The Horizon: A User Experience Assessment of Automotive User Interfaces

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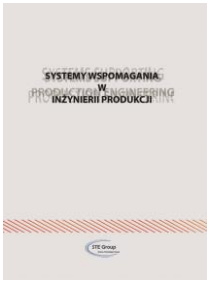

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Abstract: Innovations for new display technologies equipped in vehicles set forth a need for assessing the impact of their user-adoption and emergence. This paper offers a phenomenological approach for investigating the user interaction and user experience of driving when augmented reality, heads-up displays, and digital screens are present. In doing so, this paper aims to show how the phenomenological concept of the horizon helps us to understand the ways in which screen technologies may affect the quality of the user experience for drivers. Implications of the horizon allow us to consider how, while driving, we recognize objects categorically in sense perception, observe the present and foresee its future consequences, and make decision-procedures according to levels of priority and attention to detail. As a result, these considerations help strengthen our approach to understanding driving activity while screens are in the periphery. Thus, these findings are suggested to be adopted for further user experience quality assessments in the field of intelligent transport systems.

Keywords: Horizon, automotive user interface, user experience, phenomenology, UX design, safety

INTRODUCTION

The advent of new user interfaces equipped on vehicles sets a precedent for a more sophisticated experience of driving. Technological innovations for vehicles are produced with the aim for drivers, pedestrians, and vulnerable road users to experience the most safe, efficient, and reliable means of transportation. With these three core precepts, drivers should therefore be benefitted by useful pieces of information as displayed on screens, including regular digital screens, heads-up displays, and augmented reality displays. As such, these user interfaces overlay valuable items including GPS mapping and direction, road-conditions, weather, as well as time-sensitive information and media outlets. However, the more modern kind of this technology further extends the number of possible stimuli. Thus, while the adoption of some of these technologies leads to an enhancement in driving activity, others are evidently over stimulative. Meanwhile, proper methods to assess how drivers experience them lack consensus, since driver demographics, location, transport infrastructure, as well as vehicle specifications are of wide variation. Although such consensus may only be reached sufficiently with tested empirical results, it is useful to see how we should address this problem with the

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guidance of applicable theory. This paper analyses how the concept of the horizon, with its origins in phenomenology, provides insight to the experience of driving while screens are present in the vehicle. Firstly, I will outline the philosophical background of phenomenology and the horizon. Then, technological developments and implications of displays in vehicles will be treated, as part of the field of intelligent transport systems. And lastly, the view that such concepts, as the horizon, are helpful for building a framework to tackle the problem of understanding human-technology relations, as between drivers and screens, will be defended. In reframing the approach to the user interface design in vehicles in light of considering the horizon, we can then recognize how driving may be enhanced in terms of the experiential aspects of sense perception with multiple stimuli.

THE HORIZON

The concept of the horizon was originally developed by philosopher Edmund Husserl in the early 20th century. Husserl's treatment of the concept is similar in meaning to the limit of one's awareness in experiences. Such limits of awareness are explained by the confines of time, space, embodiment, and the first-person perspective [16] and are interpreted as the reason behind possibilities for action, through "cognitive affordances" [10]. *Oxford Languages* defines a conceptual horizon more broadly, "as the limit of a person's knowledge, experience, or interest." For our purposes, the horizon will be taken to mean the scope of one's awareness as set out by his/her past background impacting the present and future. In the concept of Husserl's horizon, there is the idea that we pay attention to objects and place them in a background. Thus, for example, by noticing a pen, one may think about the act of reading and writing, or there being written material. Likewise, in the context of transport, when a GPS device shows to the driver that the arrival will be 25 minutes delayed due to road congestion on the freeway, the driver may consider what caused this delay. These may be due to events such as, there being construction work, a road-side accident, or rush-hour, for example. Such tendency in our train of thought is the idea behind the concept of the horizon. At the same time, the horizon is not limited to being a matter of passive reception of everyday experiences and their corresponding reflection. As a matter of fact, the horizon is also involved with our actions. Edmund Husserl pointed out that,

> *I can change my standpoint in space and time, turn my regard in this or that direction, forwards or backwards in time. I can always obtain new perceptions and presentations, more or less clear and more or less rich in content, or more or less clear images in which I illustrate to myself intuitionally what is possible or likely within the fixed forms of a spatial and temporal world [7].*

By understanding human actions as being centered on one's orientation with the world, Husserl touches upon our ability to choose frames of reference in a way that not only is a shifting of perspective, but also is a guide for one to take certain

courses of action based on decision procedures and knowing what is possible in each given scenario. This feature of human behaviour is thus marked by a rich awareness of experience, which is the main subject of the horizon. Consequently, such conceptual tools from phenomenology are useful for the understanding of innovative technologies in automotive user interfaces [8].

Applying this concept in the situation of driving, three aspects are worth noting.

First, it is that we recognize objects categorically in sense perception. When drivers are on the road, such things as trees, buildings, road passages, traffic lights, road signs, sidewalks, other vehicles, as well as pedestrians are in the vicinity. Drivers recognize these items by seeing them and categorizing them as deemed relevant. In this categorization, which objects fit to which categories is determined by the unique backgrounds of knowledge, experience, and awareness, all shaping the horizon. This means, for example, that when seeing a traffic light, the driver knows that the sign is about timing and movement (when to be stationary and when to resume being mobile), and not just the change of three colours.

Second, it is that we think about the present and its future consequences. While the driver navigates the route to a desired destination, what may be considered is the fuel remaining as shown on the fuel gauge. If the amount left is insufficient for the journey, then it is a foreseen consequence that the vehicle should be refuelled, and thus the driver renavigates to a service station. By knowing or at least being aware of what is currently going on, we project what is likely to happen in the future. This also involves our understanding of cause and effect, which is informed by the background knowledge of one's horizon.

Third, it is that we make decision-procedures according to levels of priority and attention to detail. Depending on the scenario, certain tasks are more important than others. For example, if the safety of road conditions permits, a vehicle may be driven with cruise control on. However, in other conditions, this is prohibited, as for when having to follow four-way traffic light control. These separate scenarios inform the driver to decide under which conditions cruise control may be used. And further, the driver's attention is guided accordingly – as to the issue of controlling speed and direction. By having the background knowledge of the capacities of the vehicle and the rules of the road, drivers make prioritized decisions and focus their attention as necessary and appropriate.

DISPLAYS IN VEHICLES

Three types of displays (user interfaces) are often found in today's vehicles.

Standard digital displays, as equipped on most modern vehicles, may be interacted with either via touch-sensitive buttons on the screen or by pressing physical buttons and turning dials. Typically, they show some form of necessary information for the driver (such as, time, location, maps, directions, weather, etc.) along with supplementary features that are for other purposes, primarily entertainment media.

Heads-Up displays provide basic information (e.g., navigational arrows, speed, proximity) for the driver through the projection of holographic light onto the windshield. As HUDs are typically equipped on vehicles which already include digital touch-sensitive displays, they are designed to present minimal data to the road user whilst looking through the windshield and operating the vehicle. HUDs are unique in that they work in a hybrid form of presenting electronic information in a manner that blends with the natural environment for a single immersive field of view for the road user [15, 17, 18, 19].

Augmented Reality displays are the next stage (after HUDs) of virtual experience.[1] In addition to providing necessary information of primarily semiotic form as shown with HUD arrows for navigation, they present artificial objects or simulacra for the user. Thus, AR displays blend the real natural environment not only with additional points of data, but with artificial objects which otherwise may be found in complete simulations [2, 19].

By having these possible media features on standard, HUD, and AR displays for vehicles, the driver is provided information in various forms which concern:

- The act of driving: e.g., GPS, RPM, speed, local time.
- Information about the car and driving safety: e.g., engine, brakes, fuel, seatbelt, locks, road conditions.
- Entertainment: e.g., AM/FM radio, AUX/Bluetooth connected music, Apple CarPlay, Android Auto (i.e., forms of multimodal media).

It is from these points of information, that it is necessary to see how multimodal forms of stimuli impact the conditions of the driver [12].

USER EXPERIENCE ASSESSMENT

For improvements in the experience of new user interfaces, we need to change the approach of its development into being more sensitive to the driver's needs. This is a measure of the quality of being user oriented. Similarly, as with the three core precepts in the field of intelligent transport systems stated earlier (safety, efficiency, and reliability), it is crucial to implement user friendly designs that have been engineered carefully according to the experiential aspects of driving. To ensure safety for the driver while operating the vehicle (as well as for the safety of other vehicles, cf. [5]) equipped with display interfaces, it is necessary to not only determine which possible forms of data are presented to the driver, but also to see how such stimuli impact driving behaviour through understanding the experience of driving [11, 14][2]. Tuomo Kujala and Dario D. Salvucci empirically investigated how interactive displays equipped in cars affect driving behaviour and found them to be detrimental as glance time via multitasking and distraction hinders performance. In a similar fashion, Peter J. Hills et al, confirmed the "detrimental effect of vertical eye-movement carryover from one task to a second task in drivers

[1] For an account of Virtual Reality (VR) displays [9]

[2] Klaus Bengler intriguingly differentiates between driving experience and driver experience in the context of UX design for the automotive industry.

of different levels of experience, whilst accounting for road conditions" [6] proving the safety risks of multitasking for driving, especially for brake-response time [13]. The empirical findings of Kujala and Salvucci indicated that a significant factor impacting the driving experience, and by extension driver safety, is the UX design quality of displays being a measure of the probability of driver distraction. For reasons such as this, it is stated that the field of intelligent transport systems (ITS) should take these matters into account:

> *If we want an effective ITS, we should shift our focus away from technology-driven ITS research and development, to user-oriented design. For ITS to be successful in reducing incidence and severity of road crashes, research must be focused on developing criteria and procedures that will allow ITS human-machine interfaces to be designed and evaluated on safety performance grounds [3].*

As a possible solution, Kujala and Salvucci offer a strategy to target this issue by minimization of distraction, taking into account time-sensitive factors in which drivers are aware of the environment. The search for pragmatic solutions to this problem are necessary for further vehicle production as ISO 9241-220:2019 [1] specifies engineering standards that especially denote human-centered design and usability. However, their minimization approach may on some occasions be disadvantageous on the grounds that the automotive interactive design is a vital means of promoting the well-being of the driver and passengers, who may seek interest in extra media outlets being presented [4].

Therefore, the three considerations, inspired by the concept of the horizon, are put forward to suggest ways to reconcile the values of human-centered design and safe usability. The experiential features of driving for road users consists of:

(1) Recognizing objects categorically in sense perception. This means to not merely see objects and environments as general forms of shapes, sizes, and colours, but rather as distinct things (like pedestrians, animals, road signs, traffic lights, parking lots, etc.) which belong to categories of our intuitional background. Understanding object recognition and categorization helps to implement better ITS UX design solutions by the fact that in doing so, we can anticipate what one would tend to think about when perceiving things that are presented both outside of the vehicle and on the vehicle interior display. Consequently, by extension, we are then able to postulate potential driving maneuvers and behaviours.

(2) Thinking about the present and its future consequences. This means that in the driving experience, the driver both pays attention to the road and considers what to do next using the vehicle. This element is an important point for the UX design process as it is known that what occurs at present sets certain parameters of what may happen in the future. Given that what is displayed to the driver is calibrated to contemporaneous conditions (by time and place), the unique way in which relevant, time-sensitive (up to date) information is overlayed may have a significant effect on future proceedings.

(3) Making decision-procedures according to levels of priority and attention to detail. This aspect of driving is principally centered on matters of time, place, speed, movement, destination, and comfort. The UX design should be intricately oriented to the road user such that available options are presented to them in a cogent and effective manner that caters to driver needs and attention to detail. By integrating these experiential factors for the design of new automotive user interfaces, we are able to recognize the significance of user-oriented design, as each process of object recognition, foresight, and decision procedures, enter a causal chain while one is driving.

CONCLUSION

In this paper, I have argued that we may better clarify the issue of UX design and safety by approaching it from the standpoint of the driving experience. This in turn, is a matter of the limits of what we are aware of in conscious experience – best explained by the concept of the horizon. Therefore, to help develop a conceptual framework for user-oriented solutions in the field of ITS, three features inspired by the concept of the horizon were put forward. This account of how drivers experience operating vehicles on roads mounted with new display technologies indicates the need for optimal UX design development. By considering how, while driving, we recognize objects categorically in sense perception, think about the present and its future consequences, and make decision-procedures according to levels of priority and attention to detail, we may better understand the driving experience, especially for innovations in automotive user interfaces.

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