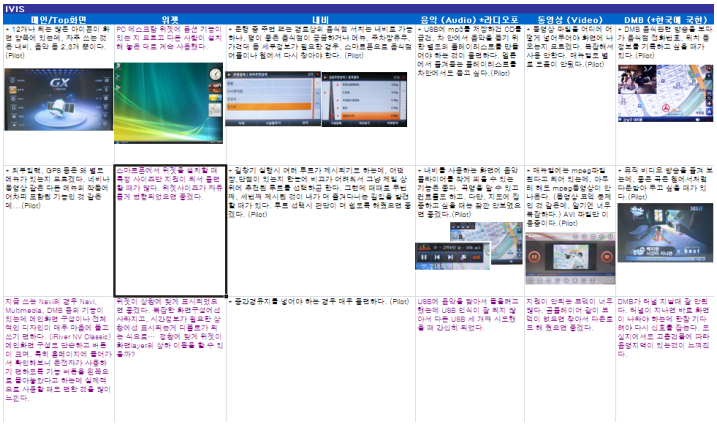

Fig. 1. Summary of Results from Nethnography and FGI

3 Standard Feature Definition

3.1 Approach

Standard features commonly used in most IVIS systems are defined by comparing popular IVIS products and Apps in Korean market. Four products and three Apps are selected from top-ranked selling items. There are three modes in relation to drivers' current location as shown in Figure 2. 1) Map view mode is the default that displays a driver's current location without specific destinations. 2) Route view mode (driving direction) will be activated when a drive selects a destination and IVIS starts to guide the route. 3) Neighborhood searching mode will be activated when a driver want to look around the current location.

Fig. 2. Screenshots of Map view mode (left), Route view mode (middle), Neighborhood searching mode (right)

3.2 Map View Mode

First of all, it is very important to calibrate his/her the current location to the point in the map in IVIS. If a driver fails to do that, IVIS will be useless. Some features in

Table 1. Common Features in Map View Mode

Feature	Aftermarket Products				Apps in Smartphone			Note
	Atlan 3D	Thinkware	Gini	Mappy	Olleh Navi	GoGo 3D	Tmap	
Main Menu	O		O	O	O	O	O	
Recent Search							O	
Navi Menu		O	O					
Search (Route, Destination)		O		O	O			Touch
Name of Current Location	O	O	O	O	O	O	O	
Eco Point	O	O						
GPS	O		O	O		O	O	
Clock	O		O	O	O	O	O	
Compass	O	O		O		O	O	Mode Change
Zoom +/-		O	O	O	O	O	O	Touch
Scale	O	O	O	O	O	O		Touch
TPEG	O		O	O	O			
View Change	O		O		O			Touch
Save Spot		O						Touch
Scroll Map	O	O	O	O	O	O	O	Touch
Mode Change				O				Compass Touch
Volume				O	O			

IVIS such as zooming, scrolling map around can support to recognize the current location inside the map in IVIS. Table 1 shows the common features in Map view mode and in which features multi-touch interactions can be applied for reducing operations in the use of IVIS.

3.3 Route View (Driving Direction) Mode

When a driver chooses a certain destination, Route view mode will start. In this mode, a driver wants to expect when he/she has to change lane and/or route, how far from starting point and destination, etc. The quality of information representation is very important in this mode. Table 2 shows the common features in Route view mode and in which features multi-touch interactions can be applied for reducing operations in the use of IVIS.

Table 2. Common Features in Route View Mode

Feature	Aftermarket Products				Apps in Smartphone			Note
	Atlan 3D	Thinkware	Gini	Mappy	Olleh Navi	GoGo 3D	Tmap	
Diverging point Info.	O	O	O	O	O	O	O	
Lane Info.	O	O	O	O	O			
Searching options (Tollway, Fastest, Shortest, etc.)	O		O	O				Touch
Distance to Destination	O	O	O	O	O		O	
Time to Destination (Arrival Time)	O	O	O	O	O	O	O	
Travelled Distance		O				O		
Travelled Time	O							
Name of Destination	O	O	O	O	O	O	O	
Traffic Sign	O	O	O	O	O	O	O	

3.4 Neighborhood Searching Mode

While driving, sometimes a driver wants to look around the current location. Searching restaurants, rest areas, gas stations, etc. are common situations. In this situation, it is important to explore the map in IVIS without distracting a driver's attention too much. Reducing operation time can a solution for this situation. In this sense, introducing multi-touch interaction is a good idea. Table 3 shows the common features in Neighborhood searching mode in which features multi-touch interactions can be applied for reducing operations in the use of IVIS.

Table 3. Common Features in Neighborhood Searching Mode

Feature	Aftermarket Products				Apps in Smartphone			Note
	Atlan 3D	Thinkware	Gini	Mappy	Olleh Navi	GoGo 3D	Tmap	
Back to Current Location	O	O	O	O	O	O	O	Touch
Set as Start	O	O	O	O	O	O		Touch
Set as by way of destination	O	O	O	O		O		Touch
Set as Destination	O	O	O	O	O	O	O	Touch
Get Direction	O	O	O	O				Touch
Save spot	O		O	O			O	Touch
Control to Scroll Map	O							Touch
Adjust angle of Map		O						Touch

4 Multi-touch Interaction

4.1 Potential for Application

With the wide spread of smart phones, people tend to take multi-touch interaction as a matter of course. Multi-touch enables users to operate a system with two or more points of contact with the surface [3, 4]. However, interaction design of IVIS seems behind this trend because the character of car industries is relatively conservative. When they introduce new technology into their products, they have to consider the safety issues. Not to make a drivers' gaze distracted can guarantee his/her safety while driving. According to an experiment with tactile, touch, and gesture interaction, touch interaction leads to fast and efficient task completion for in-vehicle system [5]. There is potential to introduce multi-touch interaction into IVIS because it can reduce operation time with less focus on screen.

4.2 Application Types

Table 1 shows the selected multi-touch gestures in smart phones and touch-enabled OS systems that have potential to be applied. When selecting appropriate interaction types, three criteria are considered. First, the interaction must be performed using one hand. Two hand interaction methods such as rotate do not work. Second, the consistency of behaviors between features in IVIS and multi-touch interaction. For example, 'Drag,' the movement of fingertip over surface without losing contact in Table 4, has the analogy of behaviors for scrolling map in Table 3. In this way, Table 4 is suggested. Not to require visual reference point is the last one. The benchmark systems in Table 1, 2, and 3 requires visual reference point when a driver interacts

Table 4. Applicable Multi-Touch Interactions for IVIS

Type	Symbol	Description
Tap		Move to the point
Double Tap		Back to current location
Hold (Press)		Activate context menu (Long Tap)
Flick		Slow scrolling map
Drag		Adjust 3D angle with Hold
Pinch/ Spread		Zoom in/out
Multi-Finger Drag		Quick scrolling map

with them. Zooming is an example. In order to zoom in and/or out, a driver has to take a look the screen and find buttons. However, 'Pinch/Spread' in Table 4 requires less drivers' attention. He/she can zoom in and/or out with contacting on any surface of the screen, so he/she can save time to find the right buttons.

5 UI Design Concept

The standard features are summarized as shown in Table 5 by referring to Table 2, 3, and 4. The table explains main features and sub-features in each main category.

Table 5. Summary of Standard Features

Main Feature	Sub-Feature
Main menu	Main Menu, Destination, Map Menu, Navi Menu, POI, TPEG will appear if tap any spot on the screen
Map Menu	Start Guidance, Set Destination, Delete Destination, Detail Route, Multiple Route, Cancel Guidance

Table 5. (*continued*)

Recent Search	No sub-menu
Navi Menu	Features for navigation control
Search (Route, Destination, etc.)	No sub-menu
Name of Current Location	On the bottom of screen
GPS	Always on status bar
Clock	Always on screen
Compass	Always on screen
Zoom in/out	Will be replaced with Pinch & Spread
Scale	Will be simplified with Press & Drag
TPEG	No sub-menu
View	Will be replaced with Two-Finger Rotate, Double Tap
Bookmark	Will be simplified with Long-Press
Map scrolling	Will be replaced with Flick, and Two-Finger Flick
Mode Change	Will be activated by Pressing over compass icon
Volume	Always on status bar
POI	Will be activated by Search options

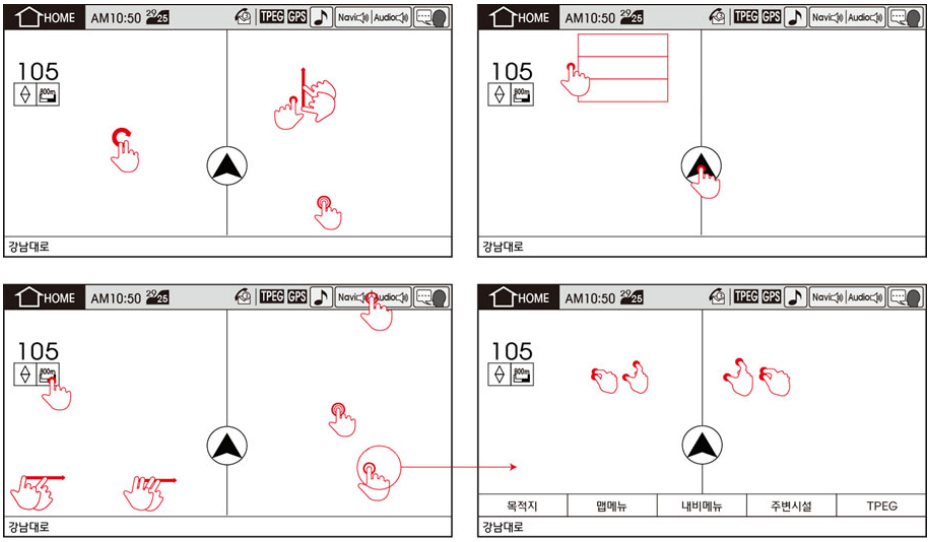

Fig. 3. Screenshots of multi-touch based UIs

6 Discussion

This study has attempted to develop a standard multi-touch based UI for the core of car navigation systems. From the reviews using paper prototypes with five participants, they give positive responses in terms of faster operation with less visual attention. In terms of how to recognize which multi-touch interactions are behind the screen, the more sophisticated UI concepts are required. For the standard navigation menus on the bottom, they have various comments depending on their systems. In order to evaluate the menus, new evaluation criteria and methods are required. For example, learning effects and faster task completion can be criteria for evaluating how to organize features and information in driver-oriented way. For the further development, working simulators will be developed and usability test will be conducted with scenarios.

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