Built-In Car Navigation System

Subjects: Others

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Driving is based on effective navigation. When using a navigation device, the user interface, the amount and quality of the underlying data and its representation all effect the quality of navigation. This study evaluates whether drivers in three different countries consider these devices to be useful and what functionality they would prefer. An online questionnaire was used to assess built-in navigation systems. The findings from 213 respondents show that current car GPSs are overloaded with features. Regardless of country, drivers simply require more basic functionality in the interface. It was also noted that the embedded functions in these devices are not fully utilized. In addition, many people use the navigation service to enter a new address while the car is moving. It may be worth examining how this option can be better implemented.

Keywords: car navigation ; built-in GPS ; GPS interface

1. Introduction

A major requirement for safe travel is fast and accurate navigation assistance. While maps once served this function, at least with the help of a navigator/passenger, technology now provides electronic and mostly automated solutions. Several different types of navigation tools are available, including free phone apps, such as Google Maps, dedicated GPS navigation devices or built-in car navigation systems. These devices all have different user interfaces and graphic displays requiring varying amounts of user attention [1].

2. Brief History In-Car Navigation Devices

Specialized devices for navigation assistance have been available for over a century. An advertisement dated 30 December 1909 describes a scrolling map associated with a steering wheel. By 1930, the Italian “Touring Club Italiano” worked on a simple principle: before starting, the driver selected and threaded the appropriate map sheets, and then the device rolled these sheets from one roll to another. The problem was that when the vehicle deviated from the route or came to a fork, the driver had to change the map sheet and find the current position [2][3].

In 1966, General Motors introduced DAIR (Driver Aid, Information and Routing), which alerted the driver to road signs, speed limits and hazards along the route [4]. The first true automotive navigation system, the Electro Gyro-Cator, appeared in 1981 from Honda, Alpine and Stanley Electric [3][5]. By 1985, the Etak Navigator, which used ‘dead reckoning’ to determine the vehicle’s position [2][6], was the world’s first publicly available, in-car navigation system.

GPS-based navigation based on the US satellite configuration was introduced in 1990 in the Mazda Eunos Cosmo as part of the touch-screen car control system [7]. Two years later, the world’s first GPS with voice navigation was introduced in the Toyota Celsior (Lexus LS—luxury sedan). In Europe, the BMW E38 incorporated GPS navigation in 1994 [8]). In the US, it was introduced a year later by Oldsmobile, and called GuideStar. Selective availability was removed by the US government in 2000, making GPS signals more accurate, and GPS-based navigation of all forms became more prevalent. More and more car companies, businesses and tech giants have since entered the automotive GPS market.

3. Evaluation of In-Car Navigation

A variety of studies have examined the effectiveness of in-car navigation. In 2009, TomTom users were asked about the use of their navigation device [9]. In 2011, a Hungarian-founded company, NNG—which developed the iGO Navigation Engine—used a questionnaire to evaluate its system [10]. A Romanian study examined traffic in reference to navigation systems [11].

With the increased use of smartphones, free navigation applications have become popular. Hu et al., (2015) examined if drivers are willing to sacrifice some of the affordances of modern navigation systems in order to prolong the phone’s battery life. The study also acquired data about the prevalence of phone-based GPSs and voice/visual preference [12]. To get information on prototypes of Google Maps Navigation during real-world usage, an Android-based feedback mechanism was developed [13]. According to the 41 participants, most used the built-in car navigation system as a supplemental application [14].

4. Spatial Knowledge Acquisition

Differences in the spatial acquisition of knowledge between verbal instructions and mobile maps during driving were investigated in 2005 [15]. Münzer et al. compared three electronic navigation systems with paper maps [1]. It was found that although navigation system users have poor survey knowledge, they have good route knowledge. It was also shown that the size of the map display has an effect on spatial knowledge acquisition [16]. 'Wizard of Oz' prototyping—a design methodology used to improve user experience (UX)—was used in the research, e.g., no GPS was used. To compare spatial knowledge acquisition, Ishikawa et al. [17] included map-based GPS navigation systems in their research (in addition to paper maps and direct travel experience).

5. Location-Based Services

Location-based services (LBS) are mobile applications that give information depending on the location and context of the user [18][19]. The largest and probably the most popular LBS applications (including driver assistance, passenger information and vehicle management) are the mobile (car or pedestrian) navigation systems [20]. These systems are created and designed to help people during wayfinding activities in different environments [21].

Location-based information can be conveyed to users through an overview map or as turn-by-turn instructions. According to Gartner [22], limited-sized screens provide a limited overview. This can be compensated with good wayfinding instructions [23]. Fabrikant and Goldsberry [24] highlighted that bottom-up and top-down mechanisms drive human visual attention. Unexperienced users process animated displays based on perceptual salience and not thematic relevance [25]. According to Ware [26], users can detect a maximum of four moving objects simultaneously.

The 'Geographic Information Displays' (GID) offered by smartphones can be examined from (a) GIScience, (b) cartographic and (c) a cognitive science perspective [27].

(a)The main challenge—from the GIScience perspective—is the 'context' (information for a person, place or object characterization)—that is, adaptation, inference, management and modeling [28]. According to Griffin et al. [29], people's behavior will change if they receive more information about the environment (e.g., spatial and task contexts often alter during navigation). Technical systems should solve this problem.

(b)In order to help the user's understanding, graphic elements on the display should change according to many visual variables [30][31]. The more sophisticated the visualizations are, the better the performance of a navigation-related task. To this end, new functions have been developed, e.g., multi-scale traversal routes in a simultaneous representation, reducing the need to zoom in and out for orientation [32]. The extent of a visualization task's performance depends on expertise [33][34][35] and emotional context [36].

(c)GIDs should support the user's mental representation of the variety of spatial conditions that can be used during navigation [27]. For navigation, spatial information must be translated from one reference frame to another [37]. GIDs can facilitate this transition by providing a track-up map that improves navigation efficiency [38]. With the help of the GID's instructions, the decision-making process of the user decreases [39][40], or rather distracts the visual attention from the environment—the space is less experienced directly by the users [41][42].

6. User Experience

The term "user experience" (UX) has a wide range of meanings [43]. According to Alben [44], 'experience' refers to the way interactive products are used: the sense of ownership, the feeling of use, how well the tools serve their purpose, whether they are understood to work and how well the tool fits into the environment in which it is used.

The UX is (1) the consequence of the user's internal state (expectations, needs, motivations, moods, etc.), (2) the characteristics of the intended system (including all products, services and infrastructure that are involved in the interaction when the product under consideration is used) and (3) the context (or environment) within which the interaction takes place.

UX is subjective: the user's state influences the perception of the system, which in turn influences the experience and the user's state. Built-in navigation systems have the potential to influence the relationship between users and their environment in deep and complex ways. Empirical and theoretical analyses show that the use of GPS units changes people's understanding of the world around them, their learning habits, their navigation techniques and their knowledge of spaces and places. GPS navigation is based on abstract representations of these spaces and places [45].

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