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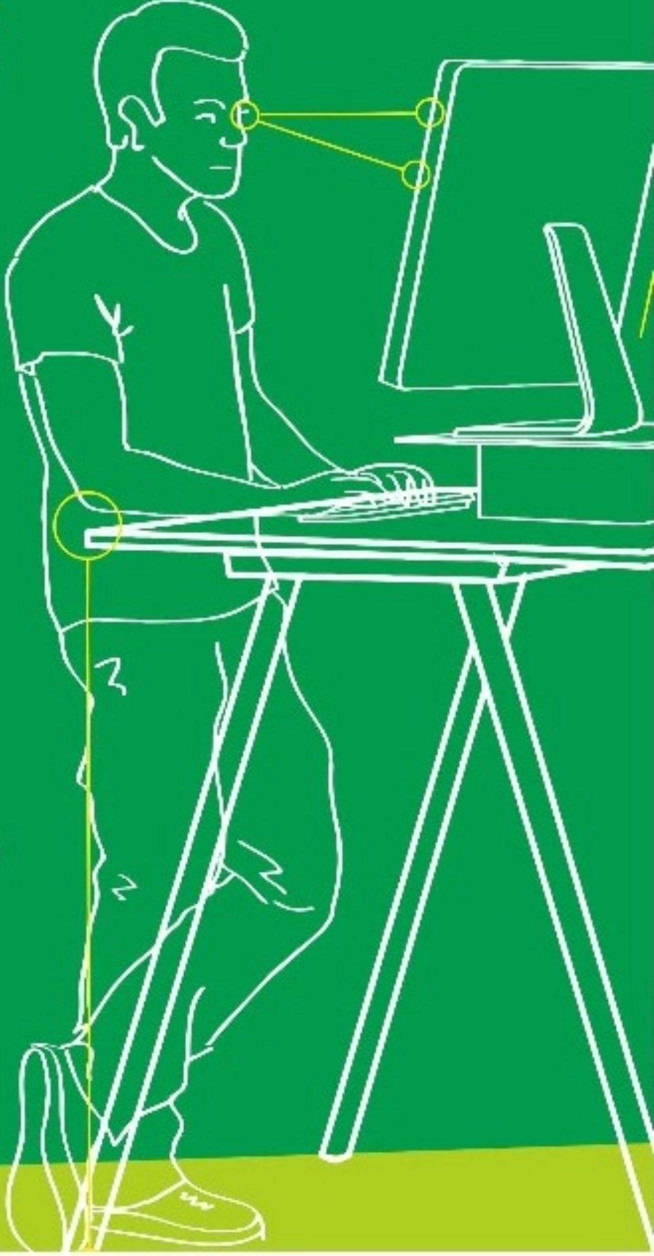
SEANES SOUTHEAST ASIAN NETWORK OF ERGONOMICS SOCIETIES

PROCEEDING SEANES 2016



THE 4TH SEANES INTERNATIONAL CONFERENCE ON HUMAN FACTORS AND ERGONOMICS IN SOUTH-EAST ASIA

29 November - 1 December 2016

Bandung - Indonesia

Hosted by

PERHIMPUNAN ERGONOMI INDONESIA

in collaboration with

INSTITUT TEKNOLOGI BANDUNG 1920

UNIVERSITAS KATOLIK PARAHYANGAN

PROCEEDING

4th SEANES International Conference on Human Factors and Ergonomics in South-East Asia

Green Ergonomics – Sustainability, Productivity, and Well-being

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Preface

Southeast Asian Network of Ergonomics Societies (SEANES) is a regional ergonomics society in Southeast Asia, founded by local ergonomics societies of few countries in the region. SEANES holds a biennial conference since 2010, which provides a forum for scientists, academics, and professionals from around the world, especially in the Southeast Asian region.

In 2016, **4th SEANES International Conference on Human Factors and Ergonomics in South-East Asia** will focus on **"Green Ergonomics: Sustainability, Productivity, and Well-being"**. Within this theme, SEANES 2016 Conference supports and expands the application of human factors and ergonomics with regards to recent local and global needs. This international conference aims to enhance the awareness of the importance of Human Factors Engineering (HFE) in various human activities and application domains, including product design, learning, communication, healthcare, transportation, defense and security.

Hosted by Indonesian Ergonomics Society (Perhimpunan Ergonomi Indonesia/PEI), in collaboration with Institut Teknologi Bandung (ITB) and Universitas Katolik Parahyangan (UNPAR), the committees publish this proceeding as publication of communities' participations on research papers.

Foreword from Conference Chair

It is with great pleasure we welcome you to the 4th SEANES International Conference on Human Factors and Ergonomics in South-East Asia (SEANES) 2016. Southeast Asian Network of Ergonomics Societies (SEANES) is a regional ergonomics society in Southeast Asia, founded by local ergonomics societies of few countries in the region. SEANES holds a biennial conference since 2010, which provides a forum for scientists, academics, and professionals in the field of ergonomics from around the world, especially in the Southeast Asian region.

This year SEANES 2016 Conference is organized for the fourth time and is hosted for the first time by Perhimpunan Ergonomi Indonesia (Indonesian Ergonomics Society) in collaboration with Industrial Engineering Department of Parahyangan Catholic University (UNPAR) and Industrial Engineering Department of Institut Teknologi Bandung (ITB). The conference is endorsed by International Ergonomics Association (IEA).

The theme “Green Ergonomics: Sustainability, Productivity, and Well-being” was chosen to reflect our passion to gather and engage ergonomists from academia and industries to exchange state-of-the-art knowledge and share their latest experience relevant to the application of human factors and ergonomics with regards to recent local and global needs. This international conference aims to enhance the awareness of the importance of Human Factors Engineering (HFE) in various human activities and application domains, including product design, learning, communication, healthcare, transportation, defense and security.

SEANES 2016 aims to engage academics and professionals in a number of interactive activities, i.e. keynote sessions, parallel paper presentation sessions, workshops, industry sessions, and also a welcome reception and a conference dinner. We have received the works of about 312 contributors from Indonesia, Malaysia, Singapore, Philippines, Thailand, India, Japan, China, Taiwan, Germany, Estonia, and Mexico through their submissions. Out of 102 research papers submitted, we selected 77 papers through a rigorous review process done by a board of international reviewers. These papers features a number of great and insightful articles related to several topics in the field of human factors and ergonomics.

Organizing the 4th SEANES Conference for the first time in Indonesia has been a great challenge. We knew that this conference would be impossible without the help from many people. We extend our gratitude to our strong and dedicated organizing committee, scientific committee, SEANES steering committee, international board of reviewers, keynote and workshop speakers, and also our generous sponsors.

Last but not least, we do hope that you enjoy the conference and your stay in Bandung. We also wish our international participants a memorable experience during your stay in Indonesia.

Johanna Renny Octavia Hariandja and Manik Mahachandra
(Conference Chairs)
On behalf of SEANES 2016 Organizing Committee

Foreword from President of PEI & SEANES

Selamat Datang di Bandung,

On behalf of the Southeast Asian Network of Ergonomics Societies (SEANES), we are very grateful for your participating in SEANES 2016. SEANES is a network of the International Ergonomics Association (IEA), and its societies are also IEA federated members, including Indonesian Ergonomics Society (PEI), Human Factors and Ergonomics Society of Malaysia (HFEM), Human Factors and Ergonomics Society of Philippines (HFESP), Human Factors and Ergonomics Society of Singapore (HFESS), and Ergonomics Society of Thailand (EST).

SEANES 2016 provides a great opportunity for sharing of ideas, research experiences and best practices in different areas of Human Factors & Ergonomics among academia, practitioners, and other stakeholders. Let's think of any possibility for collaborations in the future.

Among SEANES countries, we are heading similar challenges in improving our working conditions and promoting safety and health. Our stakeholders are looking forward to hearing our ergonomics success stories, practical ergonomics guidelines, simple ergonomics tool-kit, ergonomics approach adjusted to local conditions, more example of "ergonomics=economics", and etc. We are fortunate to have a draft of SEANES Ergonomics Checkpoints discussed in SEANES 2016. I believe that more programs can be initiated by SEANES such as ASEAN ergonomics month, training and certification, and etc. I believe that better collaborations can be established soon among individuals and societies.

This SEANES 2016 event is hosted and organized by Indonesian Ergonomics Society (Perhimpunan Ergonomi Indonesia/PEI), in cooperation with Institut Teknologi Bandung (ITB) and Universitas Katolik Parahyangan (UNPAR). Hence, I thank all the committee members for their hard work.

Finally, we hope you enjoy this SEANES 2016 event, fruitful workshop and successful conference, and also the most pleasurable stay in Bandung.

Thank you.
Sincerely,

Yassierli, Ph.D

President of Indonesian Ergonomics Society (PEI)
President of Southeast Asian Network of Ergonomics Society (SEANES)

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Driver's Distraction and Understandability of Using GPS Navigation

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ABSTRACT

GPS navigation is available on smartphone application providing turn-by-turn navigation instruction on smartphones and the distraction from GPS usage while driving also became an issue. In this paper, we present the strategy to mitigate the level of distraction by manipulating the type of display visual (2D and 3D) and placement (right, steer and left). We conducted field experiments in left-hand real traffic with 12 subjects. Our result illustrated that 3D conditions implied much fewer frequency of eye glances (FOG) than 2D conditions. Furthermore, steer conditions has much higher FOG than right and left placement conditions, but we found no significant effects on the ease of understanding (EOU) for visual display difference and the number of error for all conditions.

KEYWORDS

GPS Navigation; distraction; EOU; eye glance; real traffic experiment

INTRODUCTION

The use of vehicle technologies have grown rapidly in the near future. A significant share of their profits will be associated with the sales of telematics devices, which is computer-based in-vehicle information and communication system such as cell phones and navigation system (Tsimhoni, 2004; Richardson&Green, 2000). Human needs to determine the direction for a destination, knowing the location of a site or know the distance of a location have saturated into the increasing of human mobility. Therefore, the experts contrived a GPS (Global Positioning System) technology with high precision, global reach, convenience, high quality with low cost.

The GPS navigation system has become on of top selling technology and frequent research subject in vehicle experience (Jensen, 2010; Bumho, 2014). Now, GPS navigation is available on smartphone app providing turn-by-turn navigation instruction on smartphones in the form of portable units or in-car windscreen navigation systems. Prelimanary surveys have suggested to 95 university students in Indonesia who can drive, 89.3% of respondent using GPS navigation on smartphone app. However, the growth of the GPS system also brought up the issues regarding driver distraction (Bumho, 2014) and decreasing driver concentration. The distraction involves at least two aspects, defending the focus of anttention and doing activities excessively (Kidd, 2010). Designing these systems present many challange such as maintaining driver safety, providing information at the right time in the right way, preventing distraction as well as supporting a comfortable driving experience (Brown, 2012).

The factors of driver distraction regards the external and internal factors from the driving environments (Brooks, 2007). Driver distraction factors are defined as any stimuli include visual, auditory, biomechanical and cognitive that distracts the driver attention from the primary driving task (Ranney, 2000). Based on data reported by the official website of NHTSA (National Highway Traffic Safety Administration), the main cause of acciddent is a trigger of the driver's loss of concentration by 55%. The driver is loss of concentration when using the phone, reading a document, read short messages, look around the street for a long time and adjust the audio. Visual attention stands out as the most important attention property when driving (Bach, 2008). The driver distraction is likely the result of the dispersion of the driver's attention caused by any environmental or changes in driver's attribute (Green, 2004 ; Bumho, 2014).

The challenge of dividing attention of driving attention of the driver between road information and GPS navigation directions calls for experiments and studies how to design GPS visual systems (Jensen, 2010). Particullary, we need to understand how navigational outputs influence driving distraction (Green, 1992), driver's understandability (Bumho 2014), and if we consider how the number of error can lead to various kinds of accident (Brooks, 2007 ; Geiger, 2001). Thus, we need research that investigates how such system are used in natural contexts, i.e. as field studies involving real traffic driving. We focus on the 'design out the hazards strategies' dealing with distraction introduces by Green which mitigate the potential hazard factors by manipulating the environment (Green et al., 2008).

Many researches have worked on comparing visual and audio load of GPS navigation to minimize the driving distraction and the result is by adding audio output the driver distraction is decreased (the number of eye glances) (Green, 1999 ; Moldenhauer, 2003 ; Jensen, 2010 ; Bumho, 2014). However, Jensen et al. found that the most participants averse to use GPS navigation without visual output.

In this paper, we presented a study to focus on the strategy to minimize the distraction behaviors with system design and smartphone placement. By manipulating the type of information and placement, we explore the best strategy for delivering the navigation information to drivers. Our goal is to present guideline to reduce the distraction level while sustaining the understanding of the navigation information. Consequently, the drivers understood the direction easily and safely, even though the drivers had limited time, only enough for a quick glancing action.To achieve the research goal, we observed the number of the glancing to the GPS information and the understandability level which are inevitable during driving in real traffic. The paper is structured as follows : section 2 introduces our experiment with adapted measures used to investigate driver distraction and understandability. Next, we present result from the experiment and finally, we discuss the result and the conclusions.

METHODS

The purpose of our experiment was to study how different visual output and placement of a GPS navigation guide on smartphone affect driver distraction and performance during real traffic driving. We included two visual output modalities namely 2D model and 3D model with three placement condition namely right, steer and left.

Overall 12 people, 4 men and 8 women, have participated in the experiment. The participants are mostly undergraduate students of Industrial Engineering Diponegoro University. To control driving experience, the participants with driving license and actual driving experience are recruited. Before performed the experiment, participant should be able to pass obstacle same as the current driving license test. All participants had no color deficiencies, physically healthy and good driving records.

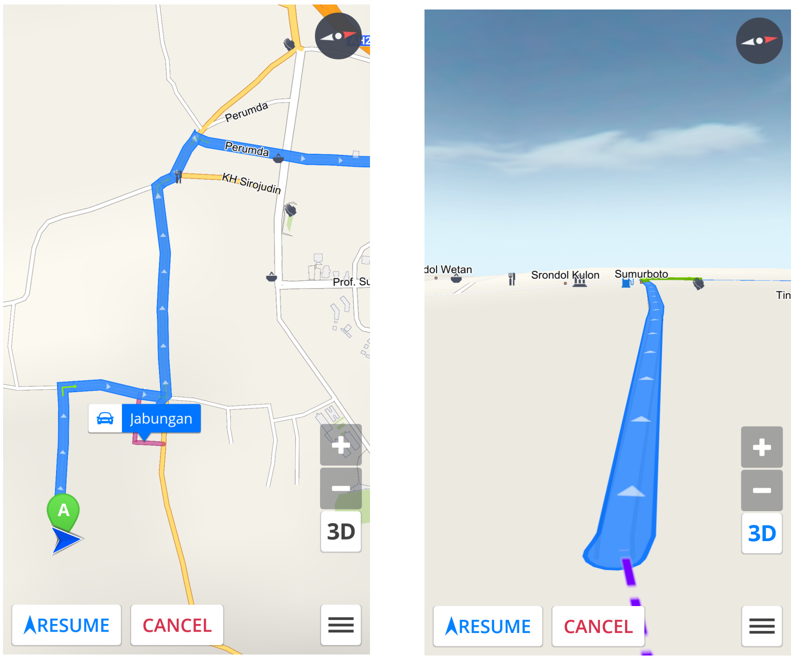
This paper uses analysis of naturalistic video data of driving with GPS navigation. The camera used in this experiment is Xiaomi Yi with 170^{o} field of view. Because we were interested in visual attention, we equipped the car with two cameras. First camera was placed in the middle of windscreen record the frequency of eye glances. Second camera was placed facing the street to record the number and kind of errors made by the participant. The followings are the examples of video output in this experiment:

(a) (b)

Figure 1. Video figure from first camera (a) and second camera (b).

The GPS navigation guide application used in the experiment was a Be On Road navigation, which consist of two visual output setting (2D and 3D). The map information is presented in egocentric view and exocentric view. The exocentric frame of reference provides a view of an object, space, or phenomenon from the outside as 3rd party, while egocentric frame of references provides a view from within the object, space or phenomenon (Dede, 2009). This difference allows human to perceive the world in different view (Bumho, 2014). The egocentric view allows the people to be more immersive and motivated through embodied, concrete learning, while whereas exocentric perspectives foster more abstract. (Dede, 2009). Based on the evidence, the egocentric map and exocentric are provided as Figure 2.

We utilized 3x2 within-subject experimental design as shown on table 1, using visual output (2D and 3D) and placement condition (right, steer and left) as independent variables and dependent variables included distraction level, error level and undestandability level as shown on figure 3. The experiment conducted in Tembalang (Diponegoro University area). The experiment comprised seven different scenario-driven tasks, whereas each one has approximately 1.5 - 1.6 km driving range. Each task should be completed within 6 minutes.



(a) (b)

Figure 2. Visual representation of 2D (a) and 3D (b)

Distraction level can be justified in various ways (Tsimhoni, 2001). However, the direct and inevitable distraction produced by the navigation is the glancing behavior about the navigation system (Bumho, 2014). This behavior disrupt the driver's attention from the road and referred as commonly applied measure for driver attention (Jensen, 2010). In this experiment, the frequency of the eye glancing was measured through counting the number of eye movement to the smartphone screen, which presented the navigation information. Ease of understanding is measured via survey. The questionnare (7pt. likert scale) was generated based on the ease of understanding measurement used in Brown's research (Brown and Bumho). Due to the difference to the research language and domain, the questionnaire was translated into Indonesian and modified according to the experimental environment.

Table 1. Experimental Design

Placement	2D	3D
Right	RD	RT
Steer	SD	ST
Left	LD	LT

(a) (b) (c)

Figure 3. Placement Condition for right (a), steer (b), and left (c)

RESULT

In this section we present the results from the experiment. We analysed 144 video recordings (two for each session). The results of frequency of glancing (FOG) and ease of understanding (EOU) were subjected to independent-samples T test. Consider to normality test, number of error (NOE) was subjected to Mann Whitney test. The results are presented in table 2 and 3.

Main Effect of Display Visual Difference

The main effect of display visual difference is statistically significant to the FOG (p=0.033<0.05). The mean value of FOG was slightly higher in 2D condition (M=66.47, Std. Err. = 1.84) than 3D condition (M=60.30, Std. Err. = 2.14). The mean value of NOE was lower in the 3D condition (M=0.86,Std. Err. = 0.18) than the 2D condition (M=0.72, Std. Err. = 0.15). This result opposes the EOU, the mean value is higher in 2D condition (M=4.87, Std. Err. = 0.17) than the 3D condition (M=4.76, Std. Err = 0.23).
We conducted interviews to the participants at the end of the session on which one of display they more understand. Through this result, there were seven participants who gave different answers between the interview and the result of the EOU scores. After eliminated these data, the new results were obtained that the average value of 3D conditions (M=4.85, Std. Err. =0.19) higher than 2D conditions (M=4.6, Std. Err. = 0.507). However, there was not statistically significant to both the EOU (p=0.711>0.05) and NOE (p=0.758>0.05).

Table 2. Mean (SE) of the Display Visual Difference

Dependent Variable	Condition	Mean (SE)
FOG	2D	66.47 (1.84)
	3D	60.30 (2.14)
EOU	2D	4.87 (0.17)
	3D	4.76 (0.23)
NOE	2D	0.86 (0.18)
	3D	0.72 (0.15)

Main Effect of Placement Difference

The mean value of FOG was highest in the steer condition (M=74.83, Std. Err. = 1.71), descending in order of right condition (M=58.71, Std. Err. = 1.62) and left condition (M=56.62, Std. Err. =2.30). The effect of placement was statistically significant between steer and left conditions (p=0.000<0.05) and right and steer conditions (p=0.000<0.05). There was no statistically significant between right and left conditions (p=0.464>0.05). This result opposes the mean value of NOE is higher in the left condition (M=1.04, Std. Err. = 0.23) than the right condition (M=0.96, Std. Err. = 0.21) and steer condition (M=0.38, Std. Err. = 0.15). However, there was not statistically significant to NOE between right and steer conditions (p=0.438>0.05), steer and left conditions (p=0.401>0.05), right and left condition (p=0.896>0.05).

Table 3. Mean (SE) of the Placement Difference

Dependent Variable	Condition	Mean (SE)
FOG	Right	58.71 (1.62)
	Steer	74.83 (1.71)
	Left	56.62 (2.30)
NOE	Right	0.96 (0.21)
	Steer	0.38 (0.15)
	Left	1.04 (0.23)

DISCUSS

The results showed a correlation between GPS visual display output and eye glance frequency. Participants overly diverted their visual attention from the driving scene to GPS system. Previous research by Green (1996) found in a comparable field study a glance frequency of one glance every 8.5 seconds for a satellite navigation system. More research by Jensen (2010) had an average glance frequency of one glance every 5.9 seconds. This corresponds well with our result as our 3D configuration had an average glance frequency of one glance every 4.6 seconds while 2D configuration glanced at GPS system every 5.9 seconds on average.

This frequency is higher than the two previous studies. Since driving performance usually decreases when visual demand increases (Brooks, 2007), such high eye glance frequencies are problematic for off-the-shelves GPS navigation systems. But the high of glance frequency could be explained by the fact that all of our participants belong to a relatively young age group. Similar studies indicate that younger and older drivers differ in driving behavior (Horberry, 2006), that younger drivers have a higher glance frequency compared to older drivers (Green, 1993 ; Jensen, 2010).

In navigation system, balancing between driver's distraction and information understandability is a tricky question (Bumho, 2014) as in this study, several participants gave different answers between the interview and the result of the EOU scores. They may not be the best solution for general driving experience. However, many alternatives are viable depending on the driving situation. Balancing the distraction and the understandability of GPS systems to address the overarching problem, further work is necessary to develop the strategies to resolve the issue, depending on the driving situations.

On the results of number of error, there are 5 types of errors found. The errors are wrong turn, stop before destination, skip destination, lost control, and incomplete the task (finish the task more than 6 minutes). The most common error is do wrong turn. This error committed because there were two or more curve are contiguous as shown figure 4, the participants misled through another turn. However, a fatal error occurs when using a steer placement condition which a participant had lost control of car and the front right tire grazed the road divider.

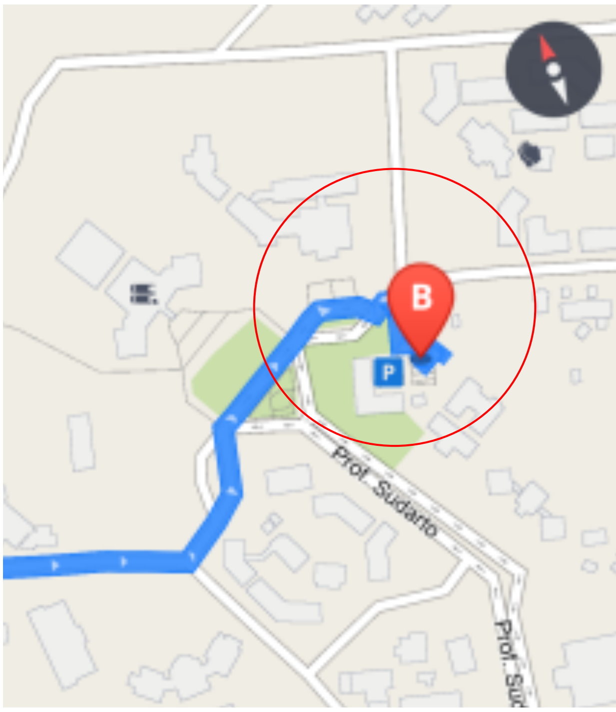


Figure 4. Road Condition

However, this research also includes limitations that further considerations are necessary. First, route selection in this study is modest. These can have complex and difficult route to obtain better results. Secondarily, the measurement of driving task performance (speeding level and task completion) and eye glance behaviour not measured in this study. Eye glance behaviour needs to include complex context as many previous research (Bach, 2008; Jensen, 2010). This measures need higher measuring devices such as eye-trackers and high-speed cameras that are able to capture the micro changes in driver's eye movement.

CONCLUSION

In this research, we tried to identify how to design navigation with lower distraction and number of error with high understandability levels by manipulating the display visual output and smartphone placement. Based on the result, we found out that the display visual output and smartphone placement influence the distraction level (as frequency of glancing; FOG). Distraction level in 3D condition is lower than 2D condition objectively and subjectively and also steer condition has the highest level of distraction compared others.

ACKNOWLEDGMENTS

We would like to thank our participants for the involvement in the experiment. Also, we thank Diponegoro University Funding for help with the funds.

REFERENCES

Zhang, P., Benbasat, I., Carey, J., Davis, F., Galletta, D. & Strong, D. (2002) Human-Computer Interaction Research in the MIS Discipline, *Communications of the AIS*, 9, 20, 334-355.

Bach, K. M., Jæger, M., Skov, M. B., G., Thomassen, N. G. (2008) You Can Touch, but You Can't Look: Interacting with In-Vehicle Systems. In Proceedings of the 26th annual SIGCHI Conference on Human Factors in Computing Systems (CHI'08), ACM Press, pp. 1139- 1148

Brooks, C. & Rakotonirainy, A.(2007). In-vehicle technologies, Advanced Driver Assistance Systems and driver distraction: Research challenges. Distracted driving. Australasian College of Road Safety.

Brown, B., & Laurier, E. (2012). The normal, Natural Troubles of Driving with GPS. The Electric Journal of Information Systems in Developing Countries, 9.

Bumho,L, Yoo Jin N., L., Sanghoo, P., Hyunsik, K., & Su-Jin, L. (2014). Driver's Distraction and Understandability (EOU) Change due to the Level of Abstractness and Modality of GPS Navigation Information during Driving. Procedia Computer Science 39 (pp.115-122)

Dede, C. (2009). Immersive interfaces for engagement and learning. science,323(5910), 66-69.

Geiger, M., Zobl, M., Bengler, K., Lang, M. (2001) Intermodal Differences in Distraction Effects while Controlling Automotive User Interfaces. In Proceedings Usability Evaluation and Interface Design, HCI 2001.

Green, P., Hoekstra, E., Williams, M., Wen, C., and George, K. (1993) Examination of a Videotape-based Method to Evaluate the Usability of Route Guidance and Traffic Information Systems, UMTRI-93-31.

Green, P. (1996) Customer Needs, New Technology, Human Factors, and Driver Science Research for Future Automobiles in Journal of the Society of Mechanical Engineers, University of Michigan Transportation Research Institute.

Green, P. (1999) Visual and Task Demands of Driver Information Systems, The University of Michigan Transportation Research Institute.

Green, P. (2004). Driver distraction, telematics design, and workload managers: Safety issues and solutions. Society of Automotive Engineers.

Green, P. (2008). Driver interface/HMI standards to minimize driver distraction/overload.

Horberry, T., Anderson, J., Regan, M. A., Triggs, T. J., & Brown, J. (2006) Driver Distraction: The Effects of Concurrent In-Vehicle Tasks, Road Environment Complexity and Age on Driving Performance. Accident Analysis and Prevention, Vol. 38, No. 1, pp. 185 - 191

Jensen, B. S., Skov, M. B., & Thiruravichandran, N. (2010). Studying driver attention and behaviour for three configurations of GPS navigation in real traffic driving. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 1271-1280).

Kidd, David. G. (2010). Distracted Driving. ASSE Foundation Research.

Moldenhauer, D. and McCrickard, S. (2003) Effect of Information Modality on Geographic Cognition in Car Navigation Systems. Center for HCI and Department of Computer Science, Virginia Tech.

Ranney, T. A., Mazzae, E., Garrott, R., & Goodman, M. J. (2000, July). NHTSA driver distraction research: Past, present, and future. In Driver Distraction Internet Forum (Vol. 2000).

Richardson, B., & Green, P. (2000). Trends in North American intelligent transportation systems: A year 2000 appraisal (Tech. Report 2000-9). Ann Arbor, Mi: University of Michigan Transportation Research Institute.

Tsimhoni, O., & Green, P. (2001). Visual demand of driving and the execution of displayintensive in-vehicle tasks. In Proceedings of the Human Factors and Ergonomics Society 45th Annual Meeting (pp. 1586-1590). Sania Monica, CA: Human Factors and Ergonomics Society.

Tsimhoni, O., Smith, D. and Green, P. (2004). Address Entry While Driving: Speech Recognition Versus a Touch-Screen Keyboard. Human Factors and Ergonomics Society, Vol. 46, No. 4, pp. 600 - 610