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Human factors and automated driving

Human Factors Principles to Guide the Design, Standards and Policies for Automated Driving Systems

Submitted by Human Factors in International Regulations for Automated Driving Systems" (HF-IRADS)

In response to the initiative from Canada and the WP.1 Chair to develop a framework document of key principles for automated vehicle safety and human centred needs, HF-IRADS has submitted this informal document as a contribution.

I. Introduction

1. The Proposal to develop a framework document of key principles for automated vehicle safety and human centered needs, submitted by Canada and the UNECE WP.1 Chair[1], states:

> "Automated vehicle technology holds great potential to enhance road safety by reducing the risk of human error, either through the provision of assistance to the human driver, or by assuming the entire driving task. However, as the driving task becomes progressively more automated and the role of the human driver evolves, this can pose new risks for human occupants of the vehicle as well as other road users that may encounter this technology on public roadways."

2. Similar points have been made by the Dutch Safety Board, in their report Who is in control? Road safety and automation in road traffic.[2]

3. The current document is produced by HF-IRADS[3] in response to that challenge and from the perspective that good design that delivers safe user interaction is an essential part of automated vehicle safety. Thus, we wholeheartedly endorse the global requirement stated by the UNECE Functional Requirements Group (FRAV) for Automated Driving Systems (ADS): **"The ADS should interact safely with the ADS vehicle user(s)."** Another safety requirement from FRAV is also highly relevant: **"The ADS shall interact safely with other road users."**[4]

4. To achieve such safe interaction, it is necessary that ADS be designed to meet human needs and capabilities, and not force the human to adapt to rigid and inappropriate designs or to adapt to immature technologies that fail to account for these needs. Nor should humans be required to compensate for inadequacies of the ADS.

5. Below, we outline an initial set of high-level human factors principles that should guide system developers and authorities to prioritise human needs when setting requirements for the design and operation of automated driving systems.[5] It is important to note that these principles may not be applicable or may apply to varying degrees depending on the automation level, the vehicle type, and the use case for the ADS technology. Nonetheless, it is important to consider these principles and their potential application at the outset of developing an automation-equipped vehicle as well as in the development of associated safety requirements by regulators.

II. Principles

(i) Usable: Interaction with the ADS should be simple, discoverable and easy to learn.[6]

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[1] ECE-TRANS-WP1-2021-Informal document-11e.

[2] https://www.onderzoeksraad.nl/en/page/4729/who-is-in-control-road-safety-and-automation-in-road-traffic (access date 12 August 2022)

[3] "Human Factors in International Regulations for Automated Driving Systems" (HF-IRADS) operates under the auspices of the International Ergonomics Association (IEA). It brings together human factors experts from across the world to support UNECE activities on the safety of automated driving systems.

[4] The most recent draft of the FRAV requirements document (the "05" document) can be found at https://wiki.unece.org/display/trans/FRAV+30th+Session.

[5] The current principles focus particularly on ADS. However, many of these principles will also apply to Advanced Driving Assistance Systems, particularly when these support or replace the human driver in continuous vehicle control.

[6] ISO 9241-11:2018(en) defines usability as the "extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use."

(ii) Transferable: Users should be able to adapt with ease when shifting from the operation of one vehicle to another. This implies some high level of commonality of interface and interaction processes across vehicle makes and models.

(iii) Consistent: In similar circumstances, a specific ADS should perform in a consistent manner both in interaction logic and in the vehicle driving behaviour.

(iv) Supporting user role awareness: Users should understand their roles and responsibilities. This implies that there should be a limited set of modes in a vehicle, i.e. a limited set of levels of automation and variety of automation functions within those levels, and that the immediate role of the user, and any upcoming user role, should be obvious.

(v) Foreseeability/predictability: Users should be able to anticipate system behaviour. When an ADS is driving, there should be no expectation of immediate intervention by the user to react and respond in an emergency.

(vi) Accessible: In so far as possible, ADS design should accommodate the full range of prospective users.

(vii) Equitable: One group of ADS users or non-users (e.g., other road users) should not be disadvantaged in favour of another group (e.g., safety of ADS users should not be prioritised over non-users).

(viii) Enhancing driving quality: automation should strengthen the joint capability of user and vehicle to achieve a specific effect (e.g., increase of traffic safety). This implies that automation must perform driving tasks competently and coordinate its activity with the human driver.

(ix) Safe interaction with other road users: The ADS interaction with other road users should be consistent and predictable and should not require other road users to have any special consideration for ADS-driven vehicles.

(x) Accurate depiction of system capabilities: There should be no misleading names for ADS functions and no exaggeration in the description of system capabilities or operation.

(xi) Trust and acceptance: Users should trust and accept ADS to a degree that is consistent with its capabilities and limitations, and systems should be designed so as to earn appropriate acceptance and trust.

III. How to achieve these principles

6. The application of human-centred design at every stage of system development is vital. ISO 9241-210:2019 provides this definition:

> "Human-centred design is an approach to interactive systems development that aims to make systems usable and useful by focusing on the users, their needs and requirements, and by applying human factors/ergonomics, and usability knowledge and techniques. This approach enhances effectiveness and efficiency, improves human well-being, user satisfaction, accessibility and sustainability; and counteracts possible adverse effects of use on human health, safety and performance."

7. An analogue of this can also be applied to the regulatory process: human factors considerations need to be embedded in that process wherever relevant. Furthermore, traditional demarcations of responsibilities in vehicle regulation need to be overcome. The need to consider human factors aspects also applies when developers and regulators make and approve substantive changes to ADS functionality and appearance. Thus, it is vital to embed such considerations in the vehicle regulatory process to ensure that human factors are appropriately considered in vehicle design and approvals. Here the work under UNECE WP.29 in the Working Party on Automated/Autonomous and Connected Vehicles (GRVA) and its subgroups on Functional Requirements and Validation Methods is essential for ADS to achieve its potential to improve road safety. On the user side, UNECE WP.1, has a similar duty to promote human factors considerations in the rules for ADS operation and use.

8. There can be tensions between the push for enhanced safety and other protective rights. A human-centred approach can resolve these tensions. For example, there should be careful consideration of the protection of privacy while nevertheless addressing safety considerations.

9. The commonality in design that is referred to in the principles is currently not available for ADS. Such a commonality in design requires research and development to show what is the optimal level of commonality for ADS interaction and how that commonality can be realised. It has to be noted that such an ADS interaction design also needs to encompass all the relevant interaction processes (including, if applicable, interaction with ADAS).