A Study on a Split-View Navigation System

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Abstract. CNS (Car Navigation System) provides traffic information with an intention to offer safe and comfortable driving experience. However, because too much information is presented into a single screen it often becomes information-crowded. This paper analyzed four commercial CNS products to collect information elements and conducted user studies such as focused groups, surveys and interviews to determine what information is needed for each position of the seat; the driver and the passenger seat. The result showed that there is clear difference in information priority between driver and the person on passenger seat. Based on such finding, this paper proposes using split-view based CNS. Split-view CNS contributes to enhance user satisfaction of driving experience by providing different information to needed for a driver and a passenger.

Keywords: Navigation · Split-view · Information delivery element

1 Introduction

1.1 Study Background and Purpose

With the development of digital technology, including Global Position System (GPS) and information communication, our lives have become speedy and efficient, and navigation devices have become popular. However, if too much information, other than that required, were exposed on navigation devices while driving, it would degrade drivers' "cognitive functions and deviate them from the inherent goal, thereby affecting safety driving negatively." To prevent this, selection of information in navigation devices is considered a highly important factor.

Currently, existing navigation information includes not only path guide as a primary function, but also additional information that is provided as a secondary function, which increases information complexity. In addition, because of elaborate Graphical User Interface (GUI), driver's eyes may be distracted, thereby interfering with driving and increasing the likelihood of traffic accidents. Accordingly, how to represent information on a screen is important because it is difficult for drivers to compare and judge information presented on a limited screen, and be aware simultaneously of the road conditions. In this regard, the need to study how to provide information on a screen by dividing navigation system information into two sub-screens has arisen. Thus, this study aims to prove that the importance of information delivery elements between the driver and passenger seats is different, thereby providing navigation information delivery elements customized for the driver and passenger seats.

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To do this, we selected four navigation systems from local companies with high market share based on market research results, and analyzed the components of the information on the screen during driving, thereby providing a navigation system that delivers the required information delivery elements for the driver and passenger seats utilizing Split View technology.

2 Theoretical Discussion

2.1 Navigation Concept

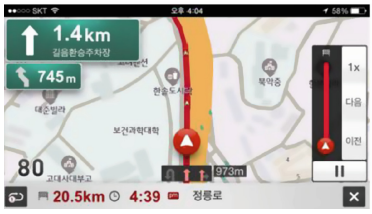
Car Navigation System is a system that provides drivers with traffic and road information, as well as the shortest and optimum path [1]. Previous GPS-based systems that guided through a travel path only by considering current location information from satellites have evolved into advanced systems that provide safe and comfortable driving environments by collecting, analyzing, and delivering traffic information in real time based on GPS and wireless communication technologies. That is, a shortest travel path was the main goal in the past, but now this has changed to the optimum travel path. Navigation system technology is cutting-edge technology that combines various industrial technologies, such as electric, electronic, communication, and vehicular, and utilization of navigation system technology is increasingly penetrating our daily living [2].

2.2 Navigation Map Software in Korea

Development of the navigation system in Korea has been accomplished by purchasing software that is a basic electronic map installed in hardware, and then re-developing it according to the design of each company. The navigation market in Korea only had approximately ten companies in 2005, but increased to 70 companies in 2007. Among them, Thinkware and Mando Map & Soft contain map software and electronic map technologies, which are the core navigation technologies. iNavi from Thinkware and Gini from Mando Map & Soft account for 70 % of the navigation market in Korea, which makes them the leading brands in navigation systems. As the demand for navigation devices increases and the electronic map market increases, the entry of new companies has also increased, such as Atlan Map from Fine Digital and SK Energy Co. Ltd. Another trend is that more consumers are buying navigation applications (apps) through telecommunication companies, rather than buying expensive navigation devices, because smart devices have become popular (Table 1).

In this market trend, competition between companies is fierce, and the difference in technology level becomes slimmer. As a result, companies do their best effort to develop distinguished software products in order to maintain a competitive edge. Because of the fierce competition, recent electronic maps are now embedded with accurate and tremendous information database, and are capable of providing intelligent customized services that help search for destinations even without the exact name, or memorize driver habits. As such, a continuous development for user-oriented electronic map updates and services has been done [3].

Table 1. Representative map software products from Korea

Map type	Category	Map software functions	Screen example
iNavi	PND	- 40% of market share in Korea – PDA-dedicated software is mounted - Convenient search function that uses recent company name, business sector, and 114 - Travel path management function, TPEG - various auxiliary services for subways and radio - Detailed 3D screen, user customized service provided	
Gini	PND	- Manufactures own terminal - Convenient search service that uses recent company name, business sector, and 114 - Travel path management function, TPEG - Various auxiliary functions and services provided, such as game and Karaoke - Detailed 3D screen, intelligent map matching	
Atlan	PND	- New concept map developed by Fine Digital's own technology - HD grade map provided - provides user-oriented services for location search, path, and traffic services - Perfect division of screen into 2D+3D or 2D+2D	
Tmap	Mobile	- Integrated search, photo search - search by name, initial, address, or telephone number - Streaming map function - Departure time prediction function, arrival time prediction function - Report and sharing function	

2.3 Study on Split-View Definition and Analysis

Split-view technology is a type of backlit color active matrix display (TFT-LCD) where two different images are displayed simultaneously over pixels adjacent to a screen. A front side of the display is divided into two images that can be seen differently according to seat position, thereby watching two different contents simultaneously [4] (Fig. 1).

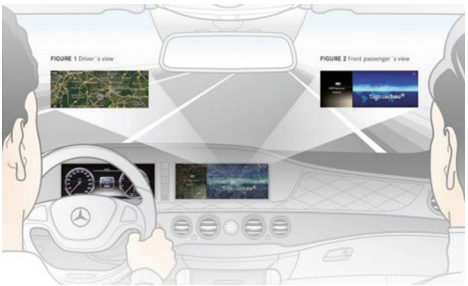


Fig. 1. Mercedes-Benz – Split view Display

2.4 Navigation Map Screen Information Components

The visual information element from the digital media information elements is divided into four elements in terms of user interaction: control, information delivery, structure, and background. Structure and background elements play a role in assisting user execution indirectly, whereas control and information delivery elements are directly related to user operational execution [5] (Table 2).

Table 2. Detailed components of map screen information

Role	Element	Detailed element
Direct role to execution	Control element	Icon, button, texts
	Information delivery element	Text, symbol, icon, pictogram, 2D, 3D, logo, background map
Indirect role to execution	Structure element	Layout
	Background element	Background color and image

3 Analysis on the Information Delivery Element in Navigations

3.1 Study Targets and Scope

In order to study a navigation map to extract information components, products from four local companies with a high market share were selected: iNavi from Map Thinkware, Gini from Mando Map & Soft, Atlan from Fine Drive, and T-map mobile

navigation from SK planet. A study scope was set with information directly related to user operation executions while driving, which is provided by the selected navigation maps as a case study analysis target; furthermore, information delivery elements, with the exception of the control element, were set with a main study scope [6].

3.2 FGI

Eight Focus Group Interview (FGI) study subjects for this research are owners of vehicles equipped with the selected four navigation systems; furthermore, the subjects use their navigation systems at least weekly, and are familiar with the use of navigation systems. A second group composed of eight subjects between the ages of 20 to 39 with experience as vehicle passengers was selected to conduct the FGI.

A questionnaire process was conducted with pre-determined questions, and the survey content concerned the information delivery elements of navigation maps while driving. Individual complaints and required improvements were also recorded on the survey.

An observation experiment was conducted to determine the subjects' overall usage behavior with regards to the navigation systems, and direct observation was conducted to observe the recognition process of the information delivery elements from the navigation devices through the Think-Aloud method and their circumstances through simulated driving. As with the first group, the subjects in the passenger seats were observed directly using the Think-Aloud method to determine their navigation-watching behavior.

3.3 FGI Results

The Focus Group Interview (FGI) analysis results show that drivers and passengers can be categorized. Table 4 lists the analyzed results per position.

In the car-driving environment, drivers had a tendency to watch the navigation device when a speeding camera was present, traffic congestion occurred, driving direction needed to be changed, and entering a tollgate. In addition, passengers had a tendency to watch the navigation device when assisting support for driver was required, traffic congestion occurred, time and distance to destination were required, surrounding information was needed, and destination-related information was required. A driver observed the navigation information while driving when vehicle control was required or navigation guidance was recognized and required, whereas passengers needed auxiliary information instead of the information elements related to vehicle driving. In summary, our study results prove that the importance of the information delivery elements varies between driver and passenger.

3.4 Navigation User Survey

A survey was conducted with 260 male and female drivers (male: 179 individuals, female: 81 individuals) with a driver's license and driving experience using navigation systems, from December 10 to 16, 2014 for one week. The survey questionnaire was

Table 3. Representative navigation map information delivery elements in Korea

Information delivery element							
iNavi		**Gini**		**Atlan**		**T-map**	
Information	Detailed element	Information	Detailed element	Information	Detailed element	Information	Detailed element
Current location	Icon, symbol, 3D	Current location	Icon, symbol, 3D	Current location	Icon, symbol, 3D	Current location	Icon, symbol,
Start point	Icon, Text, Symbol, logo	Start point	Icon, Text, Symbol	Start point	Icon, Text, Symbol, logo	Start point	Icon, Text
End point	Icon, Text, Symbol, logo	End point	Icon, Text, Symbol	End point	Icon, Text, Symbol	End point	Icon
Traffic Signs	Icon, Text, Symbol, Pictogram	Traffic Signs	Icon, Text, Symbol, Pictogram	Traffic Signs	Icon, Text, Symbol, Pictogram	Traffic Signs	Icon, Symbol, Pictogram
No parking area	Icon, Text, Pictogram	No parking area	Icon, Text, Pictogram	No parking area	Icon, Text, Pictogram	No parking area	Icon, Text, Pictogram
High Occupancy Vehicle lanes	Icon, Text, Symbol, Pictogram	High Occupancy Vehicle lanes	Icon, Text, Symbol, Pictogram	High Occupancy Vehicle lanes	Icon, Text, Symbol, Pictogram	High Occupancy Vehicle lanes	Icon, Pictogram
Speed limit	Text	Speed limit	Text	Speed limit	Text	Speed limit	Text
Hi-pass lanes	Symbol, 3D, Logo	Hi-pass lanes	3D, Logo	Hi-pass lanes	Symbol, 3D, Logo	Hi-pass lanes	Symbol, Text
Current Speed	Text	Current Speed	Text	Current Speed	Text	Current Speed	Text
Estimated time and distance	Text	Estimated time and distance	Text	Estimated time and distance	Text	Estimated time and distance	Text
Current Time	Text	Current Time	Text	Current Time	Text	Current Time	Text
Driving Distance	Icon, Symbol	Driving Distance	Icon, Symbol	Driving Distance	Icon, Symbol	Driving Distance	Icon
Turn sign	Text, Symbol	Turn sign	Text, Symbol	Turn sign	Text, Symbol	Turn sign	Text, Symbol

The information delivery element consists of texts, symbols, icons, pictograms, and logos. Here, a difference between Personal Navigation Devices(PND) and mobile devices is that PND mostly contains elaborate icons, text, and symbols, whereas mobile devices are based on simplified graphic and icons because of their small display size.

(6) A scope of this study is mainly set to the information delivery element provided by navigation systems while driving; control, structure, and background elements were removed from the scope.

Table 4. Circumstances when driver needs to see navigation system

	Driver	Passenger
Circumstance	When speeding camera is present	When assisting support for driver is required
	When traffic congestion occurs	When traffic congestion occurs
	When driving direction needs to be changed	When time and distance to destination are required.
	When a vehicle enters a tollgate	When surrounding information is required
		When destination-related information is required

composed of questions designed to know the importance of navigation map information delivery when a driver operates a vehicle using a navigation system and watching the map (when a speeding camera is present, traffic congestion occurs, direction change is needed, tollgate is entered) based on the FGI analysis results (Table 3).

3.4.1 When Speeding Camera is Present

For the question regarding the importance of the navigation map information delivery elements when a speed camera was present while driving, the subjects answered that speed limit (41.5 %) was the most important element followed by navigation voice information (35.4 %), distance to the speeding camera (13.8 %), and vehicle speed (9.2 %). The results show that drivers use the camera's speed limit and voice information mainly when a speeding camera is present (Fig. 2).

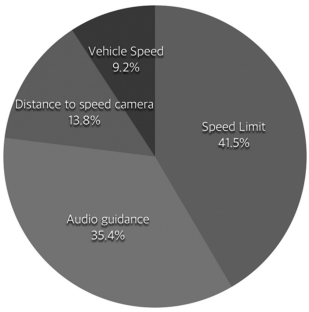


Fig. 2. Importance of navigation information delivery elements when speeding camera is present

3.4.2 When Traffic Congestion Occurs

As shown in Fig. 3, the question regarding the importance of the navigation map information delivery elements when traffic congestion occurs shows that current traffic conditions (55 %) and time to the destination (28.1 %) are the two most important elements, and accounted for 83.1 % of the responses. The next important element is

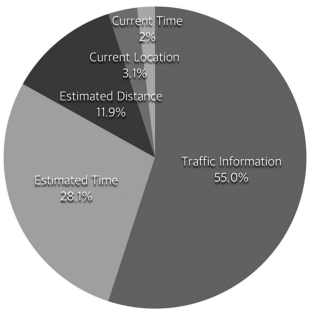


Fig. 3. Importance of navigation information delivery elements when traffic congestion occurs

distance to the destination (11.9 %), followed by current location (3.1 %) and current time (2 %), which shows that these are less important information.

3.4.3 When Driving Direction Needs to Be Changed

Regarding the question on the importance of the navigation map information delivery elements when a change in direction is required, turning direction (33.8 %), turning road lane information (33.8 %), and distance to the direction change (29.2 %) were answered with a similar degree of importance, which indicates that drivers check all three information elements (Fig. 4).

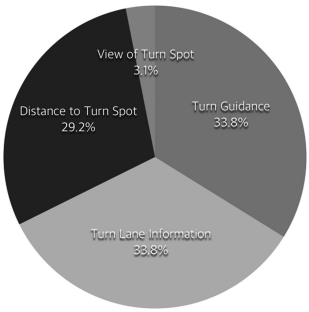


Fig. 4. Importance of navigation information delivery elements when driving direction needs to be changed.

3.4.4 When a Vehicle Enters a Tollgate

Regarding the question on the importance of the navigation map information delivery elements when a vehicle enters a tollgate, most respondents answered that high pass lane location information (52.4 %) and toll (29.2 %) are the two most important elements. That is, utilization of the navigation system is high when preparing entrance to a tollgate (Fig. 5).

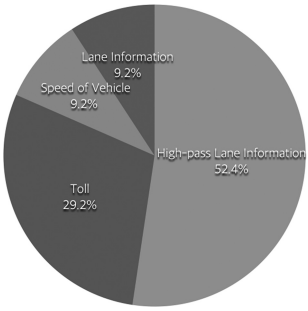


Fig. 5. Importance of navigation information delivery elements when a tollgate is entered

3.5 Interview with Passenger Seat Riders (Eight Male and Female Riders)

An interview was conducted with passenger seat riders to determine navigation utilization and the information elements that they require. The interviewees were composed of eight male and female subjects between the ages of 20 to 39 who were familiar with the use of electronics and smart devices. The interview consisted of questions designed to determine whether navigation was utilized on the way to a given destination, and which information was required after a task was given to the rider from the starting point to the destination. The interview aimed to derive the information required for passenger seat riders based on the interview results.

3.5.1 Navigation Information Elements Required for Passenger Seat Riders

The information delivery elements provided by the navigation systems were classified based on the needs produced along with the interview with passenger seat riders. Time to destination should be provided fixedly prior to and while driving for both driver and passenger, whereas weather information and destination should be provided prior to driving. While driving, rest place information should be provided fixedly for both driver and passenger, whereas traffic congestion information and toll information should be provided at the appropriate times.

4 Proposal for Navigation System Using Split-View Technology

In this paper, the navigation information delivery elements required by seat position are determined through previous studies and case studies, FGI, survey, and interview analysis, while focusing on the information delivery elements of navigation maps as described in the previous sections. Based on the results, a split-view navigation system is proposed by considering the safety of drivers and passengers, as well as the importance of information delivery elements by seat position. Here, high importance information elements are applied to the framework, and low importance information is applied or removed flexibly (Figs. 7 and 8).

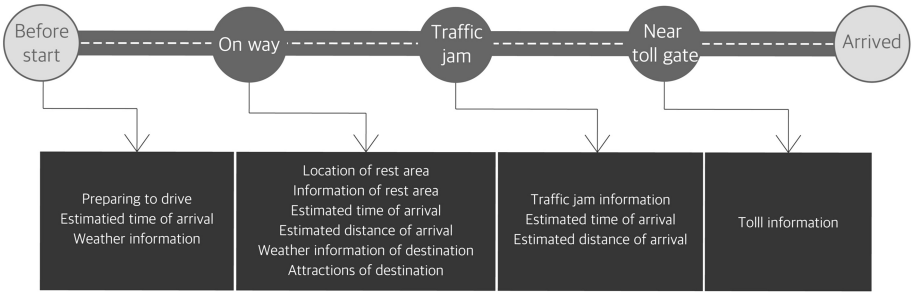


Fig. 6. Information delivery elements required when riding as a passenger

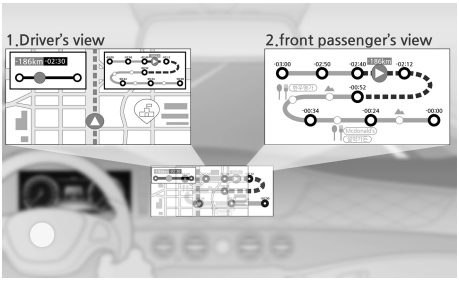


Fig. 7. During traffic congestion, split-view navigation screen.

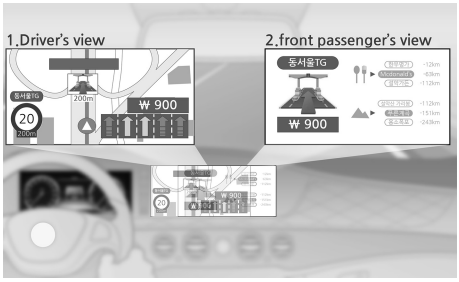


Fig. 8. When entering tollgate, split-view navigation screen.

4.1 Examples of Split-View Navigation Utilization

4.1.1 Providing Customized Information Using Split-View Navigation During Traffic Congestion

As shown in Fig. 6, the information required for drivers and passengers is provided separately using a split view. When traffic congestion occurs, information related to the distance and time to destination is provided in the view. In the view for the passenger seat, information regarding the traffic congestion areas along with distance and time to destination, tourist attractions, and restaurants around the travel path, in addition to destination information, is provided. Distance and time to destination are provided and fixed in the screen for both driver and passenger.

4.1.2 Providing Customized Information Using Split-View Navigation When Entering a Tollgate

Highly important information, such as high pass-only lane and toll, is provided so that the driver can see the required information quickly through his/her corresponding view using a split view. For the passenger, mainly auxiliary information, such as toll gate fee and next resting place location, is provided.

5 Conclusion

The car market has changed its focus from the development of mechanical performance to the development of network and GPS technology, in addition to safety and convenience. In this trend, fast and efficient navigation devices have become increasingly popular. However, current navigation systems are unidirectional in method and form in terms of providing information, and contain unnecessary information elements that increase complexity. As a result, it is difficult for drivers to accurately compare and determine road conditions and the information presented in a limited screen space that contains information only for the driver.

To solve the aforementioned problems, this study proposed a split-view navigation system in which information is divided into separate views customized according to importance for the driver and passenger in order to allow drivers to concentrate on the driving environment and increase the satisfaction of navigation application. Through the split-view navigation system, a gap of the recognition and utilization between users and devices can be reduced, and information required for drivers and passengers can be obtained quickly and conveniently. In the future, in-depth and various driving scenarios will be set up in order to conduct more user-oriented studies, and a split-view navigation prototype will be developed to conduct experiments for comparison analysis with existing navigation systems, thereby studying driving environment concentration levels and navigation utilization satisfaction.

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