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Issues to be solved for realizing human-automation coagency for collaborative control

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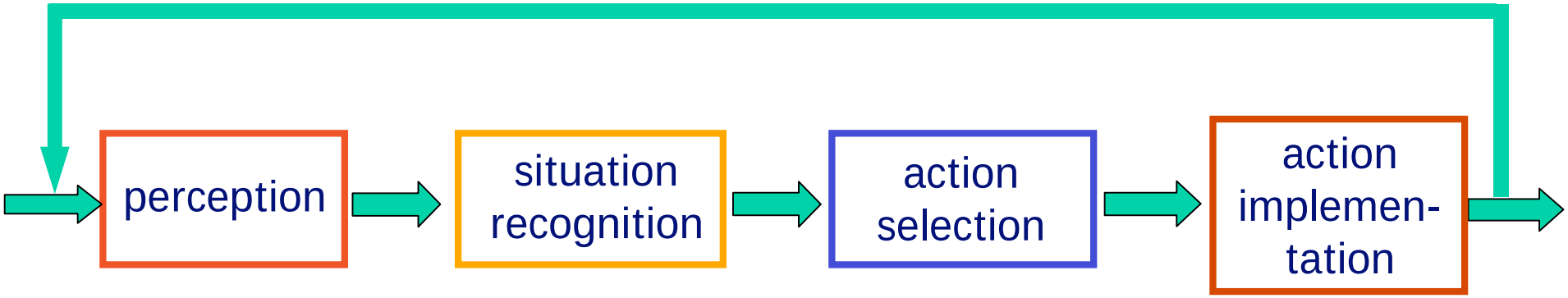
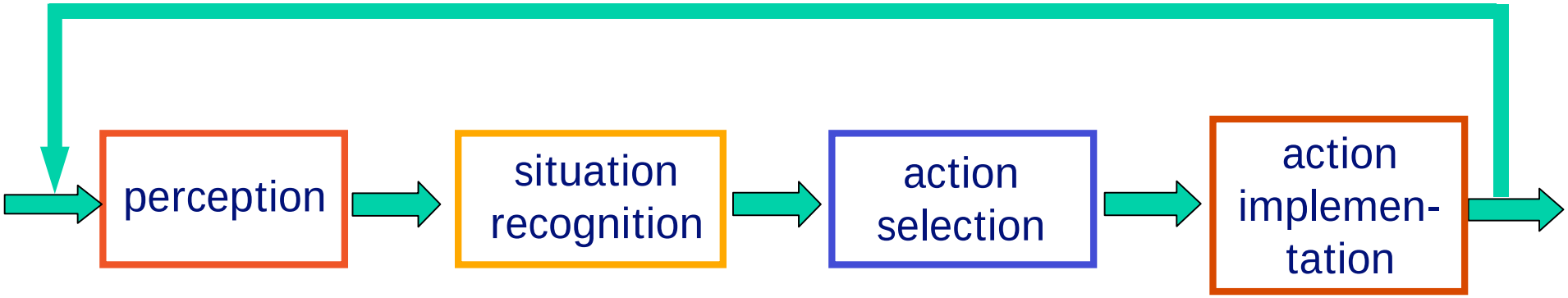
Perceptual cycles and driver assistance

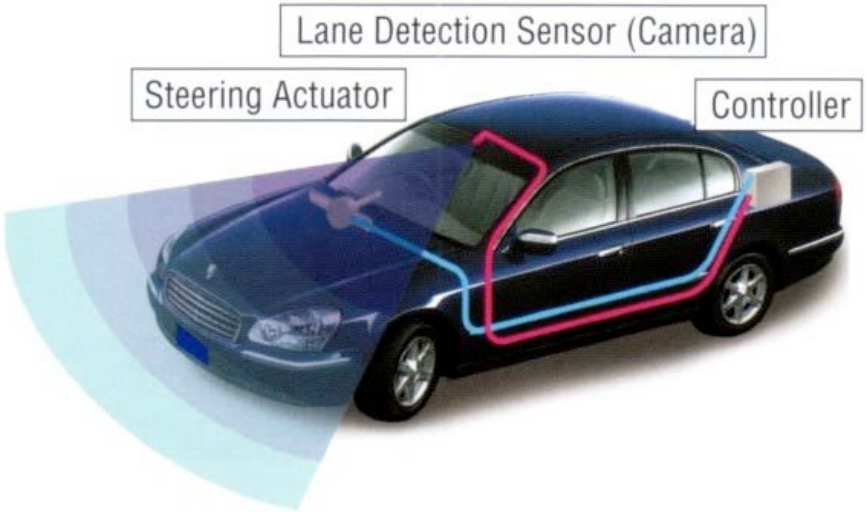


Perceptual cycles and driver assistance



extending driver's sensory capabilities	arousing attention	providing warning	implementing control action
such as to make invisible visible	to encourage the driver to pay attention to potential risks	to encourage the driver to take actions necessary in the situation	when the driver fails to perform actions necessary in the situation

Advanced Safety Vehicle (ASV) project (since 1991)



Types of driver assistance

(1) enhancing driver's perception

(2) arousing attention

(3) providing warnings

(4) implementing control actions

cautious stance on (4)

Why cautious stance on control action by ADAS?

1. Authority and responsibility

   Drivers must play the main role in driving vehicles safely.

   Convention on Road Traffic

   "Every driver of a vehicle shall in all circumstances have his vehicle under control so as to be able to exercise due and proper care and to be at all times in a position to perform all manoeuvres required of him." (Article 13.1)

   cf: Human-centered aviation automation

2. Driver's overtrust in and/or overreliance on automation

   Drivers may change their behaviour inappropriately by assuming that ADAS would take necessary actions when needed.

(Inagaki, 2010)

From a viewpoint of authority...

Setting off a warning

– fully compatible with human-centered automation
– unable to prevent accidents when disregarded

Implementing a control action

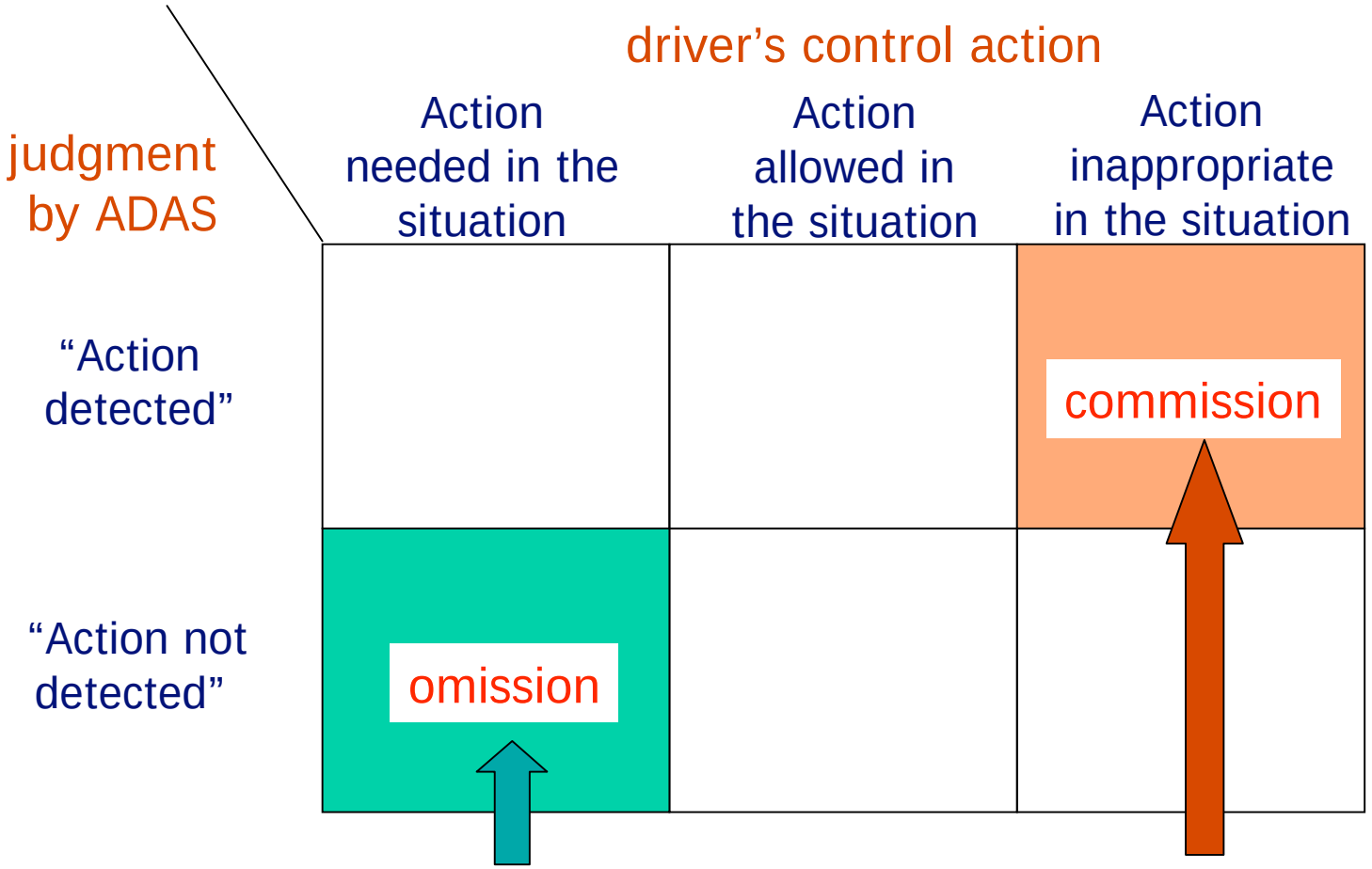
– not fully compatible with human-centered automation

(1) omission case: ADAS has authority to decide and act when the driver is unable to do what is necessary
(2) commission case: ADAS has authority to prevent the driver from doing what he/she tries to do

– <u>machine-initiated</u> trading of authority

(Inagaki & Sheridan, 2008)

To warn, or to implement a control action?



May machine have authority to decide and act when the driver is unable to do what is needed?

May machine have authority to prevent the driver from doing what he or she tries to do?

(Inagaki & Sheridan, 2008)

Overtrust in and overreliance on automation

Overtrust

- incorrect diagnostic decision to conclude that the automation is trustworthy, when it actually is not
  - dimension of trust (Lee & Moray, 1992)
  - chance of observation

Overreliance

- incorrect action selection decision determining to rely on the automation <u>by placing overtrust</u> in it
  - benefit expected
  - time allowance for human intervention

(Inagaki, 2010)

Dimension-of-trust axis

Foundation

conform to natural laws and social order

Performance

consistent, stable, and desirable performance or behaviour can be expected

Process

methods, rule bases, or control algorithms that govern the system behaviour are understandable

Purpose

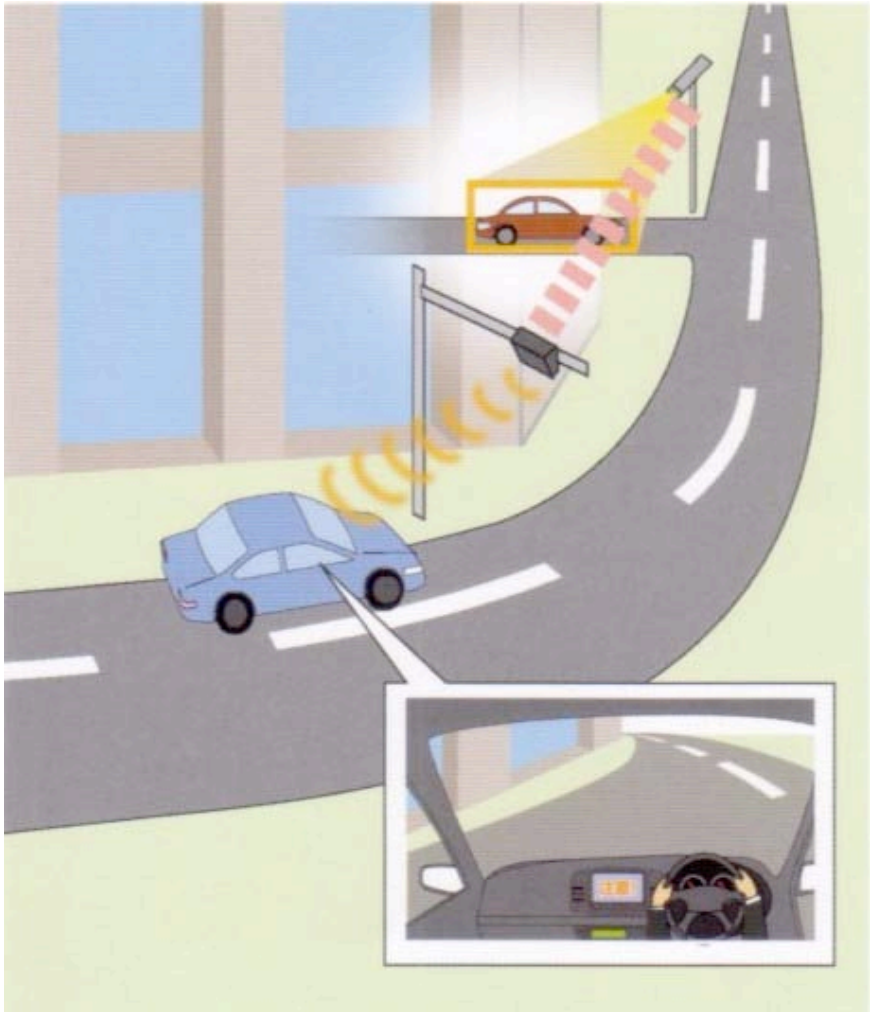
motives or designer's intention is understandable

(Lee & Moray, 1992)

Example: Overrating of performance

Performance: consistent, stable, and desirable behaviour can be expected

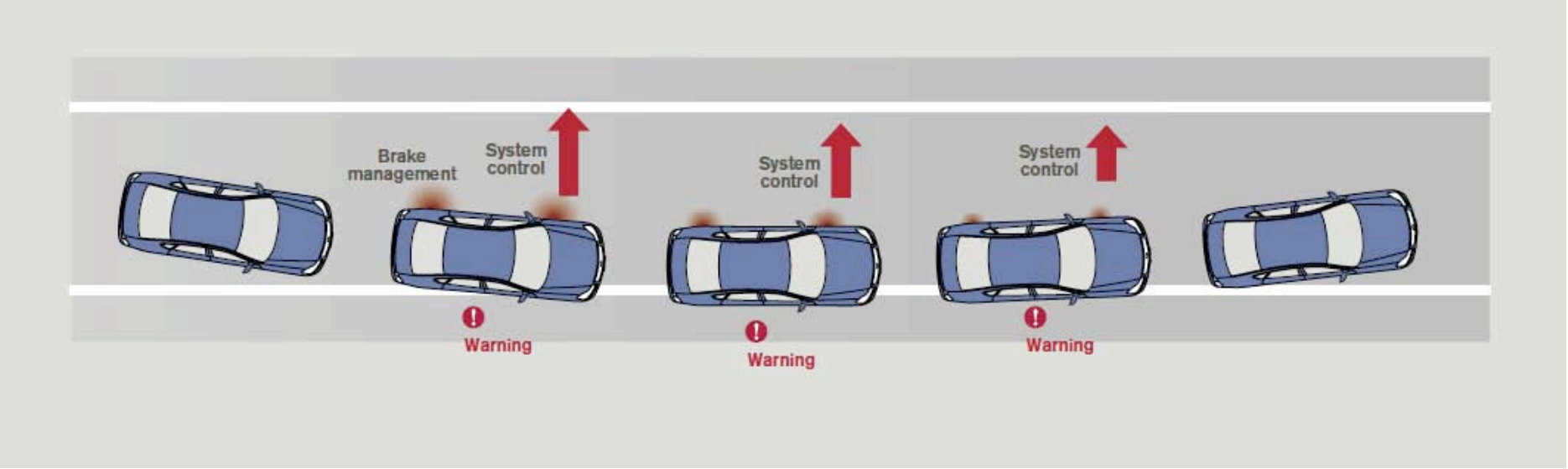
"ADAS has been responding perfectly to all the events that I have ever encountered so far. Whatever events may occur, ADAS would take care of them nicely."



Example: Overrating of process

Process: methods, rule bases, or control algorithms are understandable

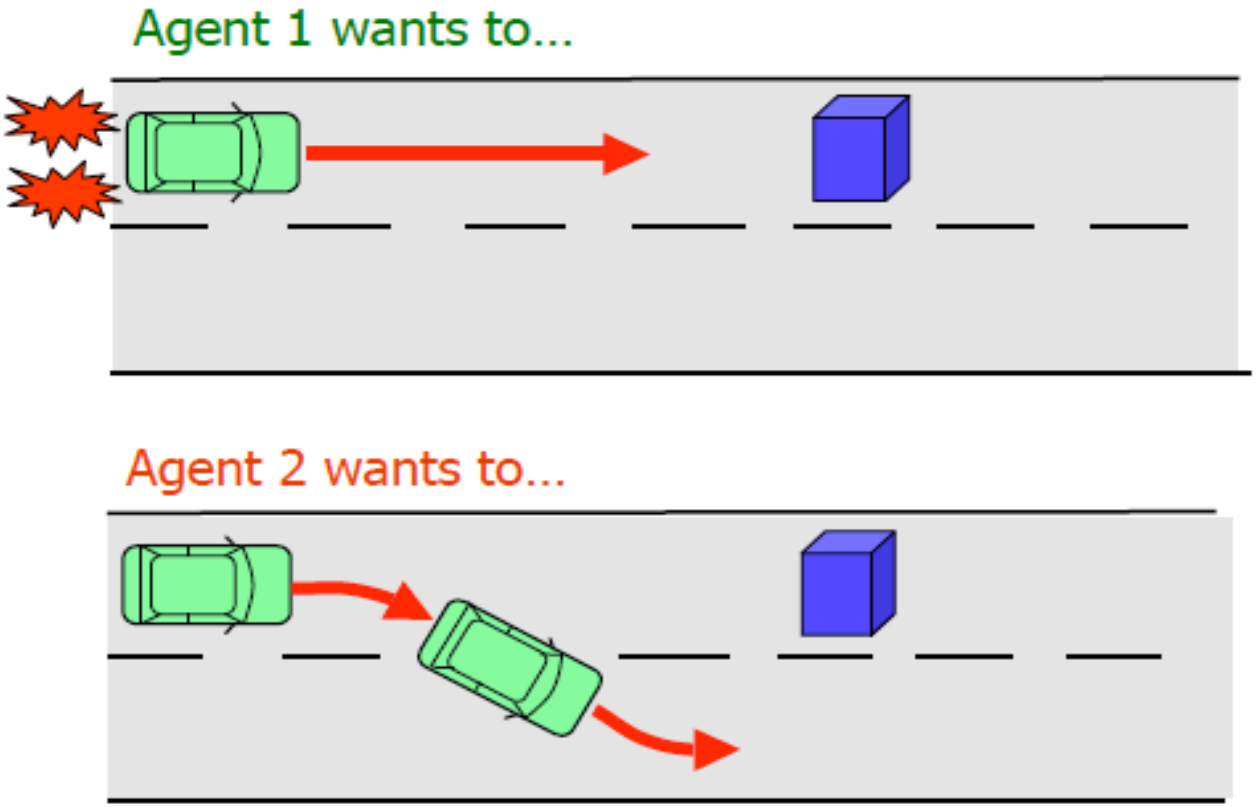
"I do not know how the function is implemented in ADAS. I am not informed how the task is carried out. However, it would be quite alright even if I do not know the details."



Example: Overrating of purpose

Purpose: motives or designer's intention is understandable

"I do not understand why ADAS is doing such a thing. However, it must be doing what it thinks it necessary and appropriate."



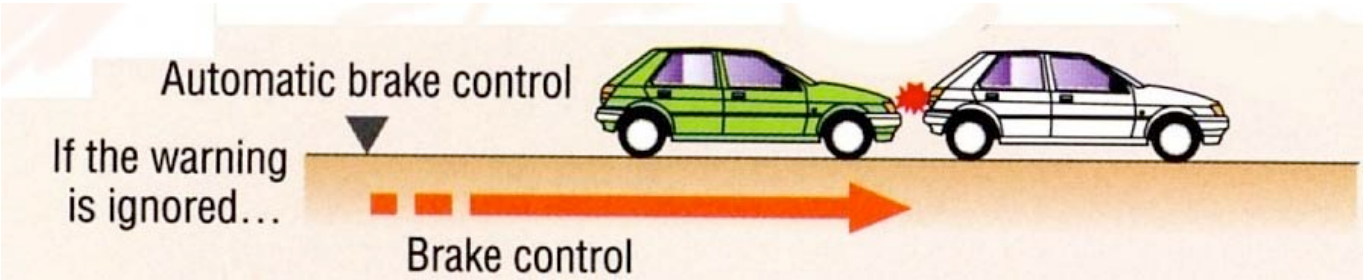
Chance-of-observation axis

(a) ADAS for use in normal driving (e.g., ACC)

- works continuously for certain period of time
- a large number of opportunities available to see ADAS behaves 'intelligently'
- easy to construct a mental model

(b) ADAS for use in emergency (e.g., PCS)

- activated only in emergency
- rather rare to see ADAS works
- hard to construct a mental model



Benefit-expected axis

(a) ADAS for use in normal driving (e.g., ACC)

- By letting ACC all the tasks for longitudinal control, the driver may be able to produce benefits
  - relax muscles and extend legs
  - allocate cognitive resources to finding a way to the destination

(b) ADAS for use in emergency (e.g., PCS)

- Unnatural to assume that the driver can produce benefits by spending time and resources that are squeezed by relying on ADAS

Time-allowance-for-human-intervention axis

(a) ADAS for use in normal driving (e.g., ACC)

- Not hard for the driver to override ACC when its performance is not satisfactory

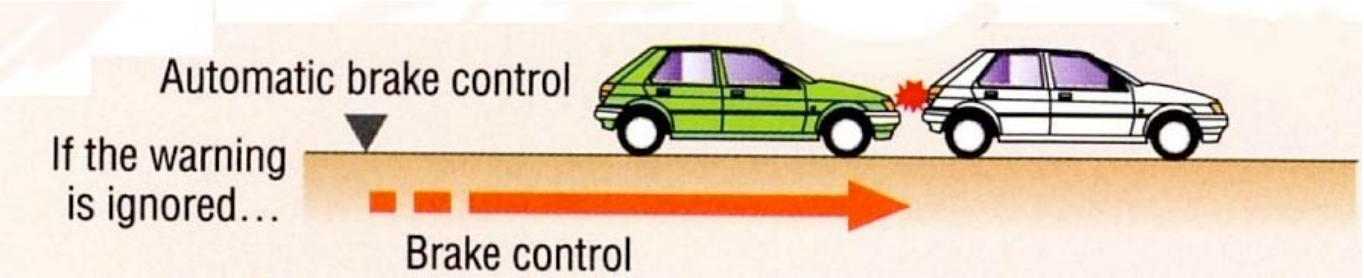
(b) ADAS for use in emergency (e.g., PCS)

- Hard for the driver to intervene into control by PCS when its performance is not satisfactory
  - time allowed for the whole process of monitoring, decision and intervention would be a few seconds

Overtrust in ADAS ⇏ *Overreliance on ADAS*

- ACC: Overtrust may yield overreliance
  - Easy to intervene into ACC when performance is not satisfactory
  - Relying on ACC can bring extra benefits

- PCS: Overtrust does not necessarily induce overreliance
  - No time left to override PCS even if the driver finds its performance unsatisfactory
  - Spend time and resource (squeezed by relying on PCS) to do something at the risk of life?



In the passage of time ...

normal driving conditions

emergency situation

ADAS for use in normal driving

ADAS for use in emergency

overtrust

<u>overreliance</u>

overtrust (?)

<u>no overreliance</u>

crucial if the driver may fail to notice that an emergency situation happened

(Inagaki, 2010)

Multi-layered driver assistance