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Road vehicles — Human performance and state in the context of automated driving —

Part 2: Considerations in designing experiments to investigate transition processes

Véhicules routiers — Etat et performance humaine dans le contexte de la conduite automatisée —

Partie 2: Principes expérimentaux pour etudier les processus de transition

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 39, *Ergonomics*.

A list of all parts in the ISO 21959 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Although automation technology is advancing at a rapid pace, the majority of automated driving levels (as defined by SAE J3016, 2016[1]) still require a human to fulfil specific remaining (driving related) tasks. The safety-critical human's task is the takeover task in transition from a higher level to a lower level of automated driving. Researchers and developers continue to seek system design and human machine interface improvements for better takeover performance. Researchers face a challenge in understanding the limitations of a human's ability to perform the takeover task, which involves different human factors. Developers work to evaluate systems to see whether the takeover process is effective at minimum risk in specific scenarios. There are a wide variety of experiments to evaluate takeover performance in transition for many different purposes. This document contains information to consider in the takeover scenario, some of which is still under investigation, in order to help readers design experiments to evaluate takeover performance and design appropriate experiments.

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Road vehicles — Human performance and state in the context of automated driving —

Part 2: Considerations in designing experiments to investigate transition processes

1 Scope

This document focuses on system-initiated and human-initiated transitions (Clause 6) from a higher level to a lower level of automated driving. Human factors and system factors that can influence takeover performance are included (Clauses 7 and 8). Although some are still under investigation, there is a need to appropriately set these factors as variables to better understand their effects or to better control/eliminate their influence. This approach will aid research design by ensuring that important factors are considered and support consistency across studies enabling meaningful comparisons of findings. This document also includes information on considerations in test scenario design (Clause 9), common measures for human takeover performance (Clause 10) and considerations in choosing a testing environment (Clause 11) to help readers design experiments comparable to other studies.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 List of Acronyms

DDT	Dynamic Driving Task
DMS	Driver Monitor System
ECG	Electrocardiogram
EEG	Electroencephalogram
HMI	Human-Machine Interface
KSS	Karolinska Sleepiness Scale
MRM	Minimal Risk Manoeuvre
NDRT	Non-driving Related Task

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NDRA	Non-driving Related Activities
OEDR	Object and Event Detection and Response
ODD	Operational Design Domain
RtI	Request to Intervene
SAGAT	Situation Awareness Global Assessment Technique
SDLP	Standard Deviation of Lateral Position
SIMS	Situational Motivation Scale
SuRT	Surrogate Reference Task
TLC	Time to Lane Crossing
TTC	Time-to-Contact/Collision

5 Purpose

The purpose of this document is to provide considerations in designing experiments to measure human takeover performance in transition situations in order to better understand human limitations, evaluate systems, and improve systems, including human machine interfaces. This document is expected to help users design appropriate experiments for their purposes. This document does not provide any design principles to restrict or direct the system design.

6 Transition process models

6.1 General

Transition processes included in this document are generally based on the models defined in ISO/TR 21959-1[2]. A human's safety-critical task is the takeover task in transition from a higher level to a lower level of automated driving both for system-initiated and human-initiated transitions. ISO/TR 21959-1[2] defines typical transition process models from automated to manual driving (i.e. level 0). However, the models can be adapted for transitions between different levels (e.g. 4→2 or 3→1). This clause reminds readers of the relevant transition process models.

6.2 Transition process model for system-initiated transitions

In a system-initiated transition, the system may issue a request to intervene (RtI) when it finds a dynamic driving task (DDT) performance-relevant system failure or an object/event which cannot be handled by the system for levels 1–4. The system also may issue an RtI when exiting the operational design domain (ODD) for which it was designed, (e.g. exiting a motorway, exiting assumed environmental conditions such as weather and traffic). The driver is expected to take over the DDT in response to an RtI to continue driving. The system may terminate immediately after issuing an RtI for level 2 while it shifts to the takeover mode following an RtI before termination for levels 3 and 4 (Figure 1). There can also be other types of transitions after an RtI, such as transitions from level 2 to level 1 and from level 3 to level 2. The driver's task model can be adjusted depending on the level after the RtI (i.e. object and event detection and response [OEDR] task for transition to level 2, OEDR task +lateral control or OEDR task +longitudinal control for transition to level 1). When the driver does not initiate intervention within the takeover mode, the system may shift to the minimal risk manoeuvre (MRM) to stop the vehicle safely for level 3 and level 4 (see 8.2.2 for details).

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