2020
23rd Presentation Session for Traffic Accident Investigations, Analysis, and Research

Using PCM on Micro Data for Autonomous Vehicles
—A Collaboration with VUFO in Germany—

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Summary:
ITARDA has had the opportunity to interact with many institutes for traffic accident research outside of Japan. In this paper, our collaborations with VUFO is introduced. Its managing director, Mr. Liers was invited to give a lecture ITARDA's 25th Anniversary Forum. ITARDA has shared the most technical exchanges with VUFO. The PCM (Pre-Crash-Matrix) format developed by VUFO is a format that provides chronological data on the movements of vehicles for 5 seconds prior to a collision, including such data for road environments, etc. ITARDA had the opportunity to participate in the workshops in which VUFO provided guidance that enabled ITARDA to produce PCM from its own micro data. ITARDA then used PCM to analyze accidents on expressways caused by abrupt lane changes, the data from which was then utilized as back data to show the validity of scenarios and parameters used in the SAKURA project on autonomous vehicles in Japan. ITARDA plans to continue further use of PCM into the future.

1. Introduction

Until now, ITARDA has served as a deputy member representing Japan in IRTAD conferences held every year in April at the OECD headquarters (Paris) at which it has reported on its research results. However, in recent years, ITARDA has also been involved in many exchanges with research institutes outside of Japan via initiatives such as its new micro database construction project. (Fig. 1)

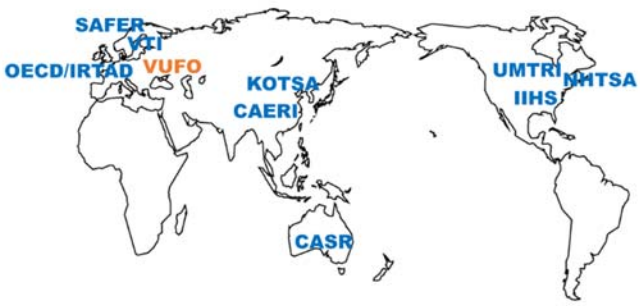

Fig. 1 - Research institutes ITARDA has visited in recent years

In this report, our collaborations with VUFO is introduced. , ITARDA has shared the most exchanges with VUFO among all such research institutes.

2. ITARDA and VUFO

2-1. Overview

While ITARDA was established in 1992, VUFO was established in 2006 and both institutes use "Institute for Traffic Accident Research" in their English names. Although there is a large difference in the quantity of traffic accident case studies performed by both institutes annually, the contents of such surveys are generally the same in nature. (Table 1)

Table 1 - Comparison of traffic accident case surveys performed by ITARDA and VUFO

Name	**ITARDA** Institute for Traffic Accident Research and Data Analysis	**VUFO** Verkehrsunfallforschung an der TU Dresden Institute for Traffic Accident Research at Dresden University of Technology
Year established Organization type	**1992** **Public interest incorporated foundation**	**2006** **Limited liability company (GmBH)**
Traffic accident case studies	**Micro data (since 1993)** Annual number of studies: Approx. 200 (Tsukuba Traffic Accident Investigation Office + Tokyo Accident Investigation Office) 1993: Establishment of Tsukuba Traffic Accident Investigation Office 2016: Establishment of Tokyo Traffic Accident Investigation Office No field surveys in recent years	**GIDAS data (since 1999)** **(German In-Depth Accident Study)** Annual number of studies: 2,000 (of those by VUFO: 1,000) On-call 24 hours for field surveys 

2-2. Details of main exchanges between ITARDA and VUFO

(1) 25th Anniversary Forum

ITARDA's 25th Anniversary Forum was held as its 20th Presentation Session in October of 2017 at the Bellesalle event hall in Tokyo's Kanda area. At this event, ITARDA invited the Managing

Fig. 2 - Photo from Mr. Liers' special lecture

Director of VUFO, Mr. Henrik Liers, to give a special lecture entitled "Traffic Accident Research in Germany". This invitation was made possible by a visit to VUFO in the fall of the previous year and a meeting with him at the OECD/IRTAD meeting held in the spring of that same year.

(2) PCM Workshop

At the request of ITARDA, a workshop was held at VUFO in October of 2019 that consisted of VUFO experts and researchers from ITARDA and Japan's National Research Institute of Police Science. By receiving detailed guidance for each step of PCM creation (see "3. PCM") using micro data, ITARDA was able to garner numerous results to aid in its future enhanced use of PCM.

Fig. 3 - Photo of workshop held at VUFO

3. PCM

3-1. Overview of PCM

The PCM (Pre-Crash-Matrix) developed by VUFO uses latitude and longitude coordinates to show the chronological movement of participants for 5 seconds prior to the traffic accident collision, as well as for the traffic infrastructure (lanes, road surface markings, etc.) and surrounding objects.

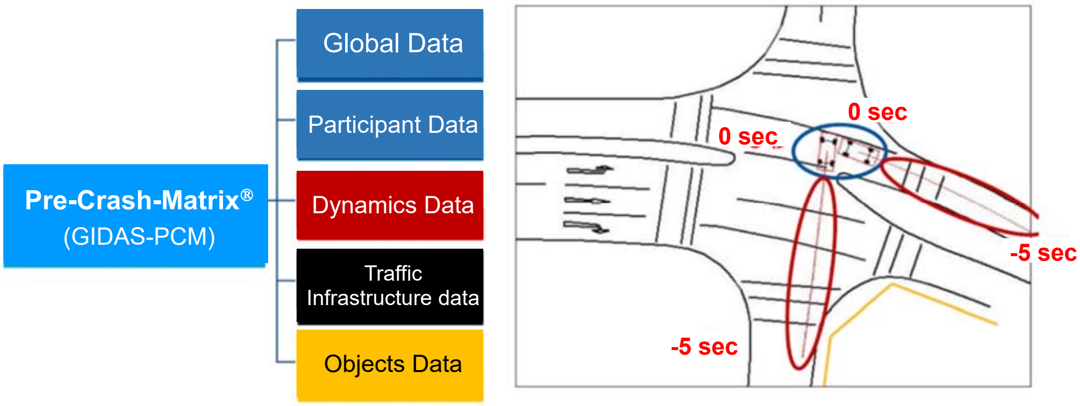

Fig. 4 - Data used to form the PCM

The usage example shown here was an attempt by VUFO to examine specifications for the detection function and braking function of a damage mitigation brake system using a PCM (Fig. 5) for a collision accident that actually occurred in Germany. As PCM is capable of being used in such a manner, it is expected that PCM will be produced from micro data by Japanese automobile manufacturers as a means of obtaining data that is extremely useful in the development of preventive safety technology and autonomous vehicles technology. (Fig. 5 & Fig. 6)

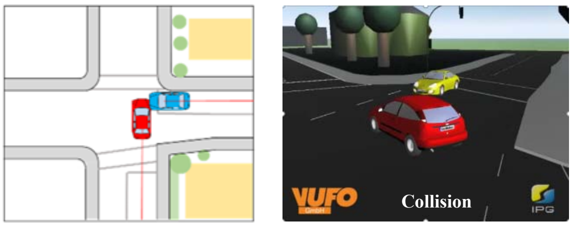

Fig. 5 - PCM simulation for actual accident

Fig. 6 - Examination of system specifications using PCM

3-2. Creation of PCM by ITARDA

At ITARDA, a PCM is being created using micro data such as vehicle surveys, road surveys, and interviews of parties concerned. Particularly in the case of vehicle surveys, it is possible to accurately reproduce dynamic data from 5 seconds prior to a collision by reading vehicle data using Bosch's CDR and GTS and also by utilizing the video of the accident provided by a dashcam. Furthermore, even in the case of road surveys, by obtaining 3D point cloud data for the road using a 3D scanner, it is possible to create a more detailed accident reconstruction simulation (PC-CRASH) and create a PCM based on that. (Fig. 7)

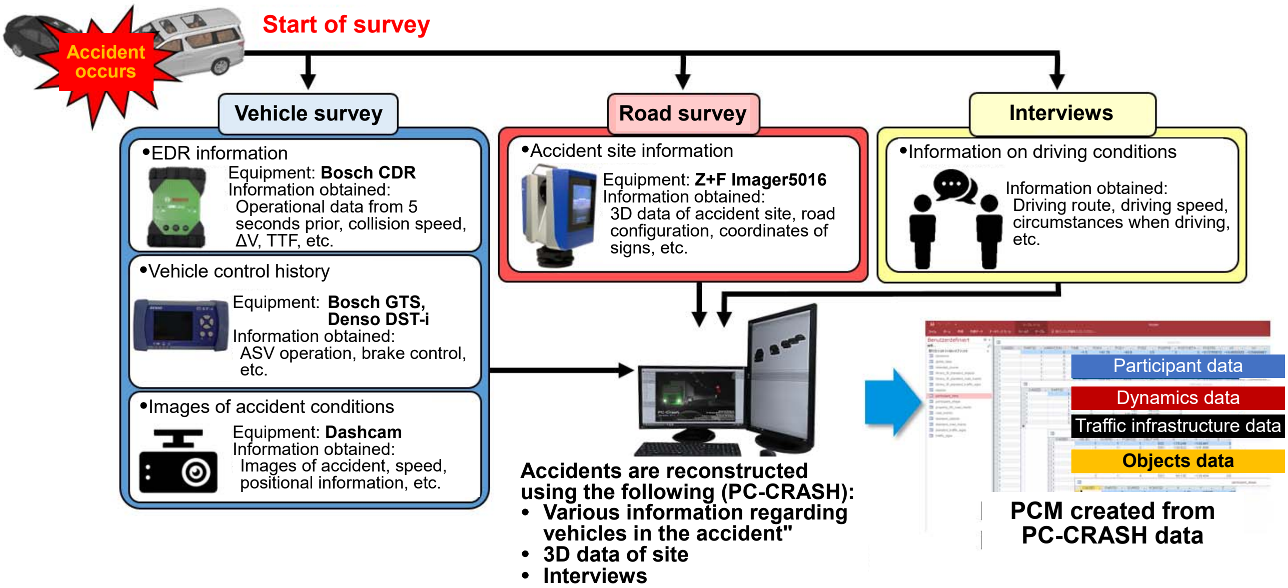

Fig. 7 - How a PCM is created by ITARDA

Shown below is the accident reconstruction (PC-CRASH) created using such a procedure and the PCM created utilizing that reproduction. This PCM is the result of the workshop held at VUFO.

Fig. 8 - Accident reconstruction using PC-CRASH

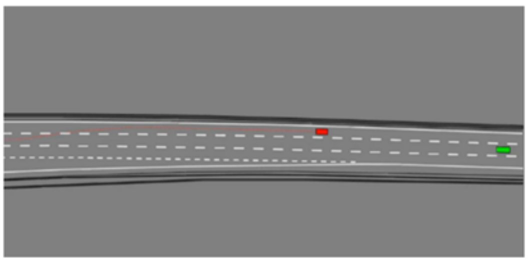

Fig. 9 - PCM created by ITARDA

4. Example of utilization by the SAKURA project

Since the year before last, the Ministry of Economy, Trade and Industry (METI) has been promoting a research and development project (SAKURA project) aimed at construction of safety evaluation technology for autonomous vehicles systems as one of its "Research and Development/Demonstration Project for Implementation of an Advanced Autonomous Driving System in Society". As part of this project, the Japan Automobile Manufacturers Association (JAMA) and the Japan Automobile Research Institute (JARI) have developed a process to ensure the safety of autonomous vehicles systems by taking into account all foreseeable scenarios on expressways.

Scenarios for autonomous vehicles traveling on expressways were classified into four types of expressway components (thru traffic lanes, merging lanes, interchanges, on/off ramps) and two autonomous vehicle driving states (remaining in same lane, changing lanes), with a total of 32 scenarios being defined according to the positions and movements of surrounding vehicles.

Shown below are four scenarios in which an autonomous vehicle in the thru traffic lane continues driving in the same lane. The PCM created by ITARDA is based on the scenario indicated by the image shown in the red box below in which another vehicle abruptly changes lanes in front of an autonomous vehicle that remains traveling in the thru traffic lane. (Fig. 10)

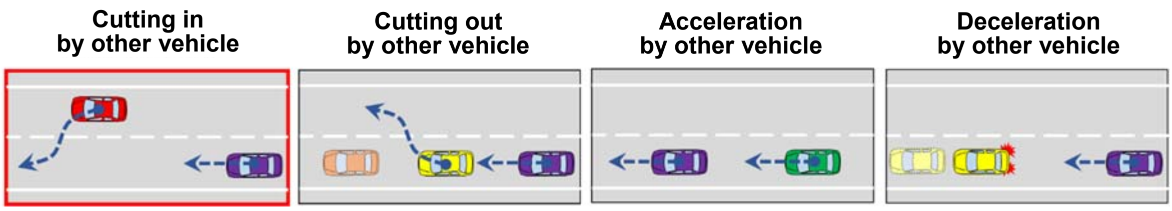

Fig. 10 - Example scenario in which an autonomous vehicle in the thru traffic lane of an expressway remains in the same lane

Furthermore, in this project, observation values for various parameters in the scenario that do not lead to a traffic accident on the actual expressway will be collected by actually driving on expressways and recording the states of other peripherally traveling vehicles. These values will then be used to define the foreseeable range of control for autonomous vehicles.

The figure to the right shows the actual parameters for ITARDA's PCM for a traffic accident caused by an abrupt lane change. In this project, these parameters are used to plot the foreseeable range and observation value, with graphs below showing examples of parameters organized according to the speed of the autonomous vehicle. By plotting parameter values for ITARDA's PCM in each graph, the validity of the assumed scenario and parameters could be confirmed as they were included in the foreseeable range. (Fig. 12)

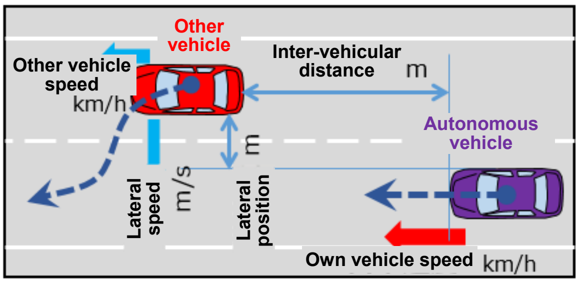

Fig. 11 - Parameters for ITARDA's PCM

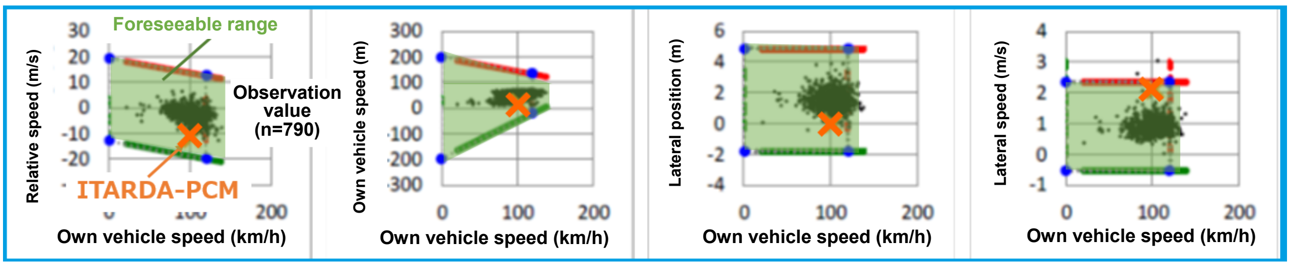

Fig. 12 - Foreseeable range/observation value and PCM plotting for each parameter (abrupt lane change)

Currently, only one ITARDA's PCM is being employed on an expressway, with further increases expected in the future.

5. Conclusion

Below is a summary of the contents covered up to the previous section.

- Through technical collaborations with our longtime exchange partner, VUFO, ITARDA was able to create a PCM as developed by VUFO using our micro data.
- ITARDA'S PCM is being used as part of the SAKURA project to provide data effective in showing the validity of assumed scenarios and we expect that the number of PCMs using our micro data will continue to increase.
- We plan to continue and strengthen our collaborations with VUFO to enhance the efficiency of the PCM creation process.

<References/Sources>

(1) VUFO、2019 年、Pre-Crash-Matrix (PCM)　Format Specification v5.0
(2) 経済産業省、2020 年、自動走行ビジネス検討会「自動走行の実現に向けた取組報告と方針」 v 4.0

(End)