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Human requirements validation for complex systems design

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Abstract

One of the most critical phases in complex systems design is the requirements engineering process. During this phase, system designers need to accurately elicit, model and validate the desired system based on user requirements. Smart driver assistive technologies (SDAT) belong to a class of complex systems that are used to alleviate accident risk by improving situation awareness, reducing driver workload or enhancing driver attentiveness. Such systems aim to draw drivers' attention on critical information cues that improve decision making. Discovering the requirements for such systems necessitates a holistic approach that addresses not only functional and non-functional aspects but also the human requirements such as drivers' situation awareness and workload. This work describes a simulation-based user requirements discovery method. It utilizes the benefits of a modular virtual reality simulator to model driving conditions to discover user needs that subsequently inform the design of prototype SDATs that exploit the augmented reality method. Herein, we illustrate the development of the simulator, the elicitation of user needs through an experiment and the prototype SDAT designs using UNITY game engine.

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Keywords: Driving simulator; Requirements discovery; Complex systems; Human factors analysis

1. Introduction

Socio-technical systems are systems that exhibit both technical and social complexity. Networked infrastructures, such as those in transportation, belong to this category of complex systems. The technical complexity of these systems refers to the functionality and human-machine interaction metaphors, while the social complexity refers to the human factors and associated human behaviour constraints. Therefore, designing such complex systems requires the investigation of both dimensions. This paper describes the analysis of human factors related requirements of future intelligent transportation systems to advance the design of novel systems to address user requirements. Therefore, in this paper we make the link between human factors and requirements of future systems in

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transportation more explicit. Essentially, human factors and requirements have a lot in common, however only a few studies apply human factors knowledge to requirements engineering. While non-functional requirements (NFR) such as performance, security and maintainability are considered for software functions, NFRs for people, such as driver situation awareness (SA) and workload, have received less attention in requirements engineering. Such requirements have been proven very significant in preventing system failure, articulated in the form of accidents in complex systems such as transportation [1]. Therefore, the systematic analysis of this type of NFRs prior to any system implementation is considered vital. The main problem in evaluating these requirements is the need for an implemented prototype system prior to a holistic analysis of system behaviour under a number of test scenarios that involve people and tasks. This, however, is expensive and risky. Therefore, the use of a simulated environment for requirements analysis saves the costs of physical mock-ups and prototypes, especially for complex systems [2].

This study focuses on the discovery of the user requirements with emphasis on SA enhancement systems and the specification of the system requirements of future SDAT that will eliminate the problem of driver overload. The method is based on the use of a custom made virtual reality (VR) simulator that models the road infrastructure and environmental characteristics, along with models of prototype SDATs using a number of visualization metaphors to simulate the candidate designs. The paper is organized as follows: related work in the areas of situation awareness, human factors and requirements is firstly reviewed, followed by the methodology for developing the driving simulator along with the design of the experiment used to elicit user requirements. The assessment process of driver workload through a series of experiments is illustrated, followed by the analysis of the results, the specification of the requirements and the design of a smart situation enhancement system. The paper concludes with a brief discussion of the implications.

2. Situation awareness

In traffic safety, SA constitutes a major critical factor, since it provides the driver with the ability to anticipate events given perceived driving and environmental conditions. SA defines the process of perceiving information (level 1) from the environment, comprehending its meaning (level 2) and projecting it into the future (level 3). SDAT have been developed to alleviate accident risk by either reducing driver workload or assessing driver attentiveness. Examples include adaptive cruise control, collision notification, driver monitoring, traffic signal recognition, night vision, lane departure warning systems and blind spot monitoring. Such systems aim to draw drivers' attention on critical cues that improve their decision making. However, they only provide limited support to SA since they address isolated factors affecting it and in some cases with negative effect due to the extra information load they incur to the driver. The first step in improving drivers' SA is to enhance their capability of perceiving and interpreting traffic and environmental conditions. These constitute level 1 and 2 of the SA process model. However, such smart systems, facilitate level 3 SA for navigation, which might decrease drivers' attention, due to secondary task execution, that could in turn lead to reduced level 1 SA. This could undermine attention to operational or tactical driving activities (e.g. braking, lane changing, gap acceptance etc.). To that end, three important issues need to be addressed prior to any SDAT development: (i) the identification of driver's information needs that could enhance SA, (ii) the specification of a SDAT feedback metaphor (type of feedback and appropriate time for issuing warnings) that will support those needs without impairing driver attention, and (iii) the evaluation of the effect of a prospective SDAT on traffic safety. This, however, is a complex process and in most cases is only feasible once a prototype of the system is available. Developing a prototype, is also time consuming and expensive. An alternative is thus the development of a simulation model of its functionality. This enables testing possible technological solutions and the evaluation of their effect on road safety prior to implementation. This is the approach employed in this study.

Endsley et al. [5] warn socio-technical system designers of the importance of maintaining SA in complex systems and draw the attention on the issues that could inhibit SA. One of the most important strains of SA is information overload. Too much information at any point in time hinders adequate SA of human operators. Overloading divides the decision maker's attention among numerous stimuli which results in increased demand for cognitive resources. When too much information is available then information scanning capability is reduced. This is due to the effect of attentional tunnelling [5] where decision makers lock their attention on certain aspects of the environment they are trying to process, and ignore other important stimuli.

This work illustrates the development of a driver support tool that relates to Endsley's design principles [5] for SA which dictate for the mitigation of information overload, reduction of display density, enhancement of the driver's ability to comprehend the meaning of data and finally assistance in developing projections of the status of important data in the near future. The concept is based on fusion of vast amount of information from the environment into meaningful attentional directives/cues that describe the situation. These directives act as precursors based on which Critical Information Cues (CIC) of any given situation are assessed. CICs by definition are situation- specific and describe the key aspects that, if tackled satisfactorily, will minimise the likelihood of accident [1,7,8].

3. Human factors and driving

Road accidents are usually attributed to human error [7,8] that is induced from low SA caused by increased workload. Humans, as information processing systems, have a number of information flow channels (visual, auditory, tactile) processing various information sources (e.g. a navigation system display, the forward view through the windscreen) of varied bandwidths (e.g. high-density traffic will require a higher sampling rate than low-density traffic). Our cognitive capacity is limited, and consequently there is an upper threshold to the amount of information we can process per second and channel [7,8]. Therefore, we tend to share our attention among a few information sources. An overloaded driver is less likely to deal effectively with an unexpected event. Fuller [6] also expresses accident risk as a function of the driver's cognitive resources and task-demand in the driver-road system. Additionally, overloading and driver distraction is interlinked [10] with distraction frequently reported as a cause of road accidents. According to Dingus et al. [25], distractions contribute to 78% of accidents and to 65% near-crashes. Distracted drivers take longer to react to stimulus. This consequently yields support to the claim that drivers' visual attention is attracted by advertisements [9]. This increases significantly the risk of accident when the driver's visual workload is already compromised. As a result, the driver may fail to sufficiently attend to the needs of the primary task (i.e. driving) and hence make errors that could lead to a hazard. Driver phenotype behaviours associated with workload include, but are not limited to, the following: lane position deviation, number of lane departures, lane departure durations and speed deviation. Hence, monitoring these phenotypes can give a good estimation of driver workload.

Listening to music, one of the most common auditory stimuli that drivers are exposed to, is another driver distraction [18]. Listening to music is often a habitual behaviour and is perceived as pleasurable activity. Therefore drivers do not tend to perceive music as a distraction that could impair their driving performance [20]. The literature, however, points to the fact that music affects driving style more when the driving conditions are complex. This is mainly articulated in peripheral vision which in effect reduces drivers' SA. Research on the influence of music on driving behaviour yielded contradictory results. Music, on one hand, positively impacts driving behaviour by soothing people's emotions and hence easing drivers' aggression. On the other hand, there is evidence [21] that listening to music while driving may distract drivers' attention and concentration. McKenzie [19] highlights that more than 25% of traffic accidents occur due to distractions caused by music. Certain qualities of music can interact with the driving task [21]. Hence, listening to music and engaging in a concurrent task negatively influences cognitive load, since both compete for the same limited cognitive resources. In addition, listening to music results in an intense emotional experience that leads to a change in heart and breathing rates, which in turn could cause aggressive driving behaviour [24] or even erratic, and possibly dangerous, driving behaviour [19]. Dalton et al [23] states that even though music impairs driving performance, it is still unknown which elements of music affect driving performance.

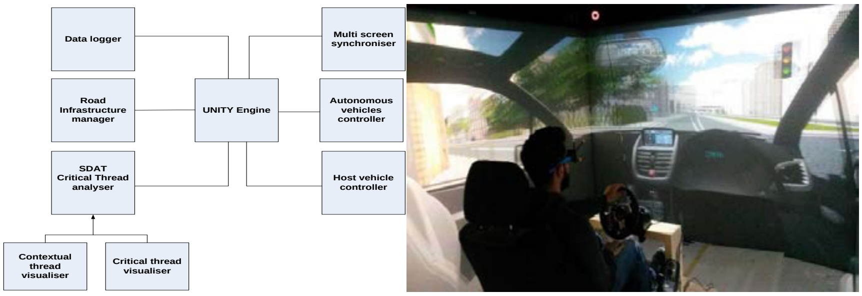

Fig. 1. (a) The main components of the simulator; (b) The driving simulator in the virtual reality lab.

Driver distractions, as explained, can emerge from either outside (billboards) or inside the car (music). Despite the isolated analyses of individual distracters, limited efforts have been made to investigate the combined effect of both endogenous and exogenous distractions on workload. Therefore, it is important to investigate the joint effect of both types of distractions on driver behavior and accident probability. This work contributes to fill in this gap through the empirical analysis of the effect of distractions on driving behavior and accident risk using native road users. This, in effect, acts as the foundation based on which future smart situation enhancement systems are specified. The use of local users tailors the analysis using native driving behaviors that could vary in different contexts.

4. Designing the driving simulator

The main components of the simulator are depicted in Fig. 1 (a). The main part of the system is the Unity game engine that includes the physics and environmental aspects of the simulation. The next component is the host vehicle controller that enables the navigation of the host vehicle using the pedals and steering wheel. The data-logger records the driving behavior for each subject taking part in the experiment, along with additional data relating to the traffic conditions and physiological state of the driver. The Multi screen controller is responsible for the synchronization of the multiple screens in the CAVE facility. The autonomous vehicles controller provides each vehicle that simulates the traffic conditions with autonomous properties. Hence, each autonomous vehicle dynamically decides its route, avoids obstacles in its way and alters its speed depending on the traffic. The road infrastructure manager component is the facility used for the development of the road network and the surrounding environment. Finally, the critical thread analyzer simulates the SDAT functionality. For this, two candidate designs have been implemented: the radar design, which provides contextual cues and the information prioritization component, that ranks information based on risk level.

5. Research design

The aim of this study was firstly to discover the user needs in terms of information overloading and SA under two experimental conditions at an accident black spot in Nicosia-Cyprus: (a) roadside advertising billboards, and (b) in-vehicle music. The second aim was to use these results to specify the candidate systems requirements for the design of a smart in-vehicle situation awareness enhancement system. To investigate these aspects it was imperative to design and develop the driving simulator, as described before. Fig.1 (b) illustrates the developed simulator in VR that enables the stereoscopic interaction of participants with the experimental conditions. Participants immerse with the experimental scenarios for a more realistic experience which improves the quality of data collected. Using this simulator, the research design then employed an experimental evaluation to test the aforementioned effects. Participants drove a pre-specified route in the designed road network both with and without billboards and in-vehicle music at a major intersection that has been identified by the police as a safety critical point. The music that was used in the vehicle in the second condition had a pop genre with upbeat rhythm. The driving scenario used included a number of slow vehicles preceding the host vehicle. Distractors were used in combination with a secondary-task that was to memorise landmarks in the road. This aimed to test the driving style of users under extreme circumstances and in combination with the experimental conditions to stress test the SA and workload levels of participants. Prior to the experiment, participants were familiarized with the simulator and briefed of the task they had to perform. The road network used for simulator training was different from the model used during the experiment. Each participant completed a set of four scenarios to cover the different combinations of experimental conditions: with/without music and with/without animated advertisements.

Data were collected at different stages: pre-experiment, during experiment and post-experiment. The pre-experiment data collection stage concentrated on participants' demographics, driving experience, driving style through a locus of control questionnaire, and historical data relating to driving. The post experiment data collection focused on recall of advertisement types and location. During the drivers' engagement with the experimental conditions, information was recorded relating to driver workload and driving behaviour. Specifically, manifestations of workload, such as lateral deviations, crash and crash location and speed, were recorded on a time-location plot. Driver behaviour was recorded in terms of lane change, headway, car overtaking and speed, acceleration, deceleration, breaking patterns and steering angle. Headway expresses the distance from the preceding vehicle and is a typical indicator of aggressive driving related to accidents. The simulator automatically recorded the data in log files for each participant. The collected data was automatically assigned to the 11 sections that were specified in advance by the analysts. The specification of these sections was based on infrastructural properties and billboard locations. Twenty (20) participants (10 male) took part in the present study, with a mean age of 35 years (SD = 18), and all with a full driving license. The age range of participants in the experiment was based on the mean age of drivers from historical records at the black spot under study. Their mean driving experience was 15.2 years (SD = 16.1). All participants were Cypriot residents and hence familiar with the local traffic regulations. During the experiment, participants were asked to drive as they would normally do, given the conditions and the posted speed limits. Users were left to continue driving even after an accident, to examine if this event affected their behaviour. After the experiment, participants were asked to recall if they saw any advertisement, the type of advertisement (static/dynamic), their location and content.

6. Data analysis

As can be deducted from the aforementioned description of the experiment, this involved a repeated measures experimental design with each of the 20 subject taking part in 4 experimental conditions. The data collected during the different stages of the study were merged into one dataset, which included the necessary information for both the participants (e.g. gender, age, driving experience) as well as their behavioral measures during the four experimental conditions (e.g. accident occurrence, speed, headway, etc). This design, resulted in 80 (correlated) observations in total. Both descriptive/exploratory data analysis as well as inferential statistical analysis employing regression modeling, were applied to this dataset with the help of the widely used statistical package SPSS (version 20). We limit the presentation here to the preliminary descriptive analysis.

6.1. Participants' responses to questionnaires

Before the experiment, participants were asked to rate their knowledge about the highway traffic code. The majority reported that they know it well (20%) or very well (70%) with only 2 participants reporting less confident with it (10%). 80% also reported that they are familiar with the particular road, whereas almost half (45%) consider this road section accident-prone compared to only 30% stating the opposite and a 25% reporting unsure. The majority (75%) are frequent drivers (i.e. they drive almost daily). Post-experimental questionnaires also provided some information that could be used in further analysis: When asked whether they noticed any advertisements, 14 out of the 20 participants (70%) responded positively. The vast majority (N=17, 85%) considered the final road section (closed to the cross-road) as the most dangerous. When asked whether the music influenced their concentration only 8 (40%) reported no influence. From the 12 who responded that music had an influence, most reported influences were positive (i.e. increase in concentration) with one negative (i.e. increase in speed), however it should be noted that detailed information was not provided by all. Finally, when asked about the slow cars, most participants (N=14, 70%) considered them as nuisance for their driving (describing them as ‘annoying’, causing anger or increasing their desire to overtake, amongst others).

6.2. Explorative descriptive analysis

In this section we explore some descriptive results regarding the measured aspects of driving behaviour and the outcome of interest (accident occurrence), by section. We also investigate relationships between these measures and the experimental conditions as well as drivers’ background variables with the outcome variable (accident) as well as some potentially confounding variables.

The estimated proportions of participants deviating from their lane at each section showed a tendency to deviate more in sections with distractions. These sections were also found to be responsible for the statistically significant differences in post hoc tests during ANOVA between sections ($F_{(lane)=}$12.25, p<0.001, $F_{(overtake)}$=15.86, p<0.001). Therefore, deviations were more significant at areas with increased distractions such as advertisements (section7) or adverse traffic conditions.

With regards to the outcome variable of interest, Fig. 2 illustrates how the chances for accident vary across road sections, and under the two experimental conditions. Further statistical analysis for the differences across sections showed that sections 10a and b present the higher (statistically significant, F=16.84, p<0.001) accident proportions. No statistically significant differences were found in regards to experimental conditions

In sum it was found that accidents occurred under conditions of increased driver information load. These were locations with either high traffic or high destructions such as animated advertisements. Music also acted as a baseline distraction that affected driver behavior and hence helped to expose driver overloading points. Observations at the overloading locations indicate that the drivers' SA level was not adequate. This denotes failure to satisfy the minimum accepted threshold for SA and workload requirement. This highlighted the need for a smart system to reduce the level of driver workload under conditions of increased visual stimuli. Specifically the requirements elicited from this study points towards a smart system that will prioritize visual information presented to drivers. The functional requirements of such a design are specified next.

7. Requirements discovery

Results from the experiments revealed the need of a SA enhancement system. A key success factor for such systems is to achieve and maintain accurate, complete and real-time information of the situation [38]. Therefore, such system should provide level1-3 SA support. These address issues relating to presentation, comprehension and projection of critical information to drivers to reduce driver workload and stress (e.g. knowing about the vehicle’s current position in relation to its destination, the relative positions and behavior of other vehicles and hazards, and how these critical variables are likely to change in the near future). Head-up displays (HUD) emerged as a technology that uses a transparent display to present data without requiring users to look away from their usual viewpoints. Therefore, they serve as a perfect technology to inform drivers of critical information, without major distraction, unlike other approaches. HUD design should, thus, have functionality that draws driver attention on key safety critical information. Domain analysis highlighted the relevance of spatial proximity with importance of information. Therefore, the criticality of the cues is defined based on proximity to other vehicles, other vehicle trajectories, predicted trajectory of surrounding vehicles and their projected impact. Another important finding is the

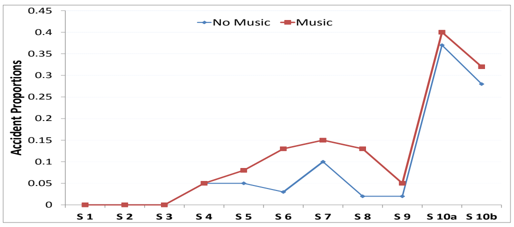

Fig. 2. Accident occurrence with/without music (left) and advertisements (right) per section (x-axis).

effect of the vehicle’s blind spot on road accidents. Blind spot is the area at the back side of the vehicle where the driver's view is obscured by the vehicle’s middle pillar. Drivers are taught to look over their shoulder before changing lanes to improve their SA. This finding highlighted the need of additional driver information requirements.

Based on the results, a smart SA enhancement system should support the information needs of drivers by reducing their workload. There are many challenges in designing such systems. The one addressed here is the design of the user interface so that it is not distractive but at the same time informative. This could be achieved by providing drivers with important situational cues that are critical for maintaining sufficient levels of SA. To reduce the likelihood of accidents, the future system's requirements should focus on information presentation and dynamic risk assessment. To that end the use of augmented reality overhead display is considered as a suitable option. The visualizations of the display should aim to provide the driver with enhanced peripheral vision with a dynamic assessment of the most critical entities within the immediate periphery of the vehicle. Based on the above, the candidate designs proposed and modelled in the virtual environment. The host vehicle is shown in a circle (in blue) surrounded by red and green vehicles of different sizes. The size of surrounding vehicles denotes the level of risk. Hence, vehicles that are in the driver’s blind spot are represented by big red icons. Low risk cars are depicted by small green icons. High proximity or hidden vehicles at intersections are also high risk and hence are big and red. Vehicles positions and speeds can be obtained from on-board sensors. Surrounding vehicles at intersections can be obtained through vehicle-to-vehicle communication protocol. The prototype visualization metaphor will be depicted on the vehicles windshield. This needs to be validated through another experiment to compare safety with/without SA enhancement. The second design of the system is based on the need to prioritize information based on risk level. This, as illustrated at the bottom of figure 6, is expressed using arrows pointing to the direction of the imminent threat. Candidate system prototype designs

The specification of the two candidate designs to support Level 1 SA adhere to the SA design principles of Endsley [5] and visual search strategies of drivers [11]. Therefore, candidate designs aimed towards eliminations of information tunnelling, improvement of information relevance and information criticality. The use of Unity and VR enables the designer to test variations of different designs by programmatically designing their virtual prototypes in Unity. Therefore, technological constraints such as the development of a smart windshield to project the information, are overcome through the virtual environment. Hence, the designer can concentrate on the functional and non-functional requirements of each candidate design. In our case, both designs have been specified in terms of functionality and user interface information architecture. The functionality of the two designs has been implemented using Unity's scripting language. Design 1, more specifically, resembles the metaphor of a radar that is depicted on the windscreen. This design is the implementation of the blueprint design if Fig. 3 and resembles the host vehicle is in the middle surrounded by red and green circles of different sizes, representing surrounding traffic threats. Information regarding the rear vehicles can be obtained through on-board sensors. Vehicles at intersections can be obtained through vehicle to vehicle communication. The visualization metaphor presented in Fig. 3 will be depicted on the vehicles windshield. Design 2 is based on the principle of information prioritisation and aims to draw attention of the driver to critical information. This information is expressed in the form of red arrows that are shown on the windscreen of the vehicle depending on the direction of the threat. Hence vehicles that are approaching from the rear left angle of the host vehicle are shown with a red arrow on the lower left corner of the windshield (Fig. 3 (b).

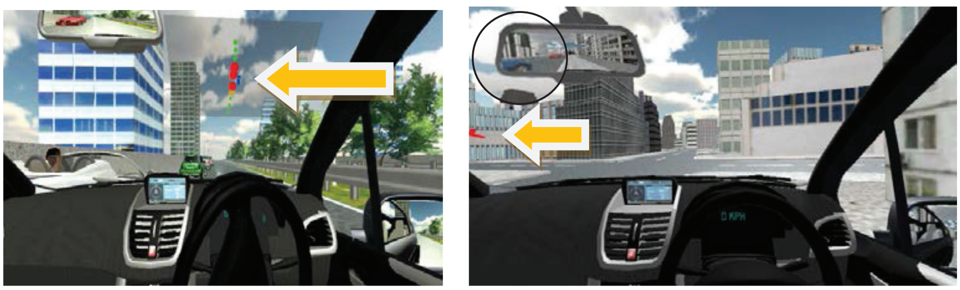

Fig. 3. (a) Visualizations of Design 1. The radar on the windscreen depicts the surrounding vehicles. The red circles are the cars on the left side. (b) Visualizations of Design 2, with the arrow indicating a threat from a car approaching from the rear left side (blind spot).

8. Conclusions

The method provides local authorities with a cost effective solution that enables the involvement of native drivers for the analysis of local driving behaviours and road design challenges for the specification of customised smart SDAT that would support the driving needs of different road users. The method enables the design and customization of the road infrastructure for what-if analyses in a modular fashion. This enables the design of the experimental settings for the analysis of a variety of conditions such as the use of advertising billboards in straightforward fashion. Preliminary results from this study highlight a relationship between music and driving speed and, consequently accident probability. A weak relationship between lateral deviations of road users and advertisement is also observed. Overall the results highlight that distractions from music and advertisements have an effect on driver behaviour and increase the likelihood of accidents. These observations provided the basis for the specification of new SDAT designs that aim to eliminate drivers overload. Specifically, the use of situation enhancement technology such as the one specified herein could alleviate these problems. The verification however from this needs to be obtained after evaluating the system under a series of experimental conditions. Limitations of this work concentrate on realism and immersion factors that laboratory methods are suffering from.

References

[1] Brookhuis K.A., D. De Waard, “On the assessment of (mental) workload and other subjective qualifications” Ergonomics, 45 (2002), pp. 1026–1030

[2] Davenne D., Lericollais R., Sagaspe P., Taillard J., Gauthier A., Espié S., Philip P. (2012). “Reliability of simulator driving tool for evaluation of sleepiness, fatigue and driving performance”, Accident Analysis and Prevention, 45, pp.677-682.

[3] Eksler V., Lassarre S., Thomas I. (2008). “Regional analysis of road mortality in Europe”, Public Health, 122, pp.826-837.

[4] Endlsey M. R. (2004). Designing for situation awareness: an approach to user-centered design, CRC press

[5] Fuller R. and Santos J. (2002). Human Factors for Highway Engineers. New York: Pergamon

[6] Gregoriades. A and Sutcliffe. A. (2007). “Workload prediction for improved design and reliability of complex systems,” Reliab. Eng. Syst. Saf., 39, n.4, pp.530–549.

[7] Gregoriades A, Sutcliffe A, Papageorgiou G, Louvieris P. (2010) “Human-Centred Safety Analysis of Prospective Road Designs”, IEEE Transactions on Systems, Man and Cybernetics, Part A, Vol 40, 2, pp 236-250.

[8] Holohan, C., Culler, R., & Wilcox, B. (1978). “Effects of visual distraction on reaction time in a simulated traffic environment”, Human Factors, 20, pp.409–413.

[9] Jamson, A. H., Westerman, S. J., Hockey, G. R. J., & Carsten, O. M. J. (2004). “Speech-based e-mail and driver behaviour: Effects of an in-vehicle message system interface”, Human Factors, 46, pp.625–639.

[10] Konstantopoulos P., Chapman P., Crundall D. (2010). “Driver’s visual attention as a function of driving experience and visibility. Using a driving simulator to explore drivers’ eye movements in day, night and rain driving”, Accident Analysis and Prevention, 42, pp.827-834.

[11] Miller G. (1956). “The magic number seven plus or minus two: Some limits on our capacity to process information”, Psychol. Rev., 63, n.2, pp.81–97.

[12] Montella A., Ariab M., D’Ambrosiob A., Galantea F., Maurielloa F., Pernettic M. (2011). “Simulator evaluation of drivers’ speed, deceleration and lateral position at rural intersections in relation to different perceptual cues”, Accident Analysis and Prevention, 43, pp.2072-2084.

[13] Williams J. C. (1988). “A data-based method for assessing and reducing human error to improve operational performance”, in Proc. Human Factors Power Plants, Monterey, CA, pp.436–450.

[14] Young M. S., Mahfoud J. M., Stanton N. A., Salmon P. M., Jenkins D. P.,. Walker G. H. (2009). “Conflicts of interest: The implications of roadside advertising for driver attention”, Transportation Research, 12, pp.381-388.

[15] Young, K. L., Regan, M. A., & Hammer, M. (2003). “Driver distraction: A review of the literature”, (report no. 206). Victoria, Australia: Monash University Accident Research Centre.

[16] DOT (2013) U.S. Department of Transportation Releases Policy on Automated Vehicle Development, www.nhtsa.gov

[17] N. Dibben, V.J. WilliamsonAn exploratory survey of in-vehicle music listening Psychology of Music, 35 (2007), pp. 571–589

[18] McKenzie, K. C. (2004). The effects of music amplitude and tempo on simulated driving performance.

[19] Kazak, S. (2009). Kuwait’s newest misdemeanour: Driving under the influence of music

[20] North, A. C., & Hargreaves, D. J. (1999). Music and driving game performance. Scandinavian Journal of Psychology, 40, 285–292.

[21] Dalton, B. H., & Behm, D. G. (2007). Effects of noise and music on human and task performance: A systematic review. Occupational Ergonomics, 7, 143–152.

[22] Wark, R. I., Lucke, R. E., & Raub, R. A. (2002). Aggressive driving: Appendix 6, Northwestern University Center for Public Safety

[23] R. J. Stone, Virtual Reality for Interactive Training: An Industrial Practitioners Viewpoint, International Journal of Human-Computer Studies, vol. 55, pp. 699-711, 2001.