Design Guide for Interfaces of Automotive Infotainment Systems Based on Value Sensitive Design: A Systematic Review of the Literature

Andrés F. Agudelo[1], Diego F. Bambague[1], César A. Collazos[1], Huizilopoztli Luna-García[2] and Habib Fardoun[3]

[1] Faculty of Electronic Engineering and Telecommunications, University of Cauca, Popayán, Colombia.
{andresfag, fbambague, ccollazo}@unicauca.edu.co

[2] Center for Automotive Research and Innovation of Mexico (CIIAM), Autonomous University of Zacatecas, Zacatecas, Mexico.
hlugar@uaz.edu.mx

[3] King Abdulaziz University, South Arabia.
hfardoun@kau.edu.sa

Abstract. Currently automobile manufacturers have tried attract the attention of buyers by adding information systems and car entertainment (infotainment systems). The present study focuses on knowing the positive and negative aspects in the design of the interfaces of automotive infotainment systems and how researchers they have tried to mitigate the negatives. In addition, it is presented how and in which projects the Value Sensitive Design framework has been used to improve the design and construction of technology from an approach oriented moral ethical values, and specifically if there is evidence of a relationship between infotainment and VSD systems. This review was carried out on 4 bases of data, where 180 articles were found, which demonstrate the need to include human factors in the development of interfaces in systems infotainment

Keywords: Value Sensitive Design, design guides, information and entertainment systems, automotive user interfaces, infotainment systems, HCI, human-computer interaction, safety, well-being.

1 Introduction

During the last years due to high market competition, automotive companies have generated developments that seek to attract the attention of buyers with new features in infotainment systems. The term Infotainment starts from the composition of information and entertainment, which can include radio, CD, MP3 browsers or internet connection [1]. These systems bombard end users with a large number of applications and options within vehicles [2], the main problem is that their interfaces are poorly designed and generate a lot of distraction to the driver when performing a task, which increases the risk of accidents on the road. Through different studies, it has been sought to mitigate this problem by redesigning

the size of the interface icons [3] or totally or partially blocking the functionalities of the infotainment system, however, the desired success has not been achieved [4].Once this problem has been identified, we proceed to find out how to involve the Value Sensitive Design (VSD) framework in the interface design guide for automotive Infotainment systems with the aim that the product generated with this guide has a greater affinity with the end user. VSD or Value Sensitive Design, is a technology design-based approach that accounts for human values in a comprehensive and principled manner throughout the conceptual, empirical, and technical research design process [5]. All this supported by HCI, Human Computer Interaction is a multidisciplinary field of study that focuses on the design of information technology and especially on the interaction between humans and computers.

This document is organized as follows: section 2 corresponds to the methodology used to carry out the systematic review, section 3 to the results and their respective analysis, and section 4 to the conclusions.

2 Investigation method

The study presented in this document was carried out following the guidelines for a systematic review of the software engineering literature proposed by Kitchenham and Charters [6]. These guidelines define the procedures to follow to identify and summarize existing data on a particular topic. The following sections present the steps to perform this review.

2.1 Research questions

The main study objective of this research is to answer the following research questions:

- How has the technology design been improved through value sensitive design?
- What problems have you faced when building infotainment system interfaces?
- Is it possible to improve the design of interfaces of automotive infotainment systems through a design guide applying VSD?

2.2 Data sources and search strategies

The search included articles written in English and / or Spanish from the last twenty years (2000-2020) to find out the improvements that the interfaces of infotainment systems have had and the advances and / or contributions made in VSD in order to improve this methodology or problems related to it. The search was carried out in electronic databases with very specific keywords and filtering criteria. The following electronic databases were used: **IEEE Xplore** (http://ieeexplore.ieee.org), **SCOPUS** (https://www.scopus.com/home.uri), Springer (http: //link.springer. com) and **ScienceDirect** (https://www.sciencedirect.com).

The search was initially carried out with the words: infotainment systems and value sensitive design and no document addressed the problems of the interface design with VSD, due to this it was decided to change the AND connector to OR and a good number of results were obtained between the which, on the VSD side, the results indicated that this framework has

been applied in different investigations with good results. - Regarding infotainment systems, studies were found showing different problems that these systems have had and studies were found where improvements were made to the interfaces from a different perspective than VSD. In addition, they took into account aspects other than safety or well-being, due to this it was decided to add the following keywords: safety and wellbeing, to find articles that focused on improving infotainment interfaces focusing on the safety and well-being of the driver and the people involved. your surroundings. For the search in Spanish, only safety and wellbeing were changed to safety and well-being. The search strings are shown below:

Table 1. *Databases and search strings*

Database	Search string
IEEE Xplore	(("infotainment system" AND "Value sensitive design") OR ("infotainment systems" OR "Value sensitive design" AND (safety OR wellbeing)))
SCOPUS	(TITLE-ABS-KEY ("infotainment system" AND "Value sensitive design") OR TITLE-ABS-KEY ("infotainment System" OR "Value sensitive design" AND (safety OR wellbeing)))
Springer	(("infotainment system" AND "Value sensitive design") OR ("infotainment systems" OR "Value sensitive design" AND (safety OR wellbeing)))
ScienceDirect	(("infotainment system" AND "Value sensitive design") OR ("infotainment systems" OR "Value sensitive design" AND (safety OR wellbeing)))

2.3 Study management and Inclusion / Exclusion criteria

The following are the reasons why some studies found were not included in the systematic review:

Table 2. *Exclusion and inclusion criteria*

Exclusion criteria (CE)	Inclusion criteria (CI)
CE 1: Document not available for to download.	CI 1: Document published between 2000 and 2020
CE 2: Documents that are not in English or Spanish.	CI 2: Documents related to Infotainment Systems or VSD
CE 3: Documents not related to Infotainment Systems or VSD	

2.4 Data extraction

The results found in each database were recorded in a template with the following information: (a) Search terms, (b) Inclusion or exclusion criteria, (c) DOI, if available, (d) Authors, (e) Article title, (f) Keywords, (g) Year of publication and (h) Type of publication such as book chapters, journal articles or conference documents.

The search for this systematic review was carried out between June and July 2020, where **229** articles were obtained. When applying the inclusion and exclusion criteria, **25** documents were selected to carry out the review process. The other documents were excluded as they did not focus on infotainment systems or the application of Value Sensitive Design to create or improve technology design. After reviewing the documents, it was found that a total of **11** studies focused on VSD and **14** studies focused on the creation of

infotainment system interface guides or problems with these systems.

Table 3. *Search results summary*

Database Name	Search results	Excluded documents that do not comply with **CE1**, **CE2** AND **CE3**	Relevant documents that comply with **CI 1** and **CI 2**
IEEE Xplore	52	45	7
SCOPUS	51	47	4
Springer	50	54	6
ScienceDirect	75	67	8
Total	229	213	25

3 Analysis of data and results

The different strategies used in the studies show the following results:

In [4] the VSD application is successfully executed in 3 studies. The first study involves cookies and informed consent in web browsers [5], the second involves projection technology, and the third involves interaction with the user and the interface for integrated land use, transportation, and environmental simulation [7].

In [1] apply the three main components of VSD (conceptual, empirical and technical research) in the development of a command and control supervision interface for a military cruise missile, the case study is the redesign of the interface for the Tomahawk missile placing importance on values such as health, safety and public welfare.

In [5] the aim is to improve support for informed consent in web-based interactions, through the development of new technical mechanisms for managing cookies. In conclusion they provide an improved solution for cookies, browsers, informed consent, and set goals for browser redesign. Furthermore, the feasibility of the VSD methodology is demonstrated in the context of a large-scale, real-world software system.

In [9] this gap is addressed with the development of a culturally sensitive method of obtaining values from people. At the end of the study it is verified that through these letters explicit and implicit values of the women of Saudi Arabia can be obtained (taking into account the difficulties of freedom of expression that exist in this culture) through the creation of scenarios where implicitly women were involved and could express what they felt without feeling judged.

In [7] the urbanSim system is developed, which is a tool for use by urban planners, who are in charge of formulating policies for land use, transport and the environment. The project integrates academic research on urban simulation model and policy evaluation, research on human-computer interaction, and software engineering, and uses a value-sensitive design process because the domain of urban development and impacts environments are loaded with values. The result is the system that predicts outcomes in terms of spatial patterns of homes, jobs, real estate inventory, and prices.

Land use patterns and transportation systems play a critical role in determining the economic

vitality, livability, and sustainability of urban areas. Both land use and transport have important environmental effects, in particular on emissions, resource consumption and the conversion of rural to suburban or urban land, in [2] simulating the effects of the scenarios on urban growth and patterns of redevelopment, transportation use, resource consumption, and environmental impacts over periods of twenty years or more, through the UrbanSim system [7]. The main software lesson learned from this work was the value of translating as much of the complex functionality of individual models as possible to the supporting infrastructure.

The study [10] discusses the design of a Household Indicators tool, employing VSD theory and methodology, since the urban planning domain has too many disagreements from stakeholders and their values, and also has too many values in the research focus on the following 4 values: freedom from prejudice, legitimacy, transparency and democratic commitment. In addition, usability and transparency.

Digital media have become widely incorporated into the activities of many households and are increasingly used by young children. The introduction of these technologies has called into question the mediation of parents. Parental control software enables parents to support risk management of their children's digital media. [11] is part of the design of an application for parents, attached to an online entertainment platform for children aged 4 to 10 years. The theory and methods of value-sensitive design are used here, and value stresses in parental software design are addressed. When carrying out the study, the values "security" and "security control" are obtained first, and secondly "quality" and "participation", necessary to carry out the software, highlighting that the media company involved in the project only had taken security into account, through this study it will be possible to improve the software by including these found values.

Because blind and deafblind people cannot drive, they depend on public transport for their daily mobility, but this can be a challenge as they are not designed for people with these limitations because it depends on visual cues such as the bus number or the Next stop. In [12] they apply VSD to identify key values, conducting semi-structured interviews to understand how they use public transport and what human values were important, in this field two key values are identified: independence and security, from this two key values are developed applications that provide information on the arrival of buses in real time and information on bus stops, and finally user studies are carried out to demonstrate that the applications allow people to travel more independently and safely, and guidelines are obtained for designing interfaces mobile phones for deafblind people and recommendations for conducting studies with them.

In [13] they deal with an issue that perhaps affects the core of society like few others and that is the raising of children, since parents seek to support the healthy social development of their children and keep them safe from harm. Through two technological trends, the first through the development of remote parenting technologies that allow parents to monitor the activities of their children and the second, the security applications for mobile phones to improve the physical safety of a person, which they are increasing. As these two trends merge, they will have implications for parent-child relationships, affecting domains such as: privacy, trust, and maturation. The problem is that young people do not like to be monitored or surveilled. They use the theory and methods of value-sensitive design to analyze different stakeholders, both direct and indirect, and values, such as privacy, security, trust, and maturation. As a contribution there is a new method to study the impacts on stakeholders

and how these analyzes can be used to develop technical strategies to design security technologies for mobile devices making them secure and private.

In [14] they deal with the issue of car safety and the challenge for those who design the systems that are inside the cars, called infotainment systems, the challenge is to create systems that do not generate excessive distraction to the driver. In the article, the research on the design requirements must be taken into account for this they relied on a system of daily use which was the Mobile Data Terminal, a device used by the Sussex Police to help officers in their duties while on patrol. The investigation involved interviewing officers, working alongside officers in real-world situations, and evaluating the system by implementing a security checklist. The findings showed that the mobile data terminal improved the productivity of the double crew on patrols, but was less effective and potentially compromised road safety when the patrol cars were single crew. The central conclusion was that telematics systems, which are considered incompatible with driving, should not be accessible while a vehicle is in motion.

In [15] the technological bias that exists in design is discussed, design is considered in the development of technology for people, but the people who will use this technology are not involved in its design. Noticing that the technology-centric design had failed, he turned the other way, taking the human as the center of things. However, human-centered design is just as inappropriate as machine-centered design, as it implies a dichotomy where one part of the system is seen as opposite to the other. This applies no less to the case of automotive environments, where the interaction has a clear purpose, that is, to safely negotiate traffic. Therefore, the design must embrace a centered function to see where the joint driver-vehicle system is center.

In [16] a framework for the evaluation of usability in the context of in-vehicle information systems (IVIS) is presented. This framework guides designers by defining usability criteria for an evaluation, selecting appropriate evaluation methods, and applying those methods. These stages form an iterative design assessment process designated with the overall goal of improving the usability of IVIS and enhancing the driving experience, without compromising driver safety.

In [17] it is discussed the amount of information to which a driver is subjected within his vehicle, the interaction between the driver and these systems are critical, since they can distract the driver from his main role, which is to drive. The article presents a method to optimize interfaces (HMI) in automotive interaction and presents a strategy to design messages or warnings in an optimal way in terms of driver safety.

In [18] he aims to describe and discuss three critical points: (1) the lack of human factors design, (2) develop selection criteria for the data sources used to produce patterns and (3) variability in the population of users of human factors design guidelines. Within the context of these issues, some of the limitations, tradeoffs, restrictions, and options associated with the development of human factors design. Guidelines for Advanced Traveler Information Systems (ATIS) are presented.

In [19] it is stated that research on driver distraction has a long history and attracts the attention of the scientific community, the public and authorities. This resulted in a large number of activities. This article summarizes the main developments, since the last ESV in 2013 from an automaker's perspective.

In [20] he gives an overview of the design guidelines for developing user-friendly navigation systems. Aspects of the controller interface, screens with voice commands, text size, screen layout details, and speed are covered. It is particularly important that the information in the vehicle is compatible with information on the road by adding human factors.

In [21] he points out that, in modern vehicles, he faces an increasing flood of information for the driver. Information established in systems such as: radio, GPS, mobile phones, etc. Future vehicle information systems will provide this wealth of information primarily in two information centers: a reconfigurable instrument cluster with relevant driver information and a center console display with relevant information for the driver and passenger

In [22] the effort devoted in recent years to the development of the occlusion technique as a procedure for evaluating the human-computer interface of vehicle information and communication systems (IVIS) designed to be used by the vehicle is discussed driver while driving. The importance of the results of the application of this procedure depends essentially on its reliability. However, there is a lack of evidence on whether this basic measurement criterion is met with this procedure, and because the questionable reliability can raise doubts about its validity. This project endeavored to clarify this problem, and reports on a new statistical analysis of data obtained from previous experiments.

In [23] he talks about the challenge presented by human-computer adaptation in autonomous vehicles. Design decisions are generally based on financial, technical, political, and personal issues. Users are motivated by needs that are rooted in what makes sense of them. Therefore, good design results from a process that focuses on understanding users and their concerns.

In [24] it is indicated that advances in vehicle instrumentation are driven by customer demand, by the desire of manufacturers to add value and by increasingly sophisticated technology. The range of information and communication equipment available to the driver has grown considerably in the last 5 years. Trip computers and radio data systems (RDS) are now standard in many vehicles, and the use of in-vehicle phones has also increased. Other driver information products such as route guidance and congestion warning systems are becoming more common. Now, as products emerge, the real needs of controllers and their interaction with new systems are receiving much more attention. Human computer interaction (HCI) is emerging as a key area, which has a significant impact on the usability and safety of in-vehicle systems.

In [25] it is established that the elderly are the fastest growing segment of the driver population. While there is a strong emphasis on older people maintaining their mobility, the safety of older drivers is a serious community concern. Frailty and declines in a variety of age-related sensory, cognitive, and physical disabilities can place older people who drive at increased risk of accident-related injury and death. Several studies have indicated that in-vehicle technologies such as Advanced Driver Assistance Systems (ADAS) and In-Vehicle Information: Systems (IVIS) can provide assistance to older drivers. However, these technologies will only benefit older drivers if their design is congruent with the complex needs and diverse skills of this driving group. The design of ADAS and IVIS is largely based on the automotive human computer interface (HMI), however, it is unclear to what extent declining sensory, cognitive and physical capabilities of older drivers are addressed in current guidelines.

In [26] the importance of multitasking in the vehicle and its popularity within a car is presented. However, as users' demand for having these systems increased, a "Design without restrictions" was generated, a philosophy to support the design, which ends up limiting it. Situational Awareness (SA), a theory that enables designers to understand how operators interact in dynamic and complex environments, SA is used to frame this experimental research. SA-based human-machine interface concepts are proposed, designed to help drivers to multitask on the vehicle, when the task is frequent, switching is required.

In [27] a set of guides for the front-end of infotainment systems are presented and with this to give a starting point for people who are dedicated to the development of interfaces for these systems. The proposed guidelines cover four dimensions inferred from the state of the art as crucial to achieve a good design of automotive interfaces: a) Design; b) Interaction; c) Security; and d) Connectivity. The guides were formed by integrating conceptual ideas from areas such as Graphic Design, User-Centered Design, Human-Machine Interaction, Usability, and Human-Computer Interaction. Also, they were structured and specified in such a way that they could be used as a comparison tool (Similar to the Evaluation-Heuristic technique) to analyze the front-end of existing infotainment systems.

Developed elements

In this category are the elements developed to achieve the objectives of each study.

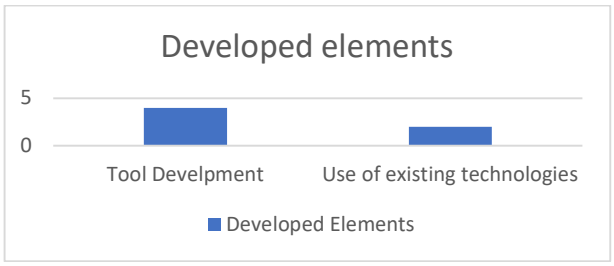

Fig. 1. *Elements developed*

As seen in Fig. 1, in 4 studies the researchers developed tools. Redesigned the command and control supervision interface [4], [7] created a solution for handling cookies in browsers. In [8] developed a system that predicts results of spatial patterns, referenced in [2] and [9]. In [11] developed applications for blind and deafblind people. And 2 studies use the existing technology, in [5] they use implantable medical devices and in [12] they use remote parenting technologies.

Technology used

Technology participated in all studies from different fields such as medicine, computer science or politics like this:

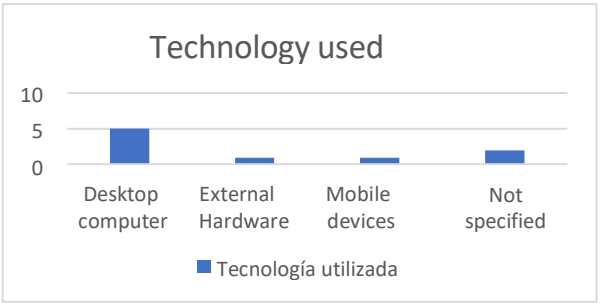

Fig. 2. *Technology used.*

As seen in Fig. 2, 5 studies [4, 7, 8, 9, 11] used desktop computers, 1 study uses implantable medical devices [5], 1 study uses mobile devices [12], 1 study uses digital media [10] but it is not specified which ones and [4] does not specify the device.

Findings on Research Questions

RQ1. How has technology design been improved through VSD?

In the reviewed articles, it was evidenced that VSD has been used effectively to improve technology design in different research fields (HCI, medicine, politics, education, etc.). In addition, it has no problem with devices, since it focuses on designing technology from a moral perspective, taking into account all those involved or interested parties that will be affected by technology and emphasizing the values that are present throughout the world development, integrating with existing design or engineering practices. Therefore, it can be said that VSD improves technology design in projects in different areas.

RQ2: What problems have you faced when building infotainment system interfaces?

The articles emphasize the problem of including man and his real needs, and his interaction with the new systems is receiving much more attention. Human computer interaction (HCI) is falling short of meeting this need despite being a key area, which has a significant impact on the usability and safety of vehicle systems.

RQ3: Is it possible to improve the interface design of automotive infotainment systems through a design guide applying VSD?

Due to the problems that infotainment system interfaces have by not having a standard to be developed and also, taking into account that despite the technology that we currently have available, these systems do not provide sufficient safety for the driver and make performing a task while driving is very complicated, it is possible to use an approach such as VSD in the automotive sector, since it focuses on the users or those involved (direct and indirect stakeholders) taking into account aspects that are really important for them from a moral perspective , allowing to improve the technology design and in this case to do so through the creation of a guide that provides a standard for the development of infotainment system interfaces.

4 Conclusions and future work

In the 25 articles selected in this systematic literature review it was found that there are many gaps in the design of infotainment system interfaces that can be addressed through an approach such as VSD.

Due to the nature of VSD it was determined that it is feasible to address some technology design issues in a totally different way than has traditionally been done.

None of the studies found used VSD to improve infotainment system interfaces, especially considering that this is an approach that is growing. On the other hand, Infotainment systems are revolutionizing the automotive industry worldwide and therefore must have a standard to be developed in order to improve safety for those involved.

Based on the results of this systematic review, there is an opportunity to promote the application of approaches such as VSD to the improvement of infotainment systems.

As future work, shortcomings in the interface design of infotainment systems can be improved by applying a VSD approach, generating a guide for the design of these interfaces, in such a way that human values are considered throughout the process.

References

1. Cummings M. L., "Integrating ethics in design through the value-sensitive design approach," *Science and Engineering Ethics*, vol. 12, no. 4, pp. 701–715, 2006.
2. Noth M., Borning A., and Waddell P., "An extensible, modular architecture for simulating urban development, transportation, and environmental impacts," *Computers, Environment and Urban Systems*, vol. 27, no. 2, pp. 181–203, 2003.
3. Silvennoinen J. M., Kujala T., and Jokinen J. P. P., "Semantic distance as a critical factor in icon design for in-car infotainment systems," *Applied Ergonomics*, vol. 65, pp. 369–381, 2017.
4. Warnow-Blewett J., "Saving the records of science and technology: The role of a discipline history center," Science and Technology Libraries, vol. 7, no. 3, pp. 29–40, 1987.
5. Friedman B., Howe D. C., and Felten E., "Informed consent in the Mozilla browser: Implementing value-sensitive design," Proceedings of the Annual Hawaii International Conference on System Sciences, vol. 2002-Janua, no. c, pp. 1–10, 2002.
6. Brereton P., Kitchenham B. A., Budgen D., Turner M., and Khalil M., "Lessons from applying the systematic literature review process within the software engineering domain," *Journal of Systems and Software*, vol. 80, no. 4, pp. 571–583, 2007.
7. Waddell P. and Borning A., "A Case Study in Digital Government: Developing and Applying UrbanSim, a System for Simulating Urban Land Use, Transportation, and Environmental Impacts," *Social Science Computer Review*, vol. 22, no. 1, pp. 37–51, 2004.
8. Denning T., Kramer D. B., Friedman B., Reynolds M. R., Gill B., and Kohno T., "CPS: beyond usability," pp. 426–435, 2014.
9. Alshehri T., Kirkham R., and Olivier P., "Scenario Co-Creation Cards: A Culturally Sensitive Tool for Eliciting Values," *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, no. 1, pp. 1–14, 2020.
10. Davis J., "Engaging and informing citizens with household indicators," *Proceedings of the Annual Hawaii International Conference on System Sciences*, pp. 1–10, 2008.
11. Nouwen M., Mechelen M. Van, and Zaman B., "A value sensitive design approach to

parental software for young children," *Proceedings of IDC 2015: The 14th International Conference on Interaction Design and Children*, pp. 363–366, 2015.
12. Azenkot S., Prasain S., Borning A., Fortuna E., Ladner R. E., and Wobbrock J. O., "Enhancing independence and safety for blind and deaf-blind public transit riders BT- 29th Annual CHI Conference on Human Factors in Computing Systems, CHI 2011, May 7, 2011 - May 12, 2011," pp. 3247–3256, 2011.
13. Czeskis A., Dermendjieva I., and Yapit H., "Parenting from the Pocket: Value Tensions and Technical Directions for Secure and Private Parent-Teen Mobile," *SOUPS: Symposium on Usable Privacy and Security*, 2010.
14. Hampton P. and Langham M., "A contextual study of police car telematics: The future of in-car information systems," *Ergonomics*, vol. 48, no. 2, pp. 109–118, 2005.
15. Hollnagel E., "A function-centred approach to joint driver-vehicle system design," Cognition*, Technology and Work*, vol. 8, no. 3, pp. 169–173, 2006.
16. Harvey C., Stanton N. A., Pickering C. A., McDonald M., and Zheng P., "A usability evaluation toolkit for In-Vehicle Information Systems (IVISs)," *Applied Ergonomics*, vol. 42, no. 4, pp. 563–574, 2011.
17. Amditis A., Polychronopoulos A., Andreone L., and Bekiaris E., "Communication and interaction strategies in automotive adaptive interfaces," *Cognition, Technology and Work*, vol. 8, no. 3, pp. 193–199, 2006.
18. Campbell J. L., "Development of human factors design guidelines for advanced traveler information systems (ATIS)," *Vehicle Navigation and Information Systems Conference (VNIS)*, pp. 161–164, 1995.
19. Heinrich C., "Fighting Driver Distraction – Recent Developments 2013 - 2015," no. 15, pp. 1–8, 2015.
20. Alam K. M., Saini M., and El Saddik A., "Toward social internet of vehicles: Concept, architecture, and applications," *IEEE Access*, vol. 3, no. c, pp. 343–357, 2015.
21. Knoll P. M., "22.1: Invited Paper: An Integrated HMI Concept for Driver Information and Driver Assistance Systems," *SID Symposium Digest of Technical Papers*, vol. 38, no. 1, pp. 1061–1064, 2007.
22. Gelau C., Henning M. J., and Krems J. F., "On the reliability of the occlusion technique as a tool for the assessment of the HMI of in-vehicle information and communication systems," *Applied Ergonomics*, vol. 40, no. 2, pp. 181–184, 2009.
23. Gowda N., Ju W., Sirkin D., and Baltzer M., "Prototyping HMI for Autonomous Vehicles: A Human Centered Design Approach."
24. Stevens A., "Safety of driver interaction with in-vehicle information systems," *Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering*, vol. 214, no. 6, pp. 639–644, 2000.
25. Young K. L., Koppel S., and Charlton J. L., "Toward best practice in Human Machine Interface design for older drivers: A review of current design guidelines," *Accident Analysis and Prevention*, vol. 106, pp. 460–467, 2017.
26. Skrypchuk L., Langdon P., Sawyer B. D., and Clarkson P. J., "Unconstrained design: improving multitasking with in-vehicle information systems through enhanced situation awareness," *Theoretical Issues in Ergonomics Science*, vol. 21, no. 2, pp. 183–219, 2020.
27. Gamboa-rosales H., Collazos C. A., Investigador P., Design G., U. C. Design, and M. Interfaces, "FRONT-END DESIGN GUIDELINES FOR INFOTAINMENT," pp. 1–9, 1801.