# Identification of problems in the design of infotainment system interfaces

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, automakers are faced with a great challenge of implementing simple physical buttons, but these do not adapt to the number of assistance, comfort and infotainment functions. Today's designs include complex menus with too many tasks, increasing complexity and visual demand. An alternative to the above are voice commands, which are not widely accepted, since they do not allow visibility of the actions, do not contain detailed feedback and the facility to undo actions is non-existent. This document presents a compilation of the main design problems for infotainment systems.

**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 the high competition in the market, automotive companies have generated developments that seek to attract the attention of buyers with innovations in infotainment systems. The term infotainment begins with the composition of information and entertainment, which can include radio, CD, MP3 browsers or Internet connection [1]. When conducting a review of the literature, it was found that the main problems with these systems lie in the fact that they have poorly designed interfaces and can generate distraction to the driver when performing a task, which increases the risk of accidents [1]. At the end of this work, it is concluded that the need to establish a general starting point for the design of infotainment system interfaces is evident.

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 [2]. 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 question

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

- What are the main design issues when creating infotainment system interfaces?

### 2.2 Data sources and search strategies

The search included articles written in English and / or Spanish from the last 12 years (2009-2021) to find out how the interfaces of infotainment systems were being designed or if guidelines for their creation were defined in the literature. 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 carried out focused exclusively on documents or articles where the creation of a guide for the design of infotainment systems was explained or detailed, for this the words: "Design guide" and "infotainment systems" and the AND connector were used. Thanks to this, a good number of results were found in which they detailed different strategies for the design of these interfaces, below are the search strings:

***Table 1.*** *Databases and search strings*

| Database | Search string |
|---|---|
| IEEE Xplore | ((“infotainment system” AND “Design guide”) OR (“infotainment systems” OR “Design guide” AND “Design problems” |
| SCOPUS | (TITLE-ABS-KEY (“infotainment system” AND “Design guide”) OR TITLE-ABS-KEY (“infotainment System” OR “Design guide” AND (Design problems))) |
| Springer | ((“infotainment system” AND “Design guide”) OR (“infotainment systems” OR “Design guide” AND (Design problems))) |
| ScienceDirect | ((“infotainment system” AND “Design guide”) OR (“infotainment systems” OR “Design guide” AND (Design problems))) |

### 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.<br>CE 2: Documents that are not in English or Spanish.<br>CE 3: Documents not related to Infotainment Systems or Design guide | CI 1: Document published between 2000 and 2020<br>CI 2: Documents related to Infotainment Systems or Design guide |

### 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.

In a previous work [3], a systematic review of the literature was carried out, which was used as the basis for this study. In addition, a more specific search was carried out between April and May 2021, where 21 articles were obtained. When applying the inclusion and exclusion criteria, 13 documents were selected to carry out the review process. The other documents were excluded because they did not focus on the creation of guides for the interface design of the infotainment system. After reviewing the documents, a total of 6 studies were found that show the intention of developing guidelines for the design of automotive interfaces.

***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 | 3 | 3 | 1 |
| SCOPUS | 9 | 5 | 2 |
| Springer | 4 | 1 | 1 |
| ScienceDirect | 6 | 4 | 2 |
| Total | 21 | 13 | 6 |

## 3 Analysis of data and results

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

In [3] Agudelo Et Al. presents the review of different studies among which the following design problems were found: poorly designed interfaces that generate

distraction, problems redesigning the size of the interface icons, and total or partial blocking of the system's functionalities. The authors point out that infotainment system interfaces, as they do not have a standard to be developed, do not provide sufficient safety to the driver and make performing a task while driving very difficult.

In [4] speech and gestures are combined. Speech is used for function identification, taking advantage of the visibility of objects in the car (eg a mirror) and simple access to a wide range of functions that amount to a very extensive menu. Using gestures for manipulation (eg left / right), detailed control is provided with immediate feedback and easy undo actions. In a user-centric process, a set of user-defined gestures is determined, as well as common voice commands. With the above, a prototype is generated, which is linked to the interior of a car and to the driving simulator. In a study with 16 participants, the impact of this form of multimodal interaction on driving performance is explored against a baseline using physical buttons. The results indicate that the use of speech and gestures is slower than the use of buttons, but results in similar driving performance.

In [5] Interaction with infotainment systems plays an important role, since on the one hand this can improve the user experience while driving, but on the other hand it can be distracting attention to the main task of driving. User interfaces in cars differ greatly with respect to the number of input and output devices and their location in the car. In this document, a first design space for driver-based automotive user interfaces is presented that allows a complete description of the input and output devices in an automobile with respect to their location and modality.

In [6], a design space for interactive vehicle windshield displays is presented and discusses whether the design can help designers create windshield applications for drivers, passengers, and pedestrians. This work presents the utility for designers of windshield applications through two scenarios, and concludes that it could be used to create applications inside and outside the car.

In [7] explains the use of mobile devices inside vehicles while driving creates an imminent safety risk. One of the most relevant solutions for this aspect is the Head-Up Display (HUD) systems, which shows information about the system, the status and the vehicle aids and a little information about the in-vehicle entertainment, in the field. driver's vision. Therefore, it is important to establish some guidelines or parameters for designing HUD interfaces, as car manufacturers do not disclose their guidelines for the general design of these interfaces.

In [8] the spread of movie devices has led to a wide variety of new tasks in the car while driving, which people perform both with integrated infotainment systems and other mobile devices. To gain insight into this new task context and how it could be improved, a qualitative contextual study is conducted with eight participants in which real-life car trips are observed. The focus was on user interaction with touchscreen mobile devices, due to its wide range of functions and services. The findings show that the car is an extension of other contexts and contains a rich set of infotainment tasks, including the use of social media. Drivers emphasized gestural interaction and the use of non-visual

modalities, to replace visual information and report changes in the driving context. Based on the findings, the design implications for the future in-car infotainment system are presented.

### Findings on Research Question

RQ1. What problems have you faced when building infotainment system interfaces?

The most common problems faced by designers of interfaces for infotainment systems are:
Manufacturers of infotainment systems do not share or make public the guides, regulations or guidelines used for the design of these systems. Manufacturers every day add more components to infotainment systems to satisfy the supposed needs of drivers (these are because functionalities are added such as applications are added to a smartphone, that is, for fashion or momentary need and that not all users need), adding components indiscriminately and increasing content saturation in these systems.
Each automotive industry conducts its own research to determine user preferences and design issues in their systems. However, these investigations are not public, for this reason it is necessary and urgent to establish some guidelines or general parameters to design interfaces of infotainment systems.

## 4 Conclusions and future work

In the articles selected in this systematic literature review, it was found that there are many gaps in the design of infotainment system interfaces that could be addressed using other methodologies.

Infotainment systems do not have a standard, which makes it difficult to establish adequate design guidelines for these interfaces and they continue to be treated as common interfaces, regardless of the context.

Infotainment systems are revolutionizing the automotive industry around the world and therefore must have a standard to develop to improve infotainment interfaces.

Based on the results of this systematic review, there is an opportunity to promote the application of new approaches for the improvement of infotainment systems and the creation of interfaces.

As future work, the deficiencies in the interface design of infotainment systems can be improved by applying new methodologies, validating their effectiveness and generating a guide for the design of these interfaces.

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