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Taxonomy of Driving Automation for Vehicles

汽车驾驶自动化分级

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Taxonomy of Driving Automation for Vehicles

1 Scope

This Standard specifies the taxonomy of driving automation function for vehicles.

This Standard applies to categories M and N vehicles with driving automation functions, and other categories of vehicles can be implemented by reference.

2 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

2.1 Driving automation

The behaviour of the vehicle continuously performing part or all of the dynamic driving tasks in an automation manner.

2.2 Driving automation system

A system that is composed of hardware and software for driving automation.

2.3 Driving automation feature

The ability of a driving automation system to perform part or all of the dynamic driving tasks within specific design operating conditions.

NOTE: A driving automation system can realize one or more driving automation functions, and each function is associated with a specific driving automation level and operational design condition. In order to accurately describe the capabilities of a driving automation system, it is necessary to clarify its driving automation level and operational design condition at the same time.

2.4 Dynamic driving task; DDT

In addition to strategic functions, the perception, decision-making, and execution behaviours required for vehicle driving include but are not limited to:

- Lateral vehicle motion control;
- Longitudinal vehicle motion control;
- Object and event detection and response;

When the operational design domain is about to exceed, driving automation system failure or other vehicle systems failure occur, so that the operational design condition cannot be satisfied; the fallback behaviour for which the minimal risk maneuver is taken over by the user or implemented by the driving automation system.

2.11 Operational design domain; ODD

The external environmental conditions that are suitable for the functioning of the driving automation system determined during the design of the driving automation system.

NOTE: Typical external environmental conditions include roads, traffic, weather, light, etc.

2.12 Operational design condition; ODC

The general term for various conditions applicable to its functional operation determined during the design of a driving automation system, including the operational design domain, vehicle status, driver and occupant status, and other necessary conditions.

2.13 Request to intervene

The notice for the driving automation system requests the dynamic driving task fallback user to take over.

2.14 Take over

The behaviour that, the dynamic driving task fallback user responses to the request to intervene, and obtains the driving right of the vehicle from the driving automation system.

2.15 Driving automation system failure

The failure of the driving automation system makes it impossible to reliably perform part or all of the dynamic driving task.

Example: Sensor failure, etc.

2.16 Other vehicle system failure

The failure of other systems in the vehicle other than the driving automation system makes the driving automation system impossible to reliably perform part or all dynamic driving tasks.

Example: Brake calliper failure, etc.

2.17 User

A collective term for human roles related to driving automation.

NOTE: The user's role can be converted under certain conditions.

2.17.1 Driver

For a specific vehicle, a user who performs part or all of the dynamic driving task and/or takes over in real time.

2.17.1.1 Conventional driver

A driver who sits in the driver's seat and directly manipulates the vehicle's braking, acceleration, steering, and shifting control devices to control the vehicle in a manual manner.

2.17.1.2 Remote driver

The driver who does not sit in the driver's seat where the vehicle braking, acceleration, steering and shifting control can be operated manually, and still can manipulate the vehicle in real time.

NOTE: The remote driver can be a user in the vehicle, a user that the vehicle is within its visual field, or a user that the vehicle is outside of its visual field.

2.17.2 Passenger

The users, in the vehicle, but do not assume any dynamic driving task and take over.

2.17.3 DDT fallback-ready user

When the Level-3 driving automation system is working, the user who can identify the request to intervene issued by the driving automation system and the obvious vehicle failure related to the dynamic driving task, and take over.

NOTE 1: This term is applicable to Level-3 driving automation functions, Level-4 and Level-5 do not have this role. The dynamic driving task fallback-ready user can be in or outside the vehicle.

NOTE 2: The dynamic driving task fallback-ready user becomes the driver when performing part or all of the dynamic driving task.

2.17.4 Dispatcher

Under the condition that the vehicle is not operated by the driver, the user who activates the driving automation system to realize the vehicle dispatch service but does not perform dynamic driving task.

NOTE: Only vehicles with Level-4 and Level-5 driving automation functions and their operational design domain covering the entire journey can be dispatched. If the driving automation system does not plan the route, the dispatcher still needs to specify the destination.

emergency braking, and lane departure suppression, etc.).

Note 2: Functions that do not have object and event detection and response capabilities (such as cruise control, electronic stability control, etc.) are not within the range of driving automation functions.

3.3.2 Level-1 driving automation

The Level-1 driving automation (partial driver assistance) system continuously implements the lateral or longitudinal vehicle motion control in dynamic driving tasks under its operational design condition; and has part of object and event detection and response capability adaptive to the implemented lateral or longitudinal vehicle motion control.

NOTE: For Level-1 driving automation, the driver and the driving automation system jointly implement all dynamic driving tasks, and supervise the behaviour of the driving automation system and perform appropriate responses or operations (such as the functions of lane centring control, adaptive cruise control, etc.).

3.3.3 Level-2 driving automation

The Level-2 driving automation (combined driver assistance) system continuously implements the lateral and longitudinal vehicle motion in the dynamic driving task under its operational design condition; and has part of object and event detection and response capability adaptive to the implemented lateral and longitudinal vehicle motion control.

NOTE: For Level-2 driving automation, the driver and the driving automation system jointly implement all dynamic driving tasks, and supervise the behaviour of the driving automation system and perform appropriate responses or operations.

3.3.4 Level-3 driving automation

The Level-3 driving automation (conditionally automated driving) system continuously implements all dynamic driving tasks under its operational design condition.

NOTE: For Level-3 driving automation, the DDT fallback-ready user implements the takeover in an appropriate way.

3.3.5 Level-4 driving automation

The Level-4 driving automation (highly automated driving) system continuously implements all dynamic driving tasks and automatically implements the minimal risk maneuver under its operational design condition.

NOTE 1: For Level-4 driving automation, when the system issues a request to intervene, the user may not respond; and the system has the ability to automatically reach the minimal risk

condition.

NOTE 2: Some vehicles with Level-4 driving automation system have no manual driving function, such as park shuttle buses.

3.3.6 Level-5 driving automation

The Level-5 driving automation (fully automated driving) system continuously implements all dynamic driving tasks and automatically implements the minimal risk maneuver under any drivable conditions.

NOTE 1: For Level-5 driving automation, when the system issues a request to intervene, the user may not respond; and the system has the ability to automatically reach the minimal risk condition.

NOTE 2: Level-5 driving automation has no restrictions on the operational design domain in the vehicle's drivable environment (except for restrictions such as commercial and regulatory factors).

3.4 Technical requirements for each level of driving automation

3.4.1 Level-0 driving automation

The Level-0 driving automation system shall meet the following requirements:

- a) Have the ability to continuously implement part of the object and event detection and response;
- b) When the driver requests the exit of the driving automation system, immediately release the system control.

NOTE: When the lane departure suppression system is working, the driver can actively control the steering wheel to exit the lane departure suppression system.

3.4.2 Level-1 driving automation

The Level-1 driving automation system shall meet the following requirements:

- a) Continuously implement lateral or longitudinal vehicle motion control in dynamic driving tasks;
- b) Possess the part of object and event detection and response capability adaptive to the lateral or longitudinal vehicle motion control;
- c) When the driver requests the exit of the driving automation system, immediately release the control of the system.

- a) It is only allowed to activate under its operational design condition.
- b) After activation, perform all dynamic driving tasks under its operational design condition.
- c) Identify whether it is about to fail to meet its operational design domain.
- d) Identify the driving automation system failure and the other vehicle system failure.
- e) Identify whether the status of the driver and occupant meets its operational design condition (if any).
- f) When one of the following situations occurs and the user does not respond to the request to intervene, the minimal risk maneuver is automatically implemented:
 - It is about to fail to meet the operational design domain;
 - The driving automation system failure or other vehicle system failure;
 - The condition of the drivers and passengers fail to meet their operational design condition;
 - Users request to achieve the minimal risk conditions.
- g) Except for the following circumstances, the system control right shall not be released:
 - The minimal risk condition has been reached;
 - The driver is performing a dynamic driving task.
- h) When the user requests the exit of the driving automation system, the system control is released. If there is a safety risk, it can be temporarily relieved.

3.4.6 Level 5 driving automation

The Level-5 driving automation system shall meet the following requirements:

- a) There is no limit to the operational design domain.
- b) It is only allowed to activate under its operational design condition.
- c) After activation, perform all dynamic driving tasks under its operational design condition.
- d) Identify the driving automation system failure and other vehicle system failure.
- e) When one of the following situations occurs and the user does not respond to the request to intervene, the minimal risk maneuver is automatically implemented:

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