Summary of International Guidelines for Human Machine Interface of Advanced Driver Assistance System

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Introduction

- Collision avoidance system has been rapidly spread
  - General users began to recognize the driving support system
  - Automatic driving technology might be developed rapidly

- Purpose of the automatic driving technology
  - Mitigation of driving load and environmental improvement
  - Reduction of traffic accidents

- Two international guidelines for driving assistance have been issued
  - Guidelines on requirements for high-priority warning signals
  - Design principles for Control Systems of Advanced Driver Assistance System (ADAS)

- Human Machine Interface in the highly ADAS is important
ADAS and Automated Driving

Advanced Safety Vehicle (Japanese project)

- Braking Control: Advanced Emergency Braking Systems (AEBS)
- Longitudinal Control: Adaptive Cruise Control (ACC)
- Horizontal Control: Lane Keeping Assist System (LKAS)

Automated driving is considered to be the development of these technologies

AEBS

SUBARU HP, members.subaru.jp

ACC

http://v40.volvo-style.com/news_20130821109

LKAS

TRW HP
http://safety.trw.com
Automated driving is expected to be continuously achieved through sophistication of driving support technologies.

- **Conventional Driving**
  - Driver only
  - Maneuvering of vehicle

- **Driver Assistance System**
  - Driver and System
  - To Operate vehicle System

- **Automated Driving**
  - System only
  - To Monitor System operation

The diagram illustrates the relationship between the degree of intervention in driving and the task performed by the driver. It shows a transition from manual driving, where the driver performs all maneuvers, to automated driving, where the system handles all aspects of the driving process.
Principle of Driver in the Loop

- A driver is considered to be part of a safety system.
- ADAS is intended to assist the driver.

![Diagram showing the principle of driver in the loop](image)

- Advanced Driving
- Conventional Driving
- Advanced Technologies
- Feedback of Vehicle Behavior
- Driver
- Vehicle

Assistant for Recognition
Assistant for Judgment
Assistant for Operation
International Harmonization of ADAS

- The industry-government-academia projects in Europe
  - HAVEit, interactive, and AdaptIVe etc.
- International regulations on the new technologies have been studied
- World Forum for Harmonization of Vehicle Regulations (UN/ECE/WP29)
  - It is necessary for ADAS to evaluate the whole vehicle system
  - WP29/ITS informal group (ITS-IG)
    - To plan the direction of the international harmonization of ADAS
    - To share the information of the cross-sectoral new technology
    - IHRA-ITS conducts related researches and studies to support their discussion
World Forum for Harmonization of Vehicle Regulations (WP.29)

- United Nations Economic Commission for Europe (UNECE)
- Inland Transport Committee (ITC)

- World Forum for Harmonization of Vehicle Regulations (WP.29)

  - ITS informal group
  - Established in 2002
  - Sharing information of cross-sectoral new technology
  - Drafting new guideline

- Lighting and Light-Signalling (GRE)
- Brakes and Running Gear (GRRF)
- Passive Safety (GRSP)
- Pollution and Energy (GRPE)
- Noise (GRB)
- General Safety Provisions (GRSG)

- Active Safety
- Passive Safety
- Environment Protection
- General Safety
ADAS and Human Machine Interface (HMI)

- ITS-IG assumes the three support levels, information presentation, warning and vehicle control
- Appropriate HMI between the vehicle and the driver is important
Bahavioural Model of a Driver and Level of Driver Assistance

<table>
<thead>
<tr>
<th>Level of ADAS</th>
<th>Driving States</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>Step 1: Detection</td>
<td>Conventional Driving</td>
</tr>
<tr>
<td>Level 1 Information Presentation</td>
<td>Step 2: Judgment</td>
<td>Night Vision &amp; Camera Monitor</td>
</tr>
<tr>
<td>Level 2 Avoidance of Hazards</td>
<td>Step 3: Operation</td>
<td>Collision avoidance Warning</td>
</tr>
<tr>
<td>Level 3 Avoidance/ Mitigation of</td>
<td></td>
<td>Adaptive Cruise Control &amp; Emergency Braking System</td>
</tr>
<tr>
<td>Hazards</td>
<td></td>
<td></td>
</tr>
</tbody>
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Assistance by Advanced Technologies
Guidelines for high-priority warning signals (2011)

Definition of emergency warning that is presented just before the collision

- ADAS detects conflict
- System indicates conflict is imminent
- ADAS issues warning signal

High-priority warning: signal around 2 seconds prior to crash event

Perception-Response Sequence
- Detection: Driver attention
- Identification: Understanding
- Decision: Choosing response
- Response: Taking action
Requirements for high-priority warning signals

- High-priority warnings should
  - be **noticeable** in the driving environment
  - be **distinguishable** from other messages in the vehicle
  - provide **spatial cues** to the hazard location.
  - inform the driver of **proximity of the hazard**
  - elicit timely **responses or decisions**

- Multiple warnings should be **prioritized**
- False / nuisance warnings rate should be low
- System status and degraded performance of high-priority warnings should be displayed
Design principles for Control Systems of ADAS (2014)

- Basic principles that describe the role of the system and the driver in consideration of human characteristics

- Control Principles

  4 Elements
  - Control
  - Operational
  - Display
  - Supplementary

  12 principles
  - Override
  - ON to OFF Switch
  - Feedback information
  - Monitor system operations
UNECE Guidelines for Keeping Drivers In-the-Loop

Principles to allow drivers to easily and accurately understand driving situations and effectively use partial-automation; e.g.,

- System actions should be easy to **override** at any time under normal driving situations;
- Drivers should have a means to **transition from ON to OFF** manually;
- Drivers should be provided with **clear feedback** informing them when the system is actively controlling the vehicle;
- Drivers should be informed of the **system status** when system operation is malfunctioning or when there is a failure;
- Drivers should be notified of the **proper use** of the system prior to general use.
- Drivers should be notified of any **system-initiated transfer** of control between the driver and vehicle;

Issue of Transfer of Control between the driver and vehicle

- At the time of system is out of use, it is necessary to switch from automatic operation to manual operation
  - Appropriate timing and method of switching are required
  - It is necessary to design the HMI considering the driver's behavior and awareness when he/she is using the system

- HMI standardization activities for automatic driving system has been initiated
  - ISO TC204/WG14
  - ISO TC22/SC13/WG8
Summary

- Automated driving is considered to be the development of ADAS technologies
- In the highly advanced driving support system, principle of “Driver in the Loop” should be applied
- HMI design based on the Guidelines for high-priority warning and control principle is required for proper development of the technology
- It is important to clarify the appropriate timing and how to switch from automatic operation to manual operation when the system is out of use
Thank you for your kind attention
Block Diagram of Car Driving

Advanced Driving

Artificial Intelligence (IVIS+ADAS)

Assistance for Recognition: Information presentation
Assistance for Judgment: Warning
Assistance for Operation: Control

Human Driver

Environment

Vehicle

Feedback of Vehicle Behavior

Conventional Driving
Harmonization of Levels of driving automation

- Classification in 4-5 levels from manual to full automation
- Name and support are little different by country and organization

<table>
<thead>
<tr>
<th>Level</th>
<th>Examples of name</th>
<th>Examples of support</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>Manual Driving, No automation</td>
<td>Conventional Driving</td>
</tr>
<tr>
<td>1</td>
<td>Individual System, Assisted, Driver Assistance</td>
<td>Single function assistance (ACC, LKAS, AEBS etc.)</td>
</tr>
<tr>
<td>2</td>
<td>System Integration, Partial Automation</td>
<td>Combined function assistance (ACC+LKAS)</td>
</tr>
<tr>
<td>3</td>
<td>Advancing System, Conditional Automation</td>
<td>Highly Automated driving mode by intelligent control in limited situation</td>
</tr>
<tr>
<td>4</td>
<td>Full Automation, High Automation</td>
<td>The driver has been released from the all operation</td>
</tr>
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Level of assistance and driver responsibility

- International consensus is necessary for responsibility in the case of an accident

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<th>Responsibility of Safety</th>
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<tr>
<td>0</td>
<td>Manual Driving, No automation</td>
<td>Driver</td>
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<td>Driver? System?</td>
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