Driver Distraction and In-vechile Information System

Marjana Čubranić-Dobrodolac [1], Svetlana Čičević [2], Momčilo Dobrodolac [3],
Andreja Samčović[4]

Abstract - **As computers and other information technology move into cars and trucks, distraction-related crashes are likely to become an important problem. Distraction is a well-established causal factor in road accidents. The range of system often termed In-Vechile Information Systems (IVIS) are the focus of this paper.**

Keywords - **distractions, drivers, IVIS, risk**

I. INTRODUCTION

Over the past century, automation has gradually moven its way into most aspects of our daily lives. Presently we use automation in many contexts, both passively (by using products/services provided using automation), and actively (by interacting with automation directly). The majority of researchers and authors prefer to refer to the whole range of driving automation technology as intelligent transport systems (ITS). ITS can be broadly regarded as falling into two distinct categories: advanced driver assistance systems (ADAS) and in-vehicle information systems (IVIS). IVIS include route guidance systems, traffic information systems, vehicle monitoring systems, audio/video devices, vehicle communication systems and driver convenience services (e.g. personal digital assistants – PDA`s, phone related services, hands-free equipment, driver identification systems). The ONS omnibus survey examined UK drivers' and passengers' attitudes towards transport [1]. In one section of this survey, they asked whether the car/van that participants used most often had a satellite IVNS installed. They also collected a range of demographic information (including age, gender, socio-economic group, gross annual income and driving frequency). The survey showed that an equal proportion of male and female drivers reported using an IVNS (7%) and that they were used by drivers of all ages, although the highest using age bands were 26-44 years (9%) and 45-54 years (9%). The GFK survey showed that in Germany, the highest purchasing age bands were 40-60 years (43%), closely followed by those under the age of 30 years (32%) and over 60 years (25%).

II. LITERATURE REVIEW

Distraction of the driver is one of the major causes for car accidents. About 20 % of injury crashes in 2009. involved reports of distracted driving [2]. In 2009, 5,474 people were killed in U.S. roadways and an estimated additional 448,000 were injured in motor vehicle crashes that were reported to have involved distracted driving [3]. Wang, Knipling, and Goodman [4] have analyzed 1995 CDS data to compare distraction-related crashes to other crashes by crash type. They raport that distraction - related crashes account for about 13 percent of crashes nationally. Their analyses by crash type and distraction showed that distraction-related single vehicle crashes (both run–off-the-road and on-road) account for about 18.1 percent of single vehicle crashes and 41.2 percent of all distraction-related crashes. Thus, the single vehicle run off the road crash The age group with the greatest proportion of distracted drivers was the under 20 age 16 percent of all drivers younger than 20 involved in fatal crashes were reported to have been distracted while driving [2].

A. Types of distraction

To understand distractions, some knowledge of theories of human attention is warranted. According to the Multiple Resource Theory [5], people are considered to have a variety of resources (visual, auditory, cognitive, and biomechanical) they can allocate to a task or combination of tasks. Overload can occur when the task demand exceeds at least one of the resources or, in less common cases, the capability to switch between tasks. So for example, people cannot read two high data rate, no redundant streams of text separated by a large visual angle because their eyes cannot be directed towards two widely separated locations at once. Similarly, people cannot retain nonchunkable long strings of digits in memory because that would overload the cognitive resource, specifically, short-term memory.

Four inter-related subcategories have been identified: visual distraction; auditory distraction; biomechanical distraction and cognitive distraction [6]. Auditory distraction – occurs when the driver momentarily or continually focuses their attention on sounds or auditory signals rather than on the road environment. Biomechanical distraction - this involves movements of the driver's body away from the standard posture required to perform the physical tasks associated with safe driving. Cognitive distraction – includes any though the road network safely and their reaction time is reduced. Visual distraction – comes in tree forms: driver's visual field is blocked when a driver focuses visual attention on something other than the road ahead (navigation system, a loss of visual attentiveness, also known as "looked but did not see").

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[1] Marjana Čubranić-Dobrodolac is with the Faculty of Transport and Traffic Engineering, Vojvode Stepe 305, 11000 Beograd, Serbia, E-mail: marjana@sf.bg.ac.rs.;

[2] Svetlana Čičević is with the Faculty of Transport and Traffic Engineering, Vojvode Stepe 305, 11000 Beograd, Serbia, E-mail: s.cicevic@sf.bg.ac.rs.;

[3] Momčilo Dobrodolac is with the Faculty of Transport and Traffic Engineering, Vojvode Stepe 305, 11000 Beograd, Serbia, E-mail: m.dobrodolac@sf.bg.ac.rs

[4] Andreja Samčović is with the Faculty of Transport and Traffic Engineering, Vojvode Stepe 305, 11000 Beograd, Serbia, E-mail: andrej@sf.bg.ac.rs

The experimental approach on studying driver distraction has been an area of interest in human factors research since the 1980s. Driving simulation studies have been frequently used in order to avoid real crash risk [7]. A popular paradigm in this line of research has been based on the measurement of driver workload and driving performance at the level of operational control of the vehicle [8]. The basic problems with interpreting the results of these experiments often reside in the not-self paced and time-pressured tasks, and subsequently in the absence of participants' possibilities to prioritize the driving over secondary tasks. The external validity of the conclusions can often be questioned [9]. These studies are valuable for revealing capacity limitations of the drivers in a dual-task situation. However, they do not necessarily tell us if the drivers are able to overcome their capacity limits with tactical behaviors in real traffic to maintain a sufficient level of driving performance. Recently, new perspectives and models for studying driver distraction on multiple levels have been proposed [10]. Lee, et al. [8] introduced the model of driver distraction comprising of breakdowns at the operational, tactical and strategic levels of control in dual-tasking while driving based on Michon's [11] three-level model of driving behavior. This model induces new types of challenges for experimental research; how can breakdown in control be measured on the levels of tactical and strategic control? These are not necessarily in direct relation to task workload or to the lapses of vehicle control at the level of operational control.

The effects of visual time sharing on driving performance have been extensively studied and are fairly well understood. When visual attention is diverted from the road (by a secondary task or by visual occlusion), the driver cannot give any tracking response, which results in periods with fixed steering wheel angle [12]. During these periods, heading errors build up which result in lane weaving and, sometimes, lane exits. Many studies have found a strong relationship between visual demand and reduced lane keeping [13]. There is considerable evidence that the driver's lane keeping performance is guided by time-based safety margins, representing the "safe boundaries" that the driver aims to stay within [14], an idea first proposed by Gibson and Crooks [15]. Physiological effects of IVIS performance have primarily been studied in the context of mental workload and stress, where usually no distinction is made between visual and cognitive load. Especially cardiac activity, measured in heart rate and heart rate variability, has been proved to be sensitive to mental workload and stress. Another common physiological workload indicator is skin conductance, which has been proved sensitive to task complexity. Today, with the advent of hands-free and voice-based solutions for the phone and other functions, the number of mainly cognitively loading in-vehicle tasks (with no visual diversion from the road ahead) is increasing. This has generated much interest in the effects of cognitive load on driving. Numerous studies have reported degrading effects of purely cognitively loading tasks in terms of reduced event detection performance. These include results from artificial detection tasks such as the Peripheral Detection Task [16], as well as more realistic tasks such as detection of critical events in simulation [13]. Recarte and Nunes [17] investigated the effect of cognitively loading tasks on visual behavior and event detection performance. They found reduced event detection as well as a concentration of gaze towards the road centre during certain cognitively loading tasks, such as word production and complex conversation. Similar results where obtained by Harbluk and Noy [18]. They found that the number of saccades decreased and that the percentage of time spent looking at the central region of the road increased with task complexity. If a driver's attention is drawn away from the primary task of driving, or they are overloaded beyond their capabilities, crash risk is elevated.

B. Factors of distraction

Advances in computer and communication technology over the last two decades have led to the development of a wide array of advanced in-vehicle information systems, collectively called telematics. The proliferation of in-vehicle technology has generated concern that these systems, singly and in combination, might cause an increase in driver distraction [19]. One of the most widely available in-vehicle advanced technologies is the route guidance system. These systems provide the driver with information about a route to a destination supplied by the driver. Because these systems use vehicle location technology, such as GPS, route directions can be timed to correspond with the driver's information needs as he or she drives. There is little information about the incidence of route-guidance systems in vehicles or the frequency with which they are used. Analysis of the crash databases yielded no instances in which use of a route-guidance system was indicated as a contributing factor in distraction-related crashes [20]. In addition, natural use studies of various route guidance systems have found no adverse effect on traffic safety, nor any increase in self-reported distraction [2, 4, 9, 19]. Despite these results, there is general agreement in the literature that the function of destination-entry is quite distracting if it involves visual displays and manual controls [13]. While most destination-entry would probably occur in a stationary vehicle, Green [3] has pointed out that there are several scenarios in which a driver might engage in destination-entry while driving, and in turn be at greater risk for a distraction- related crash: driver is in a hurry and enters the destination after starting the trip; driver changes his or her mind about the destination after starting trip; driver gets other information, such as a radio traffic report, then decides to change the route; driver entered the wrong destination; and the driver does not know the exact destination prior to departure and enters the actual destination later. Thus, there are several scenarios in which use of a route-guidance system could lead to distraction-related crashes.

Evidence obtained from simulated driving [21] and on-the-road driving [23, 24] has shown that use of a mobile phone can lead to decrements in tasks required for safe driving. There is general agreement in the literature that the most distracting activities involving cellular phone use are dialing and receiving phone calls [24, 3]. In addition, use of hand-held phones tend to be associated with greater decrements in driving performance than hands-free phones, but the conversations tend to be equally distracting, especially when the information content is high [25]. Evidence is also mounting, although still far from conclusive, that the use of cellular phones increases crash risk. In their analysis of the CDS data, Stutts, Reinfurt, and Rodgman [26] found that cellular phone use or dialing was implicated in about 1.5 percent of distraction-related crashes. One would expect this percentage to increase as the predicted use of cellular phones increases. More recent work in Virginia has found that about 5 percent of distraction-related crashes involve cellular phones [5]. Using a cell phone use while driving, whether it's hand-held or hands-free, delays a driver's reactions as much as having a blood alcohol concentration at the legal limit of .08 percent [26]. Reed and Robbins [27] conducted a simulator study to investigate the impact of text messaging while driving. Results show that participants' driving behavior was impaired, particularly reaction time (35% slower when writing a text message) and the ability to maintain lateral vehicle control.

Lee et al. [9] investigated driving performance while operating a speech-based e-mail system. Results show a 30% increase in reaction time to a braking lead vehicle when the speech-based task was carried out. Furthermore, subjective workload increased significantly while performing the e-mail task compared to a baseline condition. A follow-up study of Jameson et al. [28] confirmed these results and demonstrated a significant reduction of the time to collision in the distraction condition. The vast majority of motor vehicles are equipped with entertainment systems that include radios, cassette players, and/or compact-disc (CD) players. Operation of these systems usually involves manual manipulation of buttons, knobs, and media, as well as visual input, leading to a potential for physical, cognitive, and visual distraction. Analyses by several researchers have shown that adjusting an entertainment system is one of the leading in-vehicle triggering events for distraction-related tow-away crashes [26, 4] distraction-related police-reported crashes [29], and distraction-related fatal crashes [30].

III. CONCLUSION

The potential for novel IVIS tasks to dangerously distract is a significant safety concern. It can be difficult to legislate against driver distraction, in contrast to other impairments, such as when driving under the influence of alcohol. Distraction, unlike alcohol or fatigue, is likely to affect drivers only intermittently over the cours of journey [31]. Furthermore, drivers may even choose to engage in distracting task during periods where overall accident ris is low, for example when on quite, straight roads, or when stationary, such as when waiting at traffic lights. As driving processes become more automated, IVIS may even be important in avoiding potential driver under-load. Consequently, banning drivers from engaging in all IVIS task whilst a vechile is in motion is in motion is neither realistic nor practical.

A future research aim for driver distraction in general might migh be to combine accident analysis studies with evidence from driving performance evaluations, in order to establish the absolute risk posed by IVIS tasks. Risk is a factor of demand of performing a task, the prevalence of the system amongst the driver population, the frequency of use, and the driving environment at the instant of interaction. Consequently, determining the overall risk of a distraction source must consider exposure to the source, in addition to its distracting effects.

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