Autonomous Driving Intelligence System to Enhance Safe and Secured Traffic Society for Elderly Drivers

Project Goal：**Develop the mobility with driving intelligence to enhance accident avoidance performance by recovering degraded driving performance of elderly drivers, and deploy the system in automobile markets.**

S-イノベ S-INNOVATION 独立行政法人 科学技術振興機構

Our vision：*Mobility which realizes lively and active aged society! Aged people can actively participate the society! Safe mobility can potentially recover young spirits of aged drivers!*

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Project Partners : Toyota Motor Corporation, Toyota Central R&D Labs, Inc.
The University of Tokyo, Tokyo University of Agriculture and Technology

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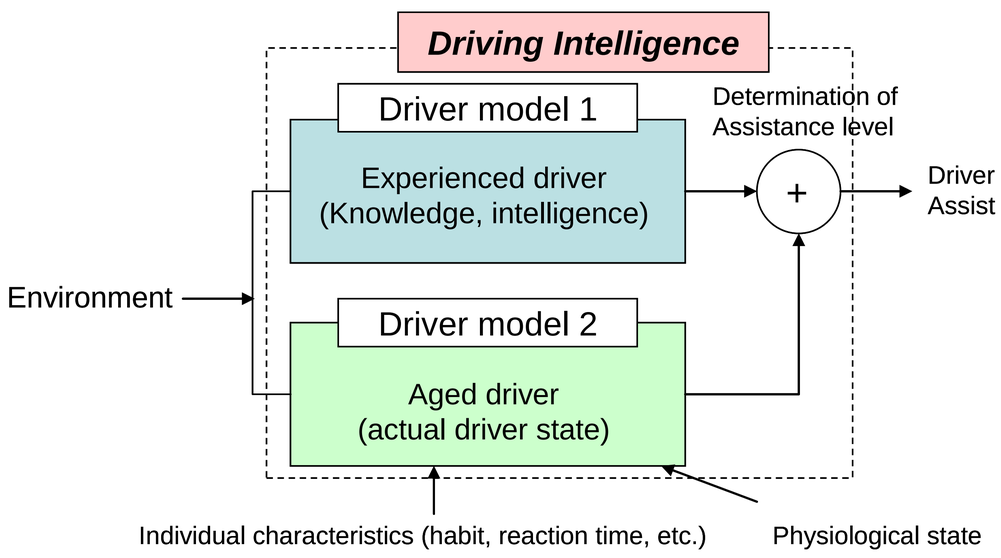


Motivation： Elderly people need active lives.

- Degraded driving performance reduce their self-confidence in driving.
- However, aged drivers have high driving motivations to improve QOL.
- Autonomous driving intelligence system with intelligence to recover degraded performance and overcome the driving fear is important.

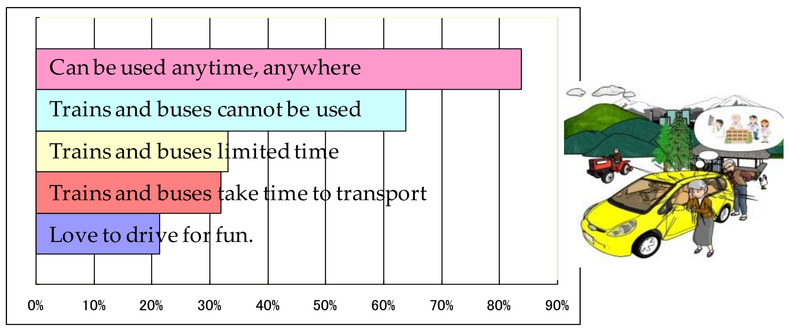


Fig.1 Necessity of automobiles

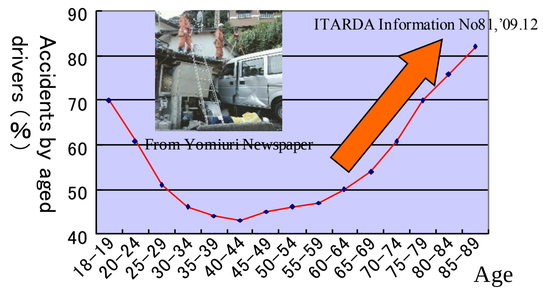


Fig.2 Ratio of accidents caused by aged drivers

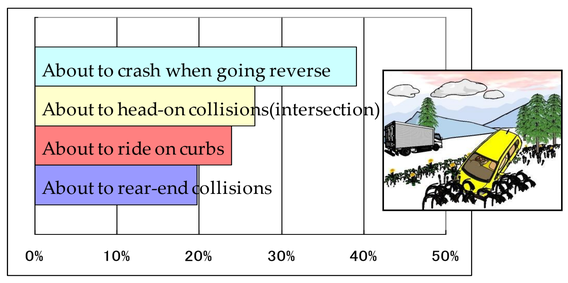


Fig. 3 Crash-relevant near-miss incident by Aged drivers

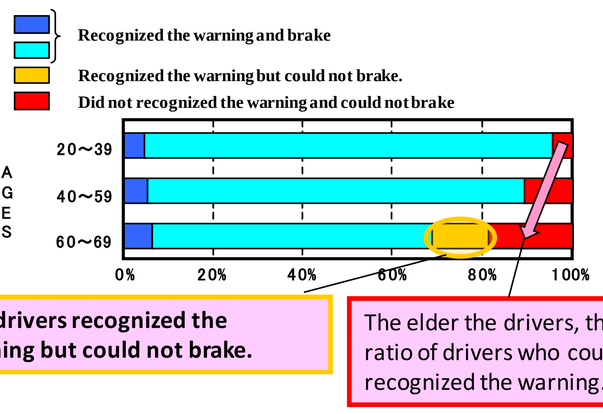


Fig.4 Reaction of drivers to active safety system (Experimental study by using Toyota Driving Simulator)

Key Concept of the project

1. Driving intelligence technology

Risk potential anticipation driver model

2. Driver-in-the-loop ADAS

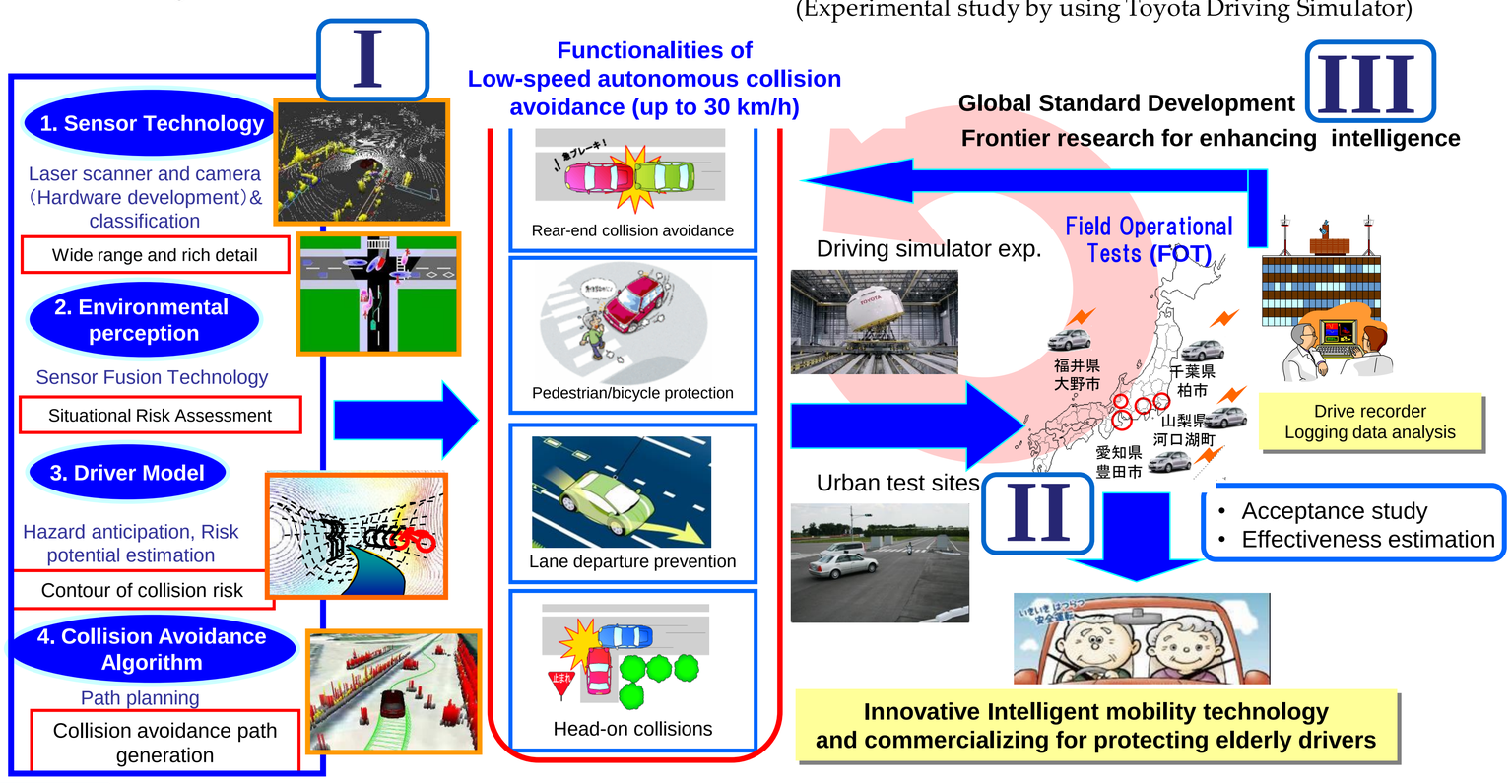
Automatic brake/steer intervention with optimized HMI

3. Collaboration between industry and univ.

Framework of joint projects between industry and university for innovation

Project Schedule

Stage 1 (2010-2012):
Development of autonomous driving intelligence system
Stage 2 (2013-2016):
Prototype construction, system improvement and assessment by FOT
Stage 3 (2017-2021):
Standardization and system deployment



Field Operational Tests of autonomous driving

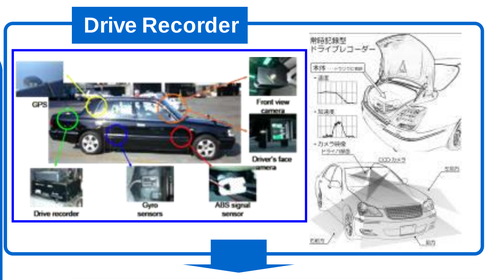
Urban Test Sites for system validation

Safety check in public roadway
- Crash-relevant scenario simulation in test sites

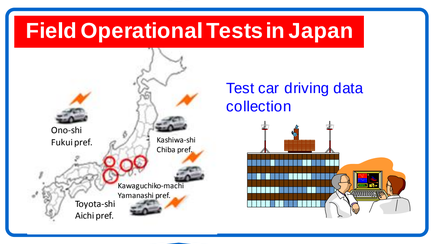
System effectiveness verification in certain circumstances

Driving simulator study
- Driver acceptance study
- HMI investigation
- System parameter study

Drive Recorder



Field Operational Tests in Japan

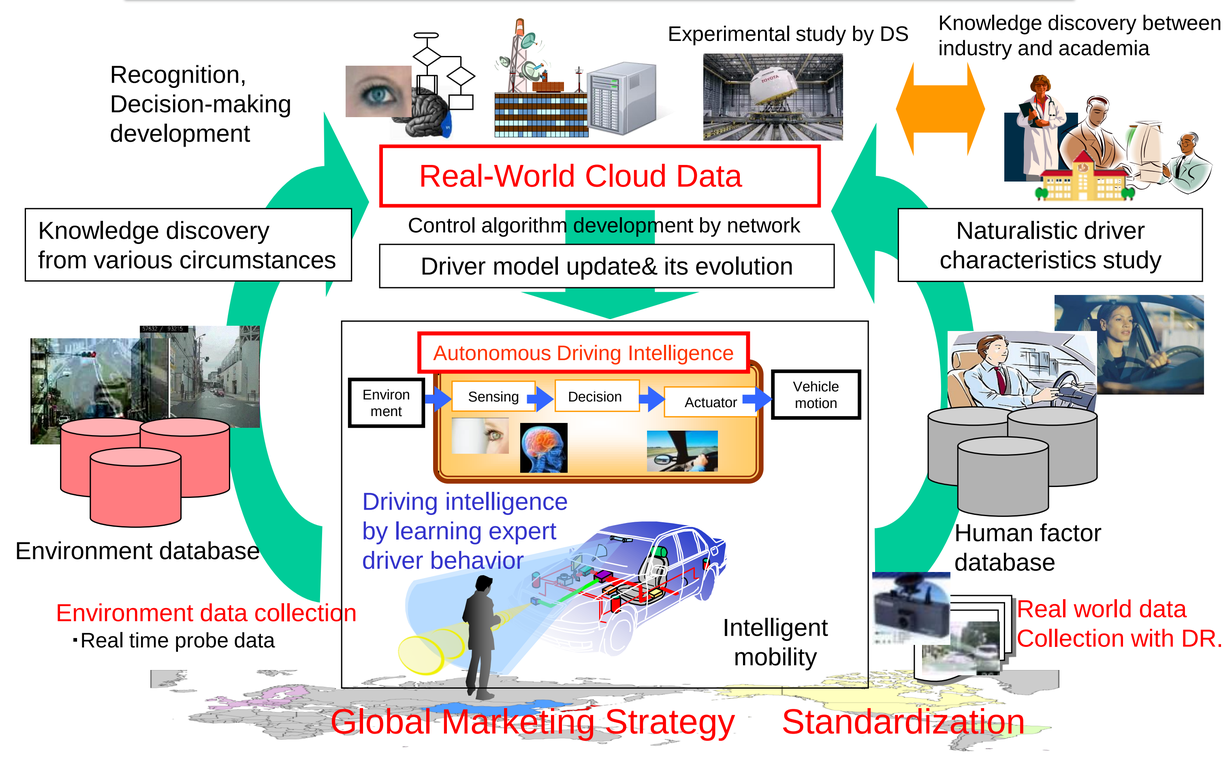


Test car driving data collection

Social experiments & FOT in public roads

- Biometric data
- Fault diagnosis/Negative check
- Accident prevention effectiveness
- Hazard map construction

Global deployment by utilizing big data



Autonomous Driving Intelligence System to Enhance Safe and Secured Traffic Society for Elderly Drivers

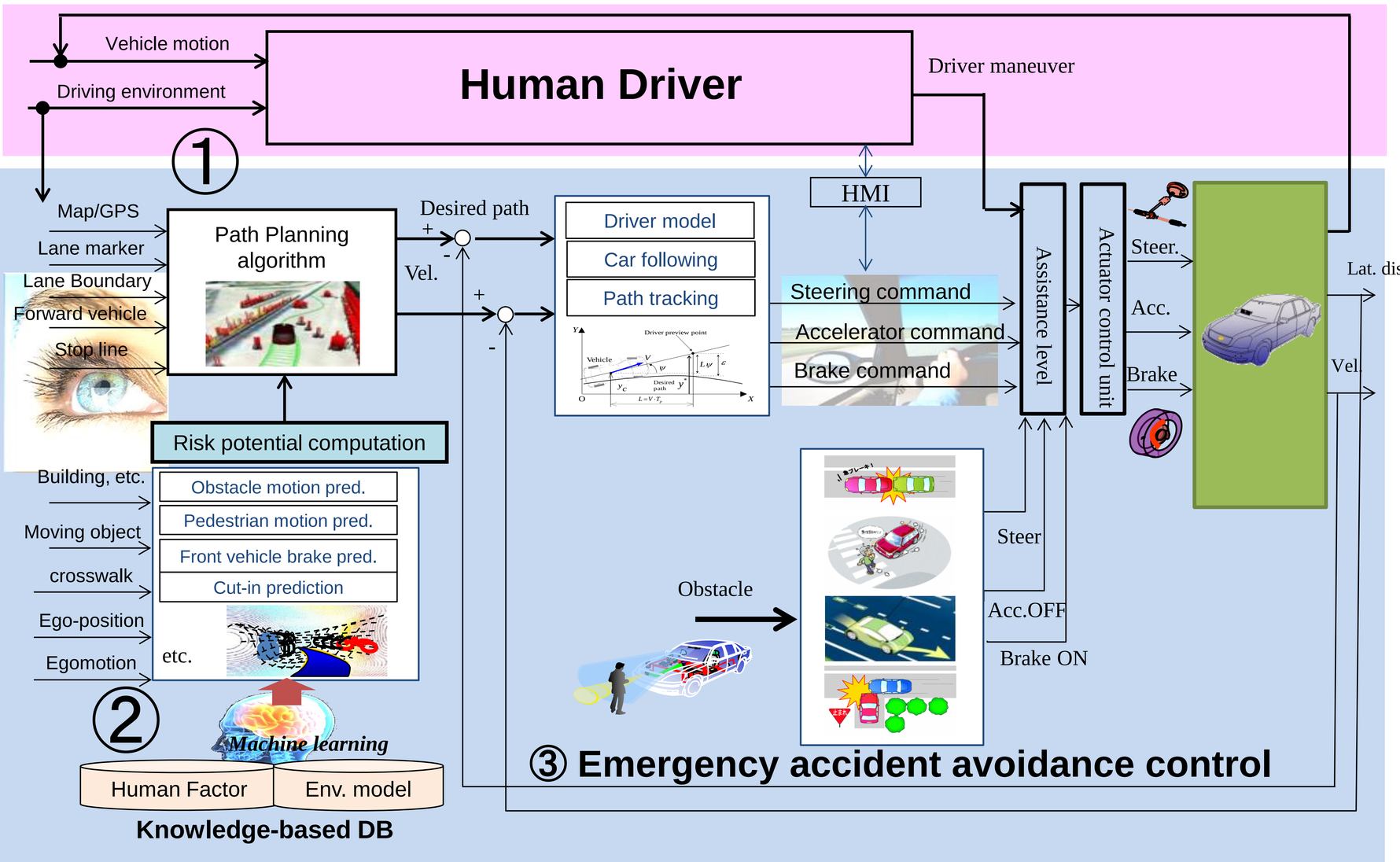
Structure of autonomous driving intelligence system: Control-oriented driver model

The autonomous driving intelligence system consists of three main control systems :

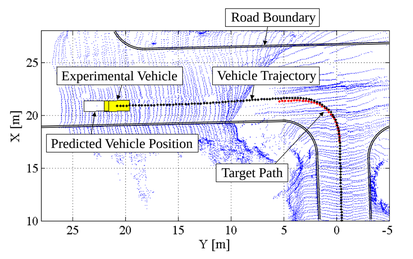
(1) Normal driving control : basic driving maneuvers, i.e. path tracking, car-following, curve negotiation.

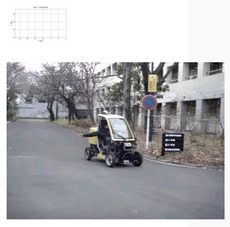
(2) Risk-potential based control : hazard anticipation based on knowledge-based expert driving behavior

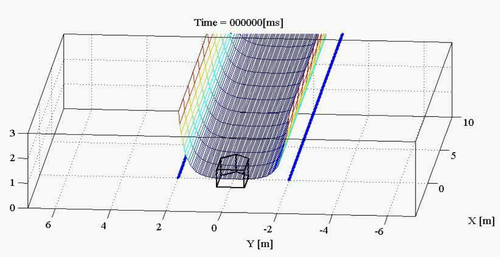
(3) Emergency accident avoidance control: automatic braking/steering at last second before the accident occurs.



① Normal Driving Control : Longitudinal and Lateral Control, i.e. car following and lane keeping integrating Risk Potential Field

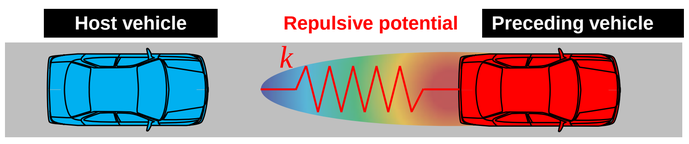


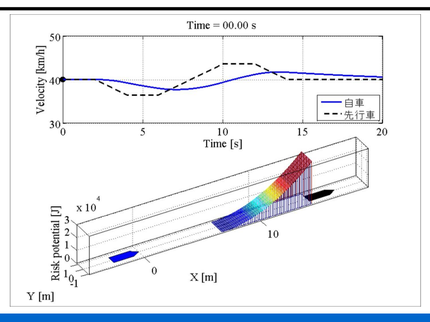




Sensing the position of the ego-car using the curb measured by laser radar, combined with GPS / digital map

Speed control due to curvature and lane tracking



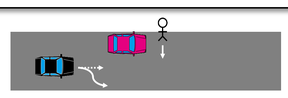


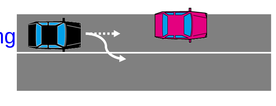
Car following control by using repulsive and attractive forces in Risk Potential Field

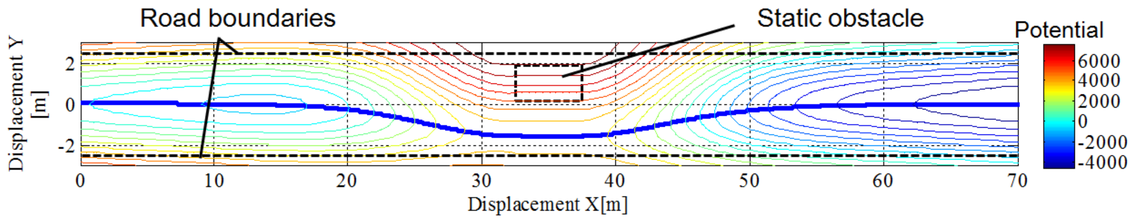
②Risk Potential Based Control : Defensive driving, Obstacle motion prediction, Hazard anticipation

Predict pedestrians behind occlusion.

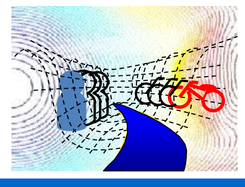
Passing a parked vehicle by determining the path with safe speed.







Contour of risk potential generated from surroundings and on-road obstacles



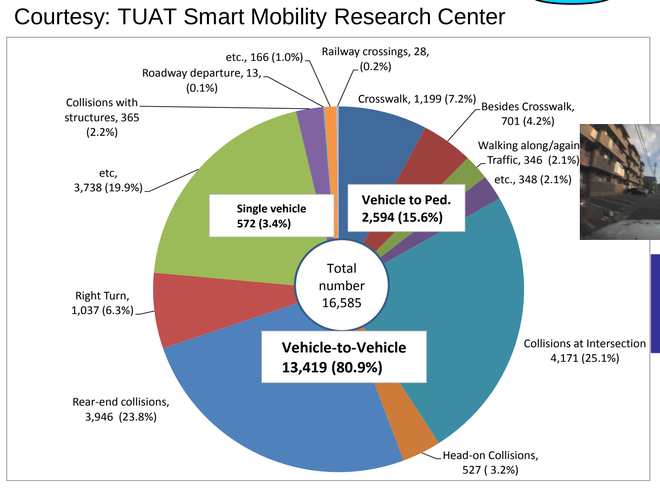
Autonomous driving intelligence must predict the possibility of appearance of pedestrians from the occluded area and determine the optimum safe speed.

Near-miss incident DB for accident reconstruction modeling

- **Hazard anticipation driver modeling** based on real-world driving situations.
- **Systematic accident reconstruction model** by identifying the environment parameters from real world data.
- **Implementation and functional testing** of the autonomous driving intelligence systems on DS.
- HMI investigation for **seamless override**.

Near-miss Incident Database Macroscopic Analysis

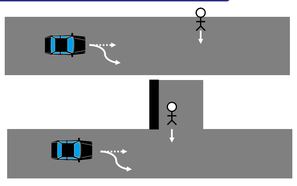
Courtesy: TUAT Smart Mobility Research Center



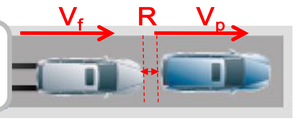
List of near-miss scenes

Scene A.

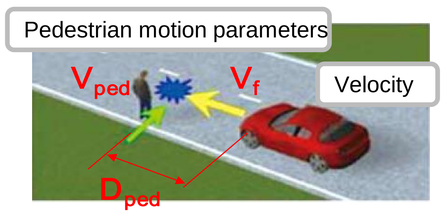
Scene B.



Headway distance
Relative velocity
Deceleration

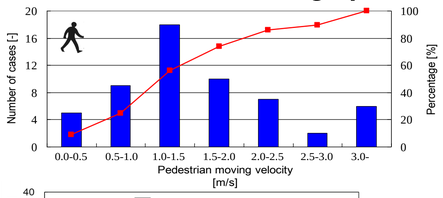


Pedestrian motion parameters

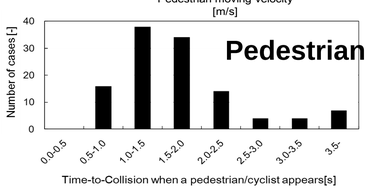


Accident reconstruction modeling & Environment parameter identification

Pedestrian moving speed



Pedestrian appearance timing



Accident reconstruction modeling

Driving Simulator for Effectiveness estimation in man-machine system

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