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# In-car game design for children: Promoting interactions inside and outside the car

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ABSTRACT

Long car rides can become a source of boredom for children, consequently causing tension inside the car. Common solutions against boredom include entertainment devices suitable for in-car use. Such devices often disengage children from other family members inside the car, as well as from the outside world. We set out to create a novel in-car game that connects children with their family and their environment, instead of only their entertainment devices. The game, called Mileys, integrates location-based information, augmented reality and virtual characters. We developed Mileys in an iterative process — findings from the first round of prototyping and evaluation guided the design of a second-generation prototype and lead to additional evaluations. In this paper we discuss lessons learned during the development and evaluation of Mileys, present challenges for location-based in-car game design, and suggest potential solutions for promoting interactions inside and outside the car.



## 1. Introduction

In-car interactions have been receiving growing attention from the HCI community [1–4]. Meschtscherjakov et al. [3] divided the car interior space into three design areas: the driver's area, the front seat area, and the back seat area. They note that most in-car systems have been focused on the driver's area. Indeed, numerous systems and devices have been designed to assist the driver with navigation, safety, fuel efficiency, and entertainment (e.g., [5–11]). However, passengers occupying the front and back seat areas have different requirements than those of the driver [3]. Including them in the design of in-car systems can help reduce passengers' boredom, increase trust and a sense of inclusion, as well as reduce drivers' level of distraction and cognitive load [12]. Therefore, the current paper focuses on the back seat area.

The back seat is often occupied by children. During family car rides, parents typically sit in the front seat and children in the back seat, so the family spends time together in a small space. Laurier et al. [13] noted that people sometimes struggle and sometimes delight in regard to traveling in a car together. The car provides a setting where parents and children can converse with one other, play games or sing songs, but it is also a site of potential conflict, for instance over sitting arrangements or control of various systems inside the car [13–15].

The key to avoiding conflicts is keeping children occupied during car rides, a goal that could be achieved in various ways. Wilfinger et al. [16] conducted a cultural probing study investigating the activities and the technology usage in the back seat of cars. They found that fighting boredom was one of the most important issues for both parents and children. Common strategies for fighting boredom included playing with traditional toys, playing social games, and using modern technology. Mobile phones in particular were considered standard equipment in the back seat, mainly for older children. Most games played in the back seat shared several key characteristics: first, they did not require physical movement apart from turning your head and upper body. Second, most games were open ended with the possibility to adapt the length of the game play according to the available time. Third, most games were based on the fact that players were moving and the physical context was constantly changing.

Furthermore, the researchers found that time spent together in the car was not considered lost or wasted. Instead, it was perceived as "family time", where activities could be performed together, creating a co-experience. Several parents also reported an educational motivation — they wished to use time in the car for educating their children. This educational motivation was found in additional studies as well [17,18]. Wilfinger et al. [16] concluded that "integrating aspects of education into {an in-car} game is a promising approach, especially when it is aimed at topics related

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to the current trip" (p. 668). Moreover, they found that children want to contribute to and support tasks like driving and navigation. Therefore, interactive technologies should enable children to take part in their parents' activities in the form of a "co-driver".

In accordance with Wilfinger et al.'s [16] findings, we set out to develop a novel in-car experience, aimed to achieve the following goals:

(1) Make car rides more interesting for child passengers.
(2) Promote child–parent interactions.
(3) Promote child–environment interactions.

In this paper we present Mileys – an in-car game that integrates location-based information, augmented reality, and virtual characters. Mileys was designed in an iterative process – findings from the first round of prototyping and evaluations with users guided the design of a second-generation prototype, and lead to additional evaluations. The automotive user interface community typically focuses on laboratory studies, whereas qualitative in-situ studies are rather neglected [3]. Therefore, we conducted all our evaluations in the field, with children playing the game during actual car rides. We discuss the lessons learned regarding in-car game design for children, present current challenges for promoting interactions inside and outside the car, and suggest potential solutions.

## 2. Related work

The car has been recognized as a suitable arena for gaming, with the potential of making use of all the unique properties of the car itself, the practices of driving, and of driving as a socially shared experience [4]. Accordingly, several in-car games have been developed in recent years.

"Backseat Playground" [19] is a game that presents sequential audio stories according to the player's location. As the car travels through the landscape, a crime story is unfolding. The player takes part in the story by using a set of tools on a hand-held device. Participants in a user study indicated that they felt as if the game was actually going on outside. A similar game [20], developed by the same team, enables two players to interact whenever they come within a specified distance of one another.

Wilfinger et al. [16] developed a concept for a back seat entertainment system called "RiddleRide" — a multiplayer context-aware quiz application aimed to entertain and educate passengers during rides. RiddleRide poses questions via speech, for example: "what do you see on the hill to your left?" Potential answers are displayed on mobile devices, and are adapted to different age or skill groups. After each player selects an answer, the system reveals the correct answers and the current score.

Sundström et al. [21] presented three in-car games aimed at making sitting safely more enjoyable for children. In all games, the restricted body was made an integral part of gameplay. The goal of the first game, called "RainbowBalance", is to balance a virtual ball using head movements. Children can see the results of their movements on a screen attached to the front seat. In the second game, called "emoCar", the driving style of the actual car determines the direction of a car avatar, driving on the roads between 'happiness', 'anger' and 'sadness'. Children need to catch the avatar by performing the appropriate facial expression for the desired direction. The third game, called "GhostCatcher", consists of an actual jar that children hold in their hands. Their goal is to open the jar only while the car is exposed to darkness (e.g., while driving through a tunnel). The jar then starts to vibrate and emit sounds, signaling that ghosts have been captured. If the jar remains open when the car is exposed to lightness, the jar goes silent and still, signaling that all ghosts have escaped. A user study with children revealed that GhostCatcher was the most enjoyable game, as well as most suited for connecting children to the car and the outside world.

Hiah et al. [18] presented a concept of a robot companion, designed to address the needs of young children sitting in the back seat. It is placed between the two front-seats, essentially serving as a virtual guide that allows children to tour through various sights and learn fun facts about them. A preliminary user study employing a "Wizard-of-Oz" methodology showed that children seemed to be more engaged when interacting with the companion robot, compared to interacting with the same system without the robot present (interacting with "the car" in general).

"nICE" [22] is a multimodal, collaborative game, played on two multi-touch tablet devices by the passengers in the front and back seat. During the game all occupants of the car are tasked with guessing the contents of hidden images based on several image snippets and audio hints. These snippets and hints can be unveiled by playing different collaborative mini-games. A user study indicated that users were highly focused on the game, neglecting the outside world.

## 3. Mileys — First-generation prototype

Mileys is a geo-located collecting game that integrates location-based information, augmented reality, and virtual characters. It is aimed to make car rides more interesting for child passengers, and promote interactions both with parents inside the car and the environment outside the car. Essentially, it turns children into "co-drivers", as suggested by Wilfinger et al. [16]. Through the game, children are expected to acquire a sense of distance, location, and spatial navigation.

The game centers around virtual characters called Mileys, which are conceptualized at certain geographic locations along the route to a pre-selected destination. Mileys are not immediately visible, but only through the application using a technique called augmented reality (AR). Using the Mileys application, users can look through a live camera stream and detect the virtual creatures, which appear as an overlay on top of the live camera stream.

The first-generation prototype of the application was used to gather initial user feedback regarding the proposed gameplay. We detail the functional specifications of this prototype, and describe the results from a field study evaluating this prototype with representative users of the target demographic.

### 3.1. Functional specifications

The first-generation prototype was implemented as an application on an Android-based mobile device. When the application is launched, child passengers see a radar-like screen that indicates the bearing and distance of nearby Mileys (see Fig. 1). The location of Mileys was defined by the system administrator, along the route to a pre-selected destination.

Based the radar interface, child passengers need to navigate the car towards the nearest Miley, through dialog with the driver. Once they are in close proximity of a Miley, the application notifies them to exit the car and go search for Mileys in AR mode (see Fig. 2). We envisioned the locations of Mileys as either places with a special historical or cultural meaning, or as places suitable for a coffee or bathroom break. In both cases, the family is expected to stop in that location and exit the car.

When the child is close enough to see the Miley in the camera screen (see Fig. 3), she can "capture" it by tapping on it. Capturing a Miley leads to a new screen where information regarding the current location is presented in a cartoon bubble, ostensibly from the Miley itself (see Fig. 4). When this activity is completed, the display returns to the radar screen, and the child returns to the car to continue searching for additional Mileys.

The technical design of Mileys is depicted in Fig. 5. In the figure, interaction flows in the UI Activities (top left) from left to right.