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In Vehicles Interfaces Development and Elderly Habits: A Possible Encounter

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ABSTRACT

This paper aims to analyze the current trends of in-vehicle interface in relation with the needs of the growing cohort of elderly drivers. Starting with the analysis of the automotive context characterized by the MADE factors, it is then explained why the category of elderly people is significant in the scenario of mobility. Furthermore, an overview of the elderly needs, impairments (physical, cognitive, and sensory impairments) and habits illustrated in relation with the in-vehicle context. In addition, the most relevant trends in the in-vehicle trends are provided and then used to verify possible encounters with the elderly needs. Finally, a more inclusive scenario is provided by illustrating promising trajectories that can guide the design of future interfaces.

Keywords: Design for elderly, HMI, Inclusive design, Human centered interface, In vehicle interface

INTRODUCTION

Nowadays the world is getting older and more populated. This is mainly due to several factors: the aging of the baby boomer generation; the extended longevity, the decreased birth rate as well as a period of relative peace all over the world (Fatima, K., & Moridpour, S. 2019). Nevertheless, while the extended life expectancy can be considered an achievement for humanity, on the other hand, it also involves several challenges, for instance, maintaining economic productivity, health care programs, and public pension benefits. Furthermore, an aging society means a population that requires higher costs in public health care and other services (News, K., & Lives, H. 2018). Aging society is a factor which involves all the field of the world and mobility is for sure not an exception. Especially for elderly people, Mobility is fundamental to active aging and is intimately linked to health status and quality of life. (Webber, S. et. 2010; Fatima, K., & Moridpour, S. 2019; Johnson, et al. 2017). While the world is aging, the field of automotive is undergoing profound transformation. Even though the current situation can be described as a VUCA situation which stands for volatility, uncertainty, complexity and ambiguity, all automotive experts agree on a completely renewed automotive future 2030 characterized by: the spread of electric and connected vehicles, the use of partially or fully automated vehicles; a loss of centrality of vehicle ownership in favor of a mobility service. All changes can be summarized under the acronym MADE which indicates: New Models of Mobility, Autonomous Driving, Digitization, Electrification. Especially considering the

forecasts for future growth volumes and the intensity of technological discontinuity, electronics is certainly the sector that will grow the most: especially in the areas of Infotainment and Advanced Driver Assistance System (ADAS) (Roland Berger 2020).

While the introduction of new technologies can be a good marketing and profit-enhancing tool for a company, it must be considered that such changes are more influenced by financial reasons than by user desirability issues. For this reason, in a world where innovation is very fast, introducing new features could be very interesting for a young population but a hindrance for older people. In fact, according to several studies people with or above 65 years old are more averse to using new tools and interfaces since the use of these would involve, at least in a first phase, errors and embarrassing situations that are hardly tolerated (Arch et al 2008; Hill et al 2015; Raymundo and Da Silvana Santana 2014; Zajicek 2001). This is also confirmed by the fact that older people prefer familiar and known steps differently from young people who usually like to explore new solutions (Pernice et al 2013). For this reason, this contribution analyzes the current in-vehicle Human machine interface (HMI) trends to provide possible improvement points to improve elderly traveling experience and verify possible encounters between the fast development of the automotive industry and the mobility of elderly people.

DESIGN AN HMI FOR CARS FOR ELDERLY PEOPLE

Over the next 50 years there will be a substantial increase in both the number and proportion of older people in most industrialized western countries. This is mainly due to the aging of the baby-boomer generation combined with a declining birth rate and an increase in global longevity (OECD, 2001).

This increase in the elderly population will have the direct consequence of increasing the number of elderly drivers who, compared to the previous generation, will be able to move around in their own vehicle, more frequently and covering longer distances (OECD, 2001). Considering this future perspective, it is important to consider some fundamental aspects of a car and in particular several aspects of the human machine interface. The challenge is mainly represented by the situation that has on one side cars which are usually characterized by constantly evolving technologies, and on the other side, seniors who are not so keen to adapt to new changes and interfaces. Hence the need to adapt technologies to a more human and inclusive vision to enable fragile users like elderly people to drive as long as possible and as safely as possible.

Regarding elderly mobility, vehicle design can play a significant role to improve older road user comfort and safety. Nevertheless, vehicle design is based on the 50th percentile 'design driver' that is, fit and relatively healthy young adults. Hence the reason why the development of a car has poorly considered elderly issues such as the sensory, cognitive, and physical impairments caused by the aging process (Charlton et al., 2002; Morris et al., 2003; OECD, 2001; Waller, 1991).

Considering the constant growing trend of aging people, vehicle designers have responsibilities to accommodate elderly needs, safety, and comfort not only to enable seniors to drive but also to make roads safer for all the drivers.

Vehicle designers should be aware of the older drivers sensory, physical, and cognitive decline abilities, their relationship with the driving tasks, and how this can be translated into new design interfaces. Recent technologies such as ADAS (Advanced Driving Assistance System) and IVIS (In-Vehicle Information System) have a great potential to help elderly to drive a car correctly, easily, and comfortably. However, such technology needs to be implemented with the right perspective, because in the opposite situation technology could create more problems than it solves for the elderly without some specific measures.

It is not the aim of this paper to suggest solutions only for elderly drivers but instead the contribution aims to provide an inclusive vision of the drivers and together with that interface which are able to change their configuration to adapt to several drivers without stigmatizing frail users. In particular it is possible to find three categories of issue that the elderly can meet while driving and can improve the in-vehicle experience: Sensory impairment, Physical impairment, Cognitive impairments (Young et al. 2017).

Regarding sensory impairment, elderly people present several declines in their senses especially regarding sight, hearing, and touch sensitivity. On the visual level, considering the difficulties of elderly to read small texts, to distinguish different colors, especially in a nighttime context, several design guidelines could be beneficial to improve the in-vehicle interface and experience such as the use of larger texts and labels, the reduced number of information presented each time, and the presentation of warnings in multisensory mode like a combination of visual, auditory, and tactile warnings. All these solutions need to be considered together with possible auditory issues, especially with high frequency sounds (Corso 1981), and a possible reduction of sensitivity to touch and vibration that some elderly may present (Gescheider 1994).

Concerning physical impairments, elderly people usually present several issues that can affect their ability to use vehicle controls and in-vehicle technology. Those issues are often related with: the decreased flexibility, which can affect the right use of controls; coordination issues and muscle weakness, which can worsen the manipulation of controls such as buttons, turn dials or the steering control. Several solutions can be adopted in order to improve the driving experience for seniors such as the design of large and more accessible controls; a clear and shorter timing to present warnings due to the fact that elderly have joint stiffness, muscle weakness and slowed cognition processing.

Regarding the cognitive impairments, aging people experience a range of cognitive decline and an overall decrease in processing speed (Eby and Molnar, 2012; Salthouse 2010; Yang and Coughlin 2014; Johnson, J., & Finn, K. 2017) In particular, seniors present a decreased ability to divide attention efficiently between multiple tasks which present therefore an overall difficulty to perform two or more tasks simultaneously. Considering the in-vehicle context, the designed interfaces required often to split the attention between information provided by the device and the driving tasks. This situation can lead elderly people to distraction or cognitive overload). Possible new guidelines should accommodate the amount, type, timing of information, and

warnings provided by in-vehicle devices. this to accommodate the increased potential for distraction, confusion, and overload (Koppel, Charlton and Fildes, 2009)

Together with sensory, physical, and cognitive impairments it is important to also consider the attitude and the habits the elderly may present towards mobility. Even tough elderly people can represent a group difficult to segment Sonja Haustein (2012), based on mobility behavior of the elderly, has provided a cluster solution of this heterogeneous group in four segments named: Captive Car Users, Affluent Mobiles, Self-Determined Mobiles, and Captive Public Transport Users. Those categories of elderly have been determined considering the mobility, accessibility to private (car) and public transportation, the use of pedestrian roads or cycling paths and their private income.

Having analyzed the elderly needs and possible behavior's model towards mobility, the contribution will compare the relevant findings with the current scenario of HMI.

CURRENT SCENARIO OF IN VEHICLES HMI TRENDS

As mentioned in the previous sections, recent advances in automotive technology – summarized under the acronym MADE – have caused radical changes in the automotive field, which has then reacted by proposing scenarios characterized by increasingly safe roads and a more sustainable model of urban mobility (Milakis, D. et al. 2017) This innovation is increasingly leading to the integration of electronic safety devices to control the vehicle - such as ADAS - which are progressively transforming the relationship between the human and the vehicle, resulting in a shift regarding driver responsibility (Terken, J. et al 2017). This creates the opportunity to transform the act of driving as a stressful and complex activity into a more relaxing and accessible travel experience that can increase people's autonomy and mobility (Pickford and Chung, 2019).Furthermore, this situation creates new opportunities to rethink the entire driving experience through new HMI systems which are requiring new ways of interaction to deal with the complexity of today's world and to manage the increased functions present in today's vehicles.

As a result, the MADE phenomenon suggests new HMI trends that can characterize the future of the in-vehicle interfaces in three macro areas of interest.

One of the most relevant trends is certainly the increased automation all over the vehicle and especially in the HMI. This is mainly generated by ADAS technology through the transition from manual driving to automated driving – in particular, referring to the SAE level 3, 4 and 5 (SAE, 2014) – with the intent to gradually move the driver out of the loop. Consequently, the increased automation transforms drivers as error-prone operators into passengers of a vehicle controlled by driving automation (Mirnig, A. G.2018). This change also produces the development of new interfaces that must make visible and clear the vehicle's intentions, to increase technology acceptance by increasing the driver's trustiness and awareness about driving automation (Giacobone, 2018).

Another relevant factor is the shift from the driver to the passenger perspective. This change presents several consequences for the user's needs inside the vehicle since their interaction is mainly related to non-driving-related-task activities, such as new forms of productivity, entertainment, gamification, or novel transportation-related services. (Pfleging et al., 2016).

Such perspective opens to possibilities not only for new private cars but also to new mobility services that transform the vehicle itself into a third living space conceived for new forms of conviviality and socialization (Lipson, H and Kurman, M 2016; Lewin, T. 2017).

The third important trend highlighted in this contribution is the implementation of AI due to the necessity of developing proactive interfaces systems for managing and controlling driving automation. By means of AI it is therefore possible to anticipate incorrect behaviors and provide suggestions on the correct and more efficient use of the machine. AI also changes the way of experiencing traveling because it permits to customize and adapt the vehicle and the trip, in advance, according to the driver's intentions and preferences (Giacobone, 2022). Furthermore, the AI can be used to create a natural Human Machine interaction that is more conversational and similar to a human-to-human conversation, in order to improve trustiness in the self-driving intentions and reliance of the vehicle.

POSSIBLE ENCOUNTER BETWEEN HMI TRENDS AND ELDERLY NEEDS

Driving automation scenario is a significant opportunity to foster inclusion since it allows the vehicle to be accessible to a wider range of people. The automated system helps to maintain elderly's autonomy as long as possible since it provides the ability to travel independently even when elderly people present age-related sensory, cognitive and psychomotor decline (Ball et al., 1998). In particular, automation supports the elderly to drive autonomously longer and safer (Li et al., 2019) because ADAS enables older drivers to keep themselves active. This is achieved by providing adequate support that fills their driving difficulties during their routines.

In addition, transforming older drivers into passengers enables them to visit many places in a comfortable and safe way, especially in specific conditions that seniors avoid due to their decline in their driving ability (Eby et al., 2016). As touched in the previous section, these benefits can be offered through non-driving-related activities during the piloted journey. The Autonomous vehicle situation changes both the value of time travel and the driving space by providing a social and relaxing transportation experience that can reduce the elderly's social marginalization and loneliness (Lipson, H and Kurman, M 2016).

All these opportunities can be mediated by an artificial intelligence capable of both controlling the driving of the vehicle and offering its co-inhabitants a new way of interacting with space far different from the traditional and stressful use of the in vehicle driving tasks. Nevertheless, a vehicle characterized by AI involves the development of a complex, proactive and will-powered system that can be easily misunderstood by its passengers if there is not an

intelligible and predictable interface. For this reason, the development of interfaces requires certain measures to increase confidence in the AI system, increasing its ability to make clear its way of processing information and its driving intentions. On this regard, several aspects can be identified both to make dialogue vehicle-passenger more accessible and to increase passenger confidence:

Creating a negotiation interface with the artificial system to enhance the passenger feel of control over the vehicle. This includes the driver into the vehicle's decision-making processes increasing their trust in the system since they can directly act on the vehicle's behavior.

Making vehicle behavior visible and transparent to the passenger - e.g., communicating or showing a vehicle action in advance - helps to make the intentions of the system more understandable. This allows the passenger to follow the vehicle's behavior step by step and to become aware of its actions and trajectories.

Providing a human-like character to the vehicle system – for example through human traits, emotions, or intentions – it helps to create empathy and trust in passengers since it ensures an already known interaction such as those between human beings. For this reason, the use of natural language or anthropomorphic systems could help the system be more believable and enjoyable while interacting with the passengers.

CONCLUSION

This contribution has therefore presented that an encounter between elderly mobility needs, and the recent in-vehicle HMI trends is possible. Therefore, it is fair to imagine a future scenario more inclusive for seniors that would like to continue to move independently also in their latest part of their life. In particular several trajectories seem particularly promising to realize this perspective such as: the increasing automation, especially considering the driving activities of a senior and its relative issue due to the aging factors; a shift from the interface of human as a driver to human as a passenger; a car driven by anthropomorphic artificial intelligence that exploits already known user experiences (especially human ones); An AI-based interface system that is able to understand the elderly driver's shortcomings and provides warning messages in advance compared to younger drivers.

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