

Considerations Regarding Introduction of Optical and/or Audible Signals Intended to Signal the Status & Intent of Automated Vehicle Systems

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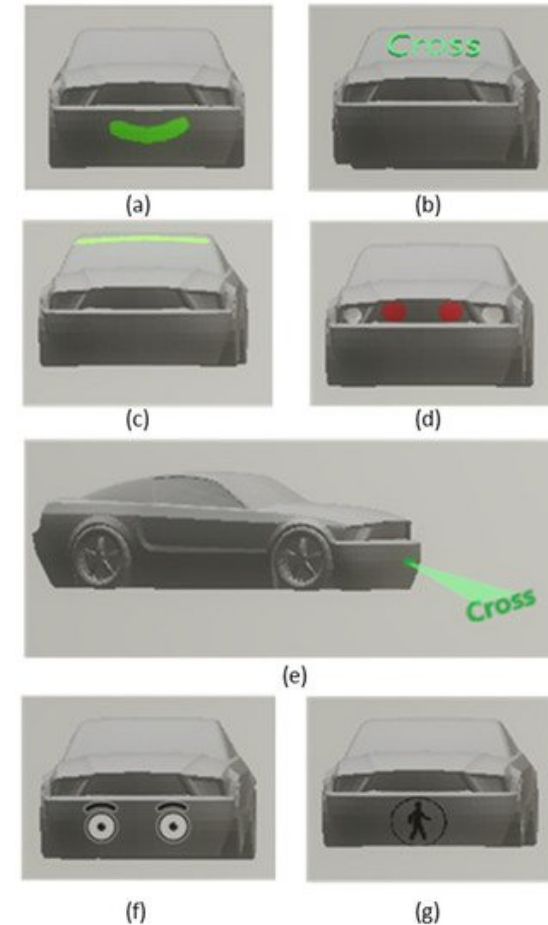
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Optical and/or Audible Signals in DAS and ADS Vehicles

Proposition Under Discussion: Automated vehicles should use optical and/or audible signals to indicate whether they are operating in an automated mode and their intent.

Why?

- There has been increasing concern that if there is not a driver present in an automated vehicle, this will remove an important source of communication between road users
 - Loss of eye contact and physical gestures to indicate intent
 - Interactions with pedestrians, cyclists, but also with vehicle drivers
- Moreover, in intermediate levels of automation, where there is a human in the “driver’s seat” but they are not actively driving, there could be misinterpretation about vehicle intent
 - If pedestrian is unaware that a vehicle is in an automated mode, a pedestrian at a crosswalk might assume that a stopped vehicle is not going to advance because the “driver” is not looking at the road.
- These are reasonable concerns that are very worthy of evaluation.



A sampling of a range of eHMI design proposals – from Carmona et al., 2021



Optical and/or Audible Signals in DAS and ADS Vehicles

Concern: Can and will the introduction of new methods of signalization sufficiently offset the risk of new forms of confusion & miscommunication?

- Are eye contact and hand gestures as significant a source of functional communication as many assume?
 - Research indicates that it is not
- How often are eye contact and hand gestures misinterpreted (and we might be better off without)?
- Will some pedestrians become sufficiently used to DAS & ADS vehicles signaling when they are going to start moving that these pedestrians will inadvertently walk in front of a conventional vehicle that has just started to move because it is not using this signaling feature?
- If a vehicle is identified as operating in an automated mode, will other road users assume it will behave differently – resulting in misinterpretations?
- What are the specific scenarios that really need to be solved (e.g., can the essential needs be narrowed down to a limited set of situations)?

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Item 3 (c) (iii) of the provisional agenda

Automated driving:

Optical and/or audible signals in DAS and ADS vehicles

Submitted by the WP.1 Chair

The WP.1 Chair has requested professor B. Mehler of MIT to offer first insights on the issue of optical and/or audible signals in DAS and ADS vehicles in order to facilitate WP.1 discussion on this subject. WP.1 will be invited to discuss this informal document.

ECE-TRANS-WP.1-2021-Informal-No.3e

March 5, 2021

Brief Comments on Requiring Automated Vehicles to Communicate a Mode of Operation: The Importance of Avoiding Unintended Consequences



Optical and/or Audible Signals in DAS and ADS Vehicles

Additional points to consider in thinking about adding signals to vehicles:

- Humans are primed to look toward movement.
 - This can draw attention to an important message, but it also can distract from other signals in the environment, so it needs to be used cautiously
- Presentation of too many signals can lead to information overload and confusion.
- Surrounding road users with a sea of added signals when many vehicles are present may risk saturation of attention.
- Designers need to keep in mind that only limited color options are available for optical signals as the use of red, yellow, and blue are already codified.
 - White and cyan may be leading contenders.
 - Green for “go” and red for “stop” can confuse as to who is to go and who is to stop.





Optical and/or Audible Signals in DAS and ADS Vehicles

Key Points of Agreement:

- “First and foremost, AVs should use the existing external signalization devices which are available in and used by current existing vehicles (direction indicators, brake lights, horn, etc.) without driver assistance systems. *New and different solutions could cause confusion when road users have to interact with multiple vehicles, both conventional and automated.*”
- “We conclude that the traffic rules for automated vehicles must not be different from existing traffic rules.”
- A number of points highlight the need to be very specific in defining the special cases in which new signals are employed.

Question:

- Point 6 referred to an optical signal as being useful as a “temporary solution” for specific needs. What aspects call out for temporary solutions?

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Item 3 (c) iii of the provisional agenda

Position statement on optical and/or audible signals in the context of driver assistance systems, advanced driver assistance systems and autonomous vehicles

Submitted by Germany

Following the preliminary discussion on the topic at the last session, supported by Informal document No. 3, Germany, with the present document, would like to contribute to continue discussing the topic during the present session.

Germany discussed the topic of signaling requirements for Automated and Autonomous Vehicles (AVs).

**ECE-TRANS-WP1-2021-Informal document-2e
August 30, 2021**

Recommendations

If authorization and/or requirements for signaling operational state and intent in DAS and ADS equipped vehicles are issued:

- Need to be very specific about where and why new signals are needed.
 - Does the need / potential benefit outweigh the risk of possible confusion / misunderstanding on the part of other road users?
- As suggested by the phrasing of the proposition, both operational state (in autonomous mode) and intent need to be present.
- The number of possible “intent” signals should be kept to a minimum. Perhaps limited to when an AV is stopped:
 - “I’m operational and stopped – you can cautiously proceed”, and
 - “I’m operational and moving or about to start moving – don’t proceed”.
- Careful functional evaluation of any proposed designs are needed.
 - To establish frequency of confusion or misinterpretation (risk/benefit ratio)
 - Understandability by non-literate adults, children, and across cultures
 - Test utility under various lighting, weather, and traffic density conditions
 - Standardization similar to brake and directional signal indicators needed



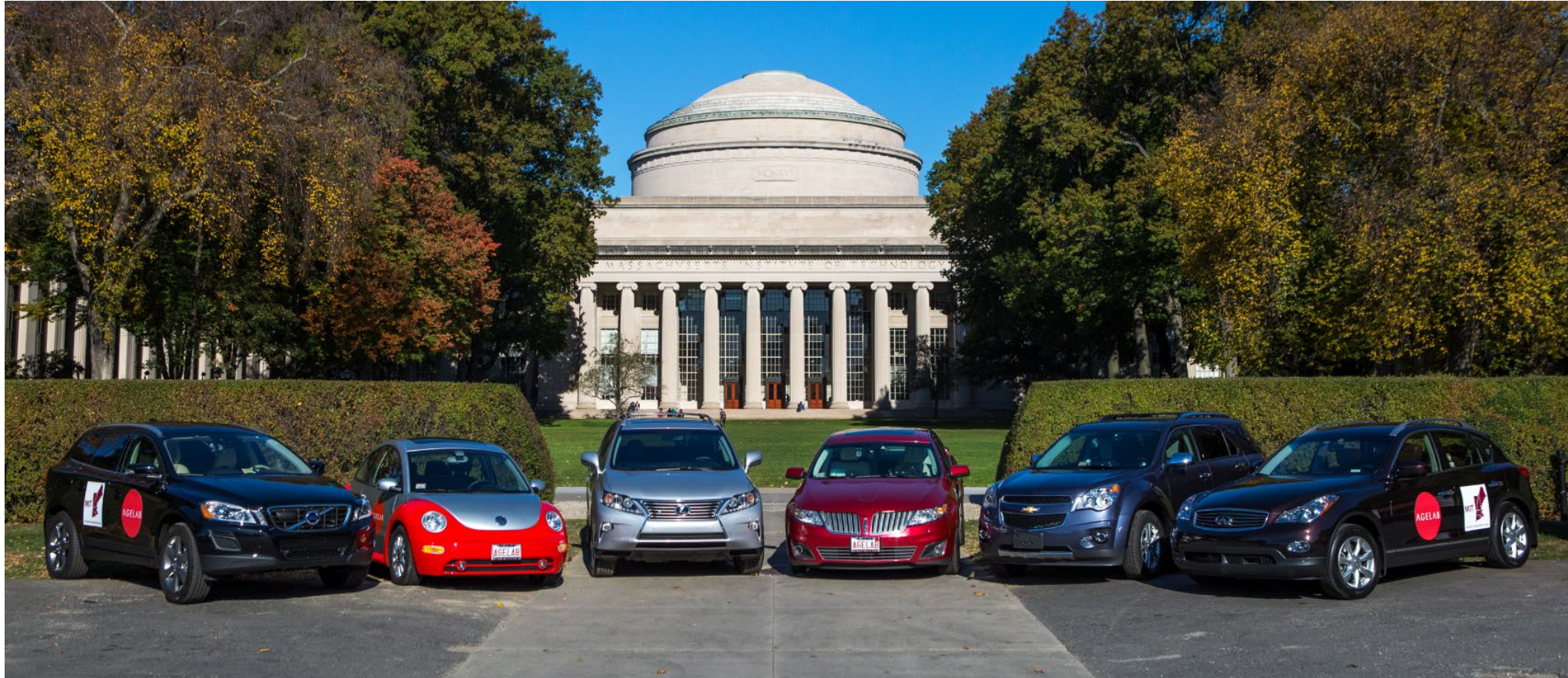
Current signalization is limited to a few basic concepts and easily learned. Can we do equally well with new signals?

Other Implication Questions

If authorization and/or requirements for signaling operational state and intent in DAS and ADS equipped vehicles are issued:

- Would this requirement extend to SAE Level 3 vehicles where automation is operational and effectively “driving” and a human is not required to attend to the road until signaled by the vehicle to take back control?
 - If yes, what if anything will be required in terms of retrofitting existing L3 vehicles?
- Would this requirement extend to SAE Level 2 vehicles where automation is operational and effectively “driving” even though a human is supposed to be supervising?
 - If yes, what if anything will be required in terms of retrofitting existing L2 vehicles?

Discussion / Questions



For Further Follow-up:

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Appendix: Selected References

The following is a selected list of research relevant to the points raised in these comments. It is by no means exhaustive, likely does not include some highly relevant work, and should ideally be expanded at a future time to provide a more complete background on these issues.

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