

interactive



Accident avoidance by active intervention for Intelligent Vehicles

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Information, Warning and Intervention (IWI) Strategies for ADAS
ITS TOKYO - Special Session SIS63
Building the Future on Advanced Integrated Safety Applications

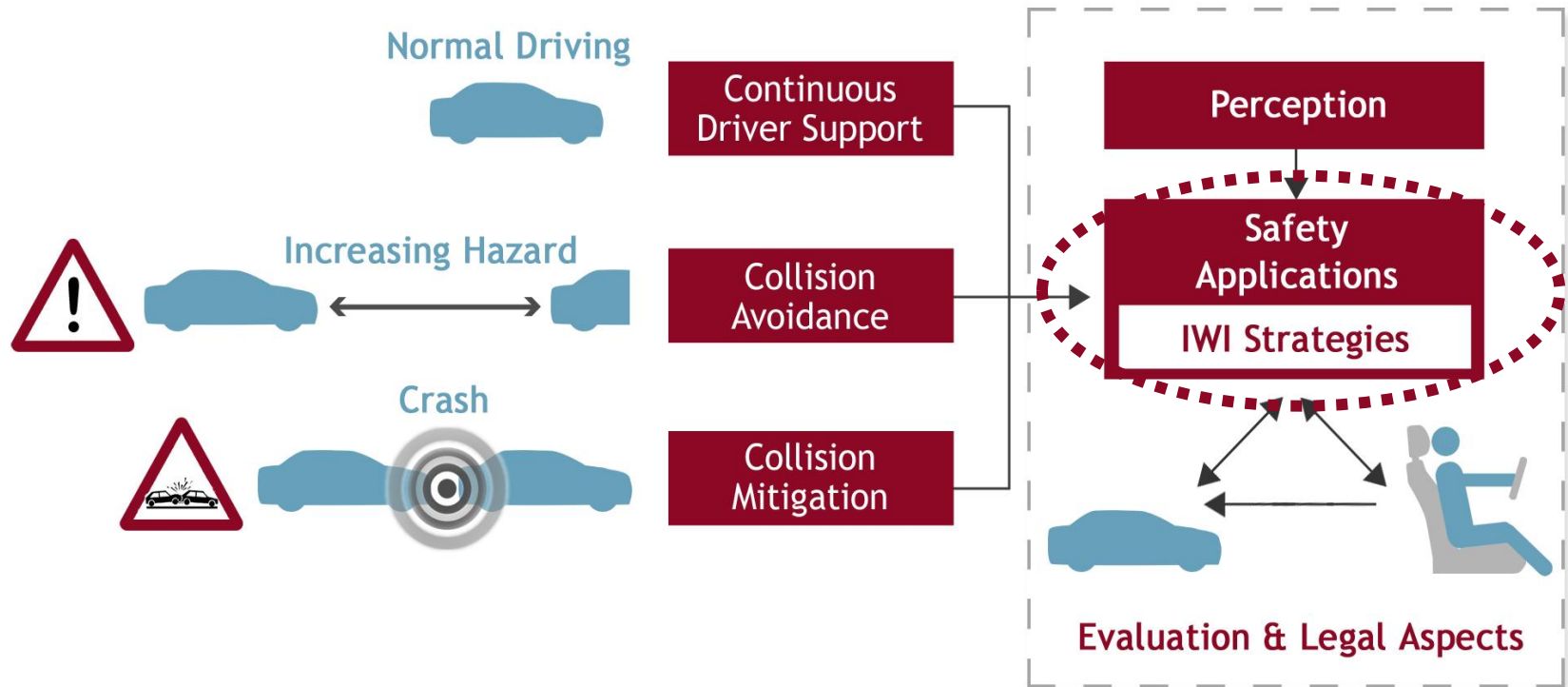
Martin Brockmann - Allround-Team GmbH
Tokyo, October 18th 2013

Outline

- Role within interactive
- **Information, Warning & Intervention Strategies**
- Work process: Iterative
- IWI Testing: Experimental Studies
- Design Elements for Integrated ADAS: Acoustic, Visual, Haptic
- IWI Strategies (Examples)
 - Sequence of Interaction
 - Arbitration



Role within interactive



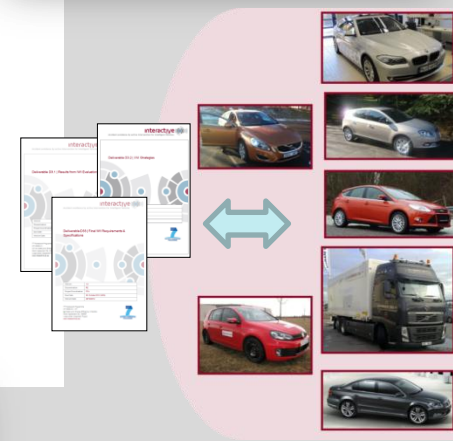
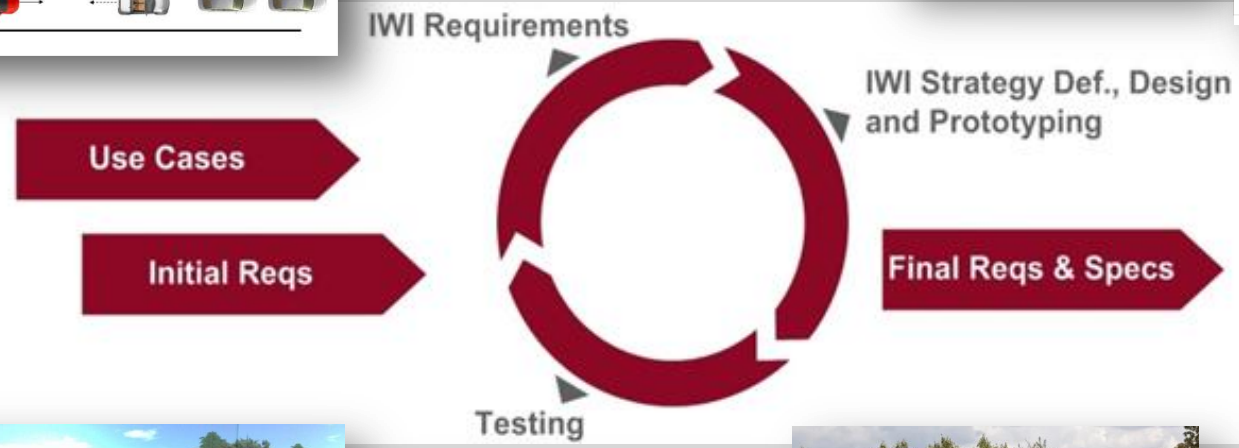
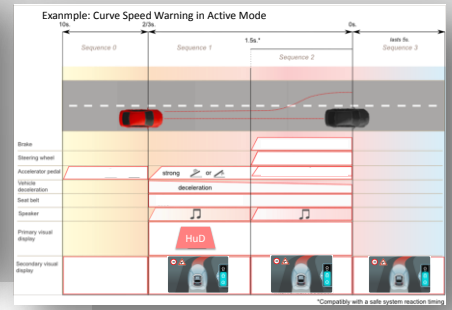
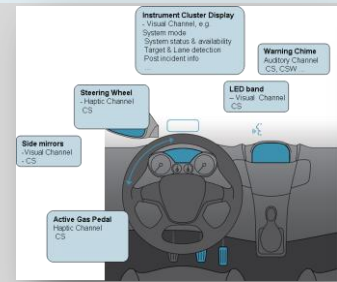
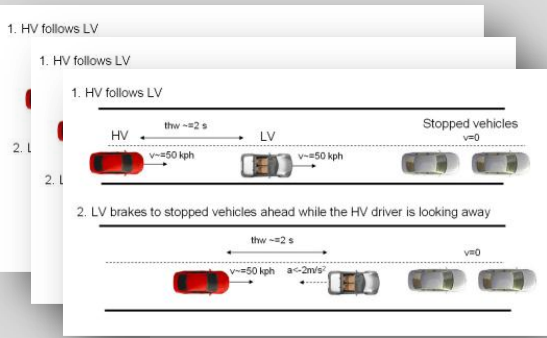
IWI - Information, Warning & Intervention Strategies

- **IWI** strategies should
 - define the actual function from a driver's perspective
 - explain how, when and where information, warnings and interventions should be activated
 - specify the appropriate type of interaction
 - Information and Warnings, which can be visual, acoustic or haptic
 - Interventions via active steering, braking or accelerating



→ Guidelines on how to create successful integration of ADAS information, warnings, and interventions into an overall function

Work process: Iterative



Work Process: Integration

- **Integrated Concept for Information, Warning & Intervention**
 - Integrating all interactive functions
 - emergency systems and continuous automation functions
 - lateral and longitudinal support

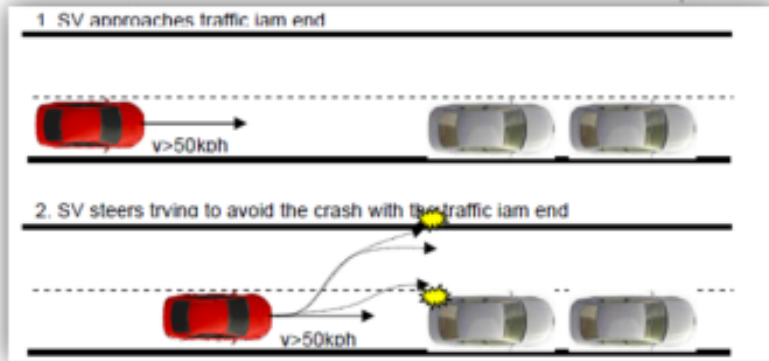
interactive Applications

CS Continuous Support (CRF)	CS Continuous Support (FFA)	SC Safe Cruise	CSW/CSC Curve Speed Warning / Control	RORP Run off Road Prevention	RORP in curve	SIA Side Impact Protection	LCCA Lane Change Collision Avoidance	RECA Rear-end Collision Avoidance	CMS Collision Mitigation System	ESA Emergency Steer Assist	OVCA Oncoming Vehicle Collision Avoidance/Mitigation	eDPP enhanced Dynamic Path Predictor
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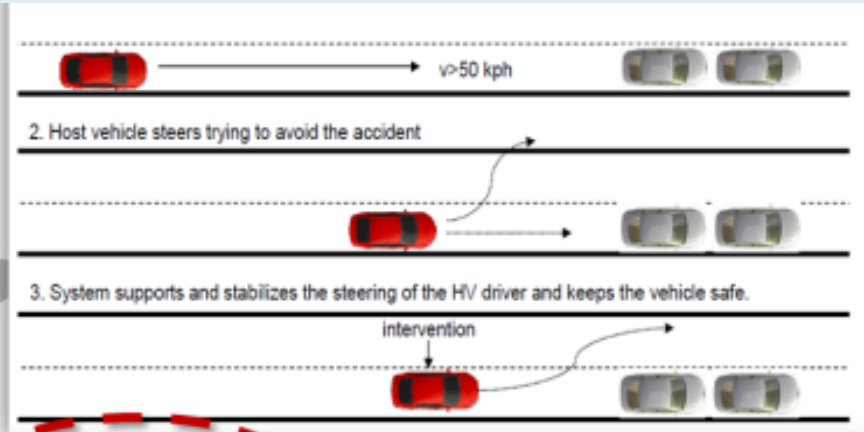
Integrated Concept

Work process: Use cases

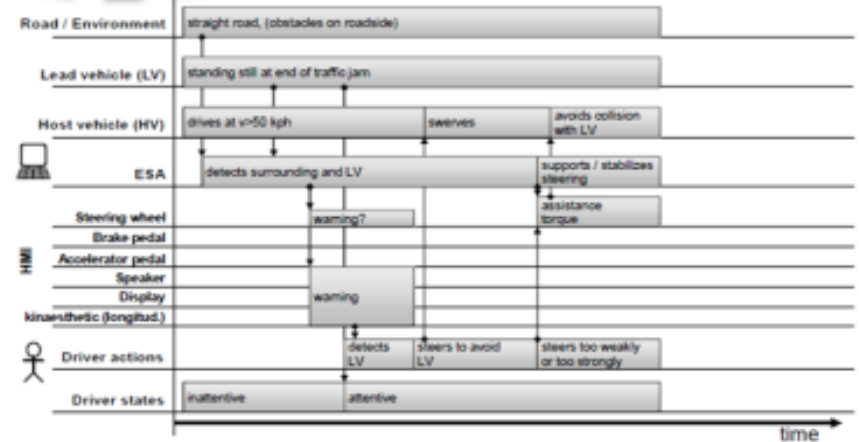
IWI Requirements



Testing



Sequence diagram



IWI Testing: Experimental Studies

- Testing facilities
 - two static vehicle simulators and one truck simulator
 - two moving based simulators
 - one test vehicle with full drive by wire capability



- Ten experimental studies involving more than 400 participants
 - professional drivers of commercial vehicles
 - private car drivers

IWI Testing: Experimental Studies

- **System initiated evasive steering maneuvers** in Rear-End, Lateral and Mixed intersection situations
- **Preferred communication channels** (visual, auditory, haptic) in different critical situations



- **Driver-vehicle interaction with and without steer by x/ de-coupled driver**
- **Evaluation of warning options and warning levels**

Acoustic Design Elements for Integrated ADAS



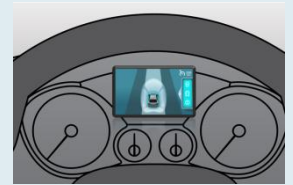
- **Some general strategies:**

- Lateral and longitudinal warning should be clearly distinguishable
 - I.e., **all lateral** sounds
 - should have same characteristics
 - should be clearly different from **all longitudinal** sounds
 - Sounds should be **spatialized** (or panned) to the location of the hazard
 - I.e., run-off-road to the right
 - warnings should be perceived as coming from the right

- **Two design approaches**

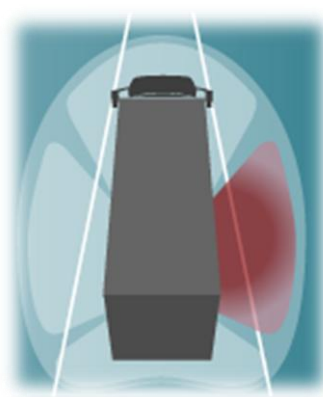
- **Earcons:** Synthetic, musical sounds – simple tones or even melodies.
 - **Auditory icons:** Real-world sounds with inherent meaning. E.g. skidding tyres to represent a breaking car in the front
- Can be very efficient in terms of understanding and reaction time

Visual Design Elements for Integrated ADAS (1/2)

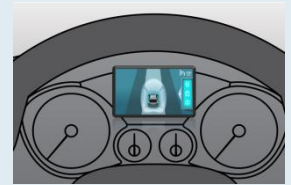


- **Safety shield metaphor**

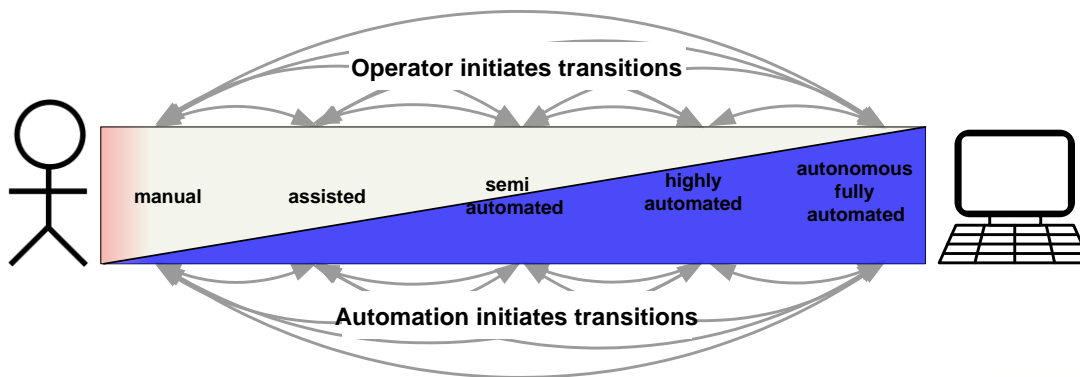
- a safety shield around the ego-vehicle to use the direction-criticality/distance-metaphor
- with segments of lateral and longitudinal elements
- spatial compatibility of warnings



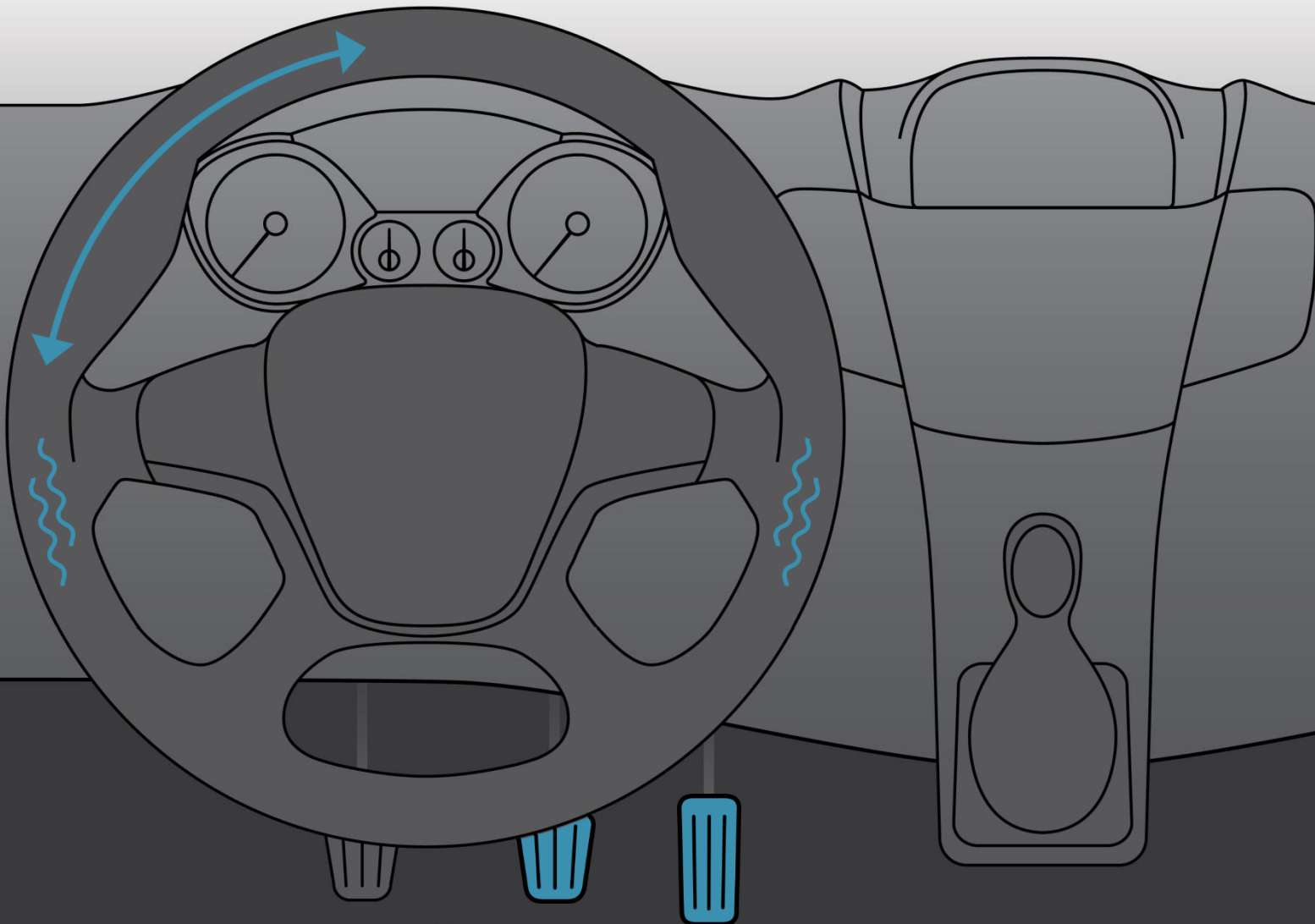
Visual Design Elements for Integrated ADAS (2/2)



- **Mode indicator for systems providing different levels of automation**
 - Automation mode display on an one-dimensional scale
 - Always visible
 - Increasing automation levels - filling from the bottom

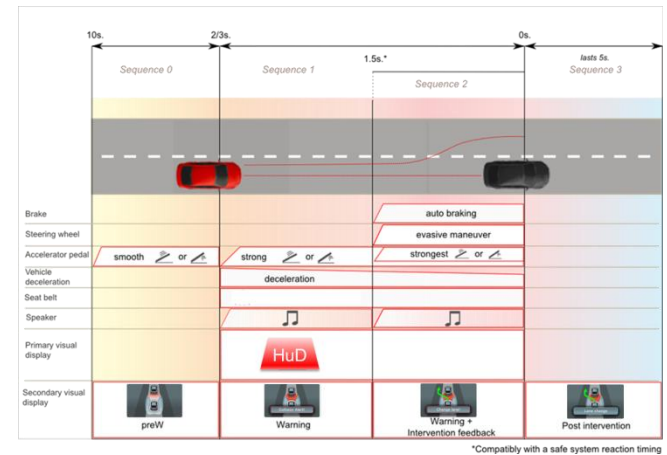


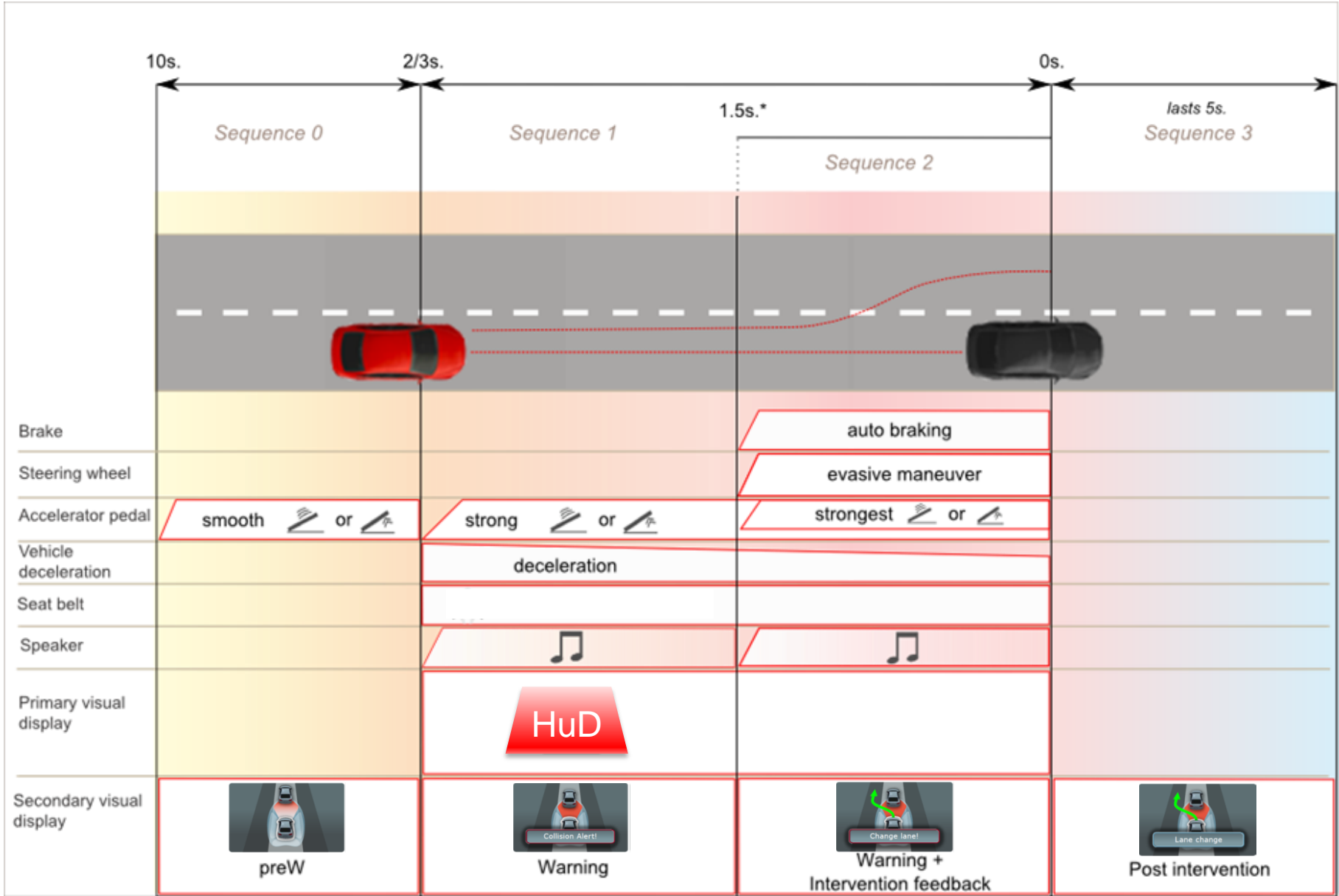
Haptic Design for Integrated ADAS: Common haptic elements for warning and interventions



IWI Strategies (Examples) - Sequence of Interaction

- How does the assistance evolve in specific situations:
 - Should a driver be given visual, auditory and/or haptic warnings before a steering or braking intervention?
- Structuring of escalation sequence into specific sequence levels
 - from early pre-warning
 - to post-intervention information



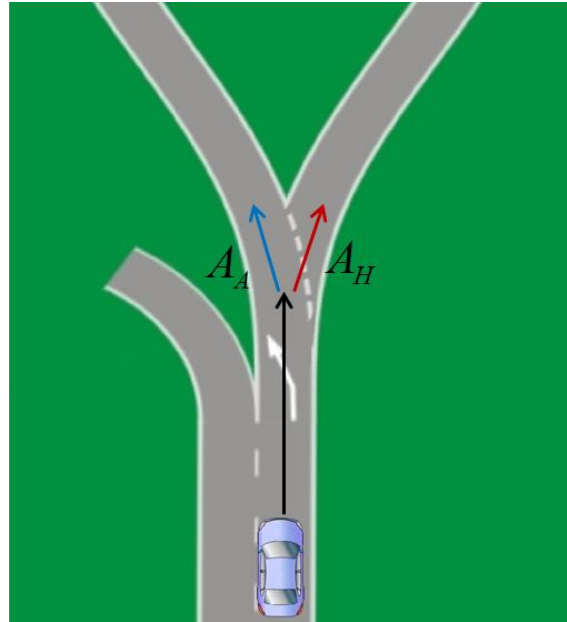


*Compatibly with a safe system reaction timing

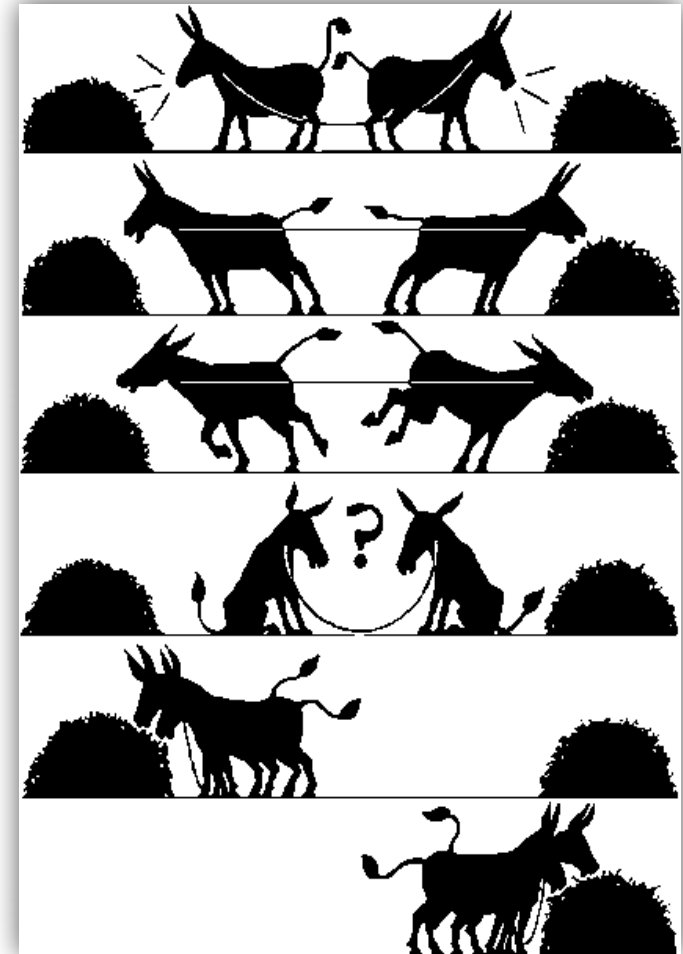
IWI Strategies (Examples) - Arbitration

Arbitration

- how to resolve disagreement between driver and system.
- I.e. automated acceleration is always overrideable by the driver by braking



Conflict situation: road fork (Figure 25) where the human wants to turn left (A_H) and the automation right (A_A).



IWI Strategies (Examples) – Arbitration Matrix

		Intervention						
		Current automation action (Type of intervention, based on currently selected maneuver and control)						
		Braking Only	Braking and Steering		Steering Only			
		Braking (object ahead)	Braking and Steering Left (object ahead)	Braking and Steering Right (object ahead)	Steering Left (object ahead)	Steering Right (object ahead)	Steering Left (Road Departure)	Steering Right (Road Departure)
Driver action	brake pedal	automation behaviour: continue (driver agrees), <i>modify if driver brakes stronger than system</i> interaction:	automation behaviour: continue (driver agrees) what if braking by driver hinders steering? interaction:	automation behaviour: continue (driver agrees) what if braking by driver hinders steering? interaction:	automation behaviour: continue, <i>modify to account for driver braking</i> interaction:	automation behaviour: continue, <i>modify to account for driver braking</i> interaction:	automation behaviour: continue, <i>modify to account for driver braking</i> interaction:	automation behaviour: continue, <i>modify to account for driver braking</i> interaction:
	gas pedal	automation behaviour: discontinue, - switch to steering only? - transition to manual? interaction:	automation behaviour: discontinue, - switch to steering only? - transition to manual? interaction:	automation behaviour: discontinue, - switch to steering only? - transition to manual? interaction:	automation behaviour: continue / discontinue ? <i>modify to account for driver acceleration /</i> interaction:	automation behaviour: continue / discontinue ? <i>modify to account for driver acceleration /</i> interaction:	automation behaviour: continue, <i>modify to account for driver acceleration</i> interaction:	automation behaviour: continue, <i>modify to account for driver acceleration</i> interaction:
	steer left	automation behaviour: discontinue, - switch to combined braking+steering or steering only?, - transition to manual? interaction:	automation behaviour: continue (driver agrees), <i>modify to account for driver steering</i> interaction:	automation behaviour: continue (driver agrees), <i>modify to account for driver steering</i> interaction:	interaction:	interaction:	interaction:	interaction:
	steer right	automation behaviour: discontinue, - switch to combined braking+steering or steering only?, - transition to manual? interaction:	automation behaviour: discontinue ?, - switch to braking only or braking+steering left? - transition to manual? interaction:	automation behaviour: continue (driver agrees), <i>modify to account for driver steering</i> interaction:	automation behaviour: discontinue ?, - switch to braking only or steering right? - transition to manual? interaction:	automation behaviour: continue (driver agrees), <i>modify to account for driver steering</i> interaction:	automation behaviour: discontinue, - transition to manual interaction:	automation behaviour: discontinue, - transition to manual interaction:

Action selection as arbitration matrix, actions are selected and re-selected based on automation *and* driver's intents and actions

Main Project Outcomes

- **Prototype vehicles**
- **D3.1 “Results from IWI evaluation”**. *Experimental results from 13 experiments*
- **D3.2 “IWI strategies”**. **Generic IWI strategies provided as *guidelines***
- **D3.3 “Final IWI Requirements & Specifications”**. **Functional and non-functional requirements *applied to demonstrators***

Short version

Full Version Public

Short version



Acknowledgements

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