Second Phase of Cross-Ministerial Strategic Innovation Promotion Program
— Innovation of Automated Driving for Universal Services (System and Service Expansion)

Study of the Impact of Automated Driving on Reducing Traffic Accidents and on Others

Report (Summery)

March 2019

The University of Tokyo

Doshisha University

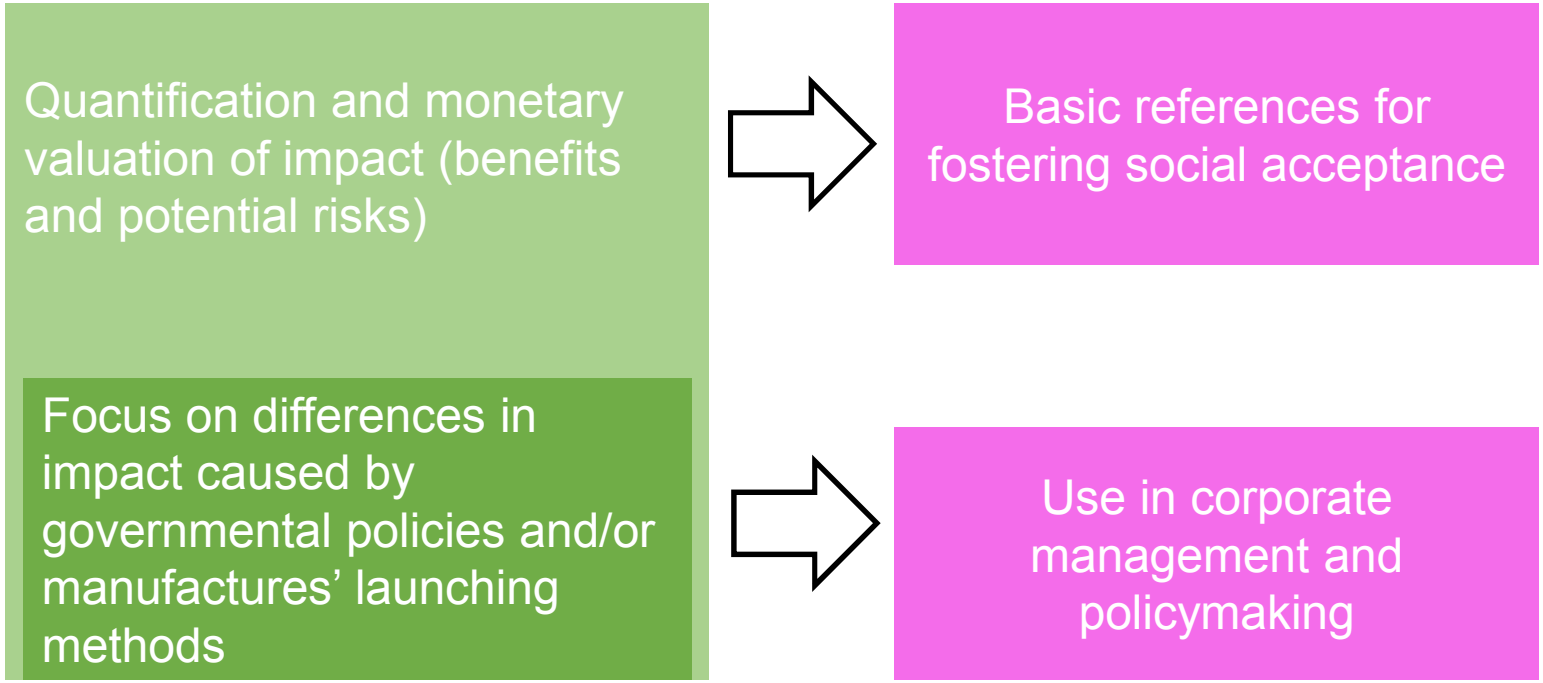
mobi

ITEC
Institute for Technology, Enterprise and Competitiveness

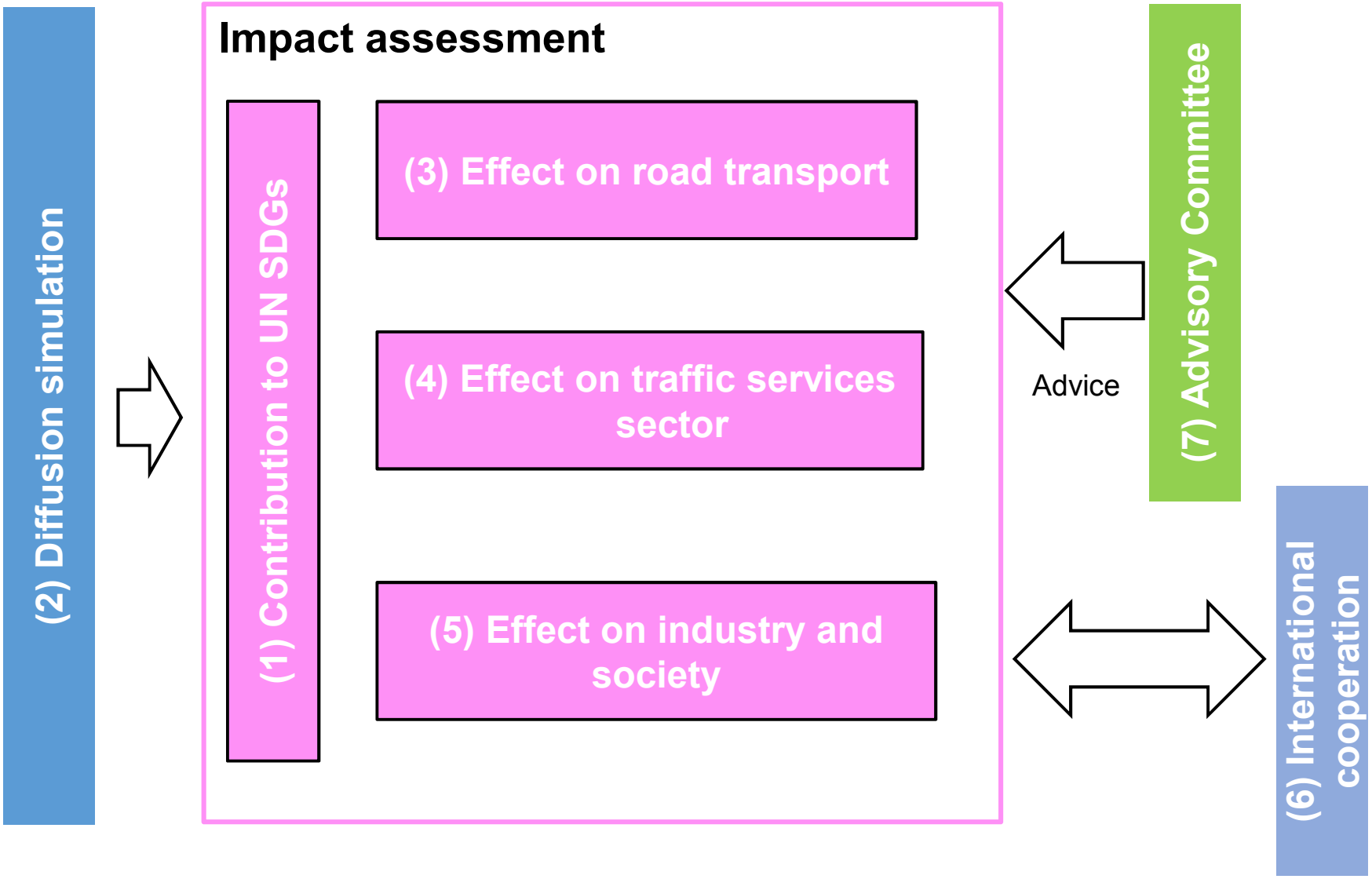
Objective of study

Research and development plan for Second Phase of Cross-Ministerial Strategic Innovation Promotion Program — Innovation of Automated Driving for Universal Services (System and Service Expansion)

Commercial development and increased diffusion of automated driving (AD) vehicles will help to reduce traffic accidents, alleviate traffic congestion, ensure mobility for vulnerable road users, resolve the driver shortage and reduce costs in logistics and transport services, and resolve other social problems. The aim is to achieve a society in which everyone is able to enjoy a high-quality life.



Overall configuration of study



Study items
(★ indicates items conducted in FY 2018)

(1) Relevance of AD to SDGs ★

(2) Simulation of AD vehicle diffusion ★

(3) Effect on road transport ★

i. Estimation of effectiveness in reducing traffic accidents
ii. Estimation of reduction of traffic congestion and reduction of CO_2 emissions

(4) Effect on traffic services sector

i. Ensuring mobility for vulnerable road users and in depopulated areas and other locations with poor access to transport
ii. Reduction of costs and resolution of driver shortage in logistics and transport services
iii. Change in ownership and usage of vehicle, and the structure of consumers' choice

(5) Effect on industry and society

i. Effect on whole automobile industry due to change in vehicle ownership structure and other effects
ii. Contribution to growth of the total factor productivity of the Japanese economy

(6) Formation of organization for international cooperation ★

(7) Convening of Advisory Committee ★

Relevance of AD to SDGs

The method of organization was studied. The relevance of the following five social impacts of AD to 169 Targets is going to be organized:

1) Reduction of traffic accidents,
2) Reduction of traffic congestion and CO_2 emissions,
3) Effect on city structure,

   Changes in land use (e.g. conversion of parking lots to the other uses) , urban compactization or expansion into outlying areas etc.

4) Effect on economy and industries,

   Changes in the industrial organization of automobile industry, changes in the national industrial structure in relation to the changed inputs and final demand in the automobile industry, improvement in the productivity in a wide range of industrial sectors including transportation and agriculture, creation of new business etc.

5) Effect on lifestyles and educational opportunity.

   Changes in people's lifestyles, securing a means of transport for vulnerable road users, improved accessibility to facilities such as schools thanks to increased mobility and expansion of travel area etc.

On April 5, 2019, a "Advisory Committee on the Relevance of AD to SDGs" is scheduled to be held at Doshisha University to study the impacts from AD and their relevance to SDGs.

Simulation of AD vehicle diffusion (1)

1) Survey of existing research on factors affecting the diffusion of AD vehicles

   A survey of existing research in Japan and other countries is on going. The factors affecting the diffusion of AD vehicles will be divided into

   (a) Supply side factors including “technical development”, and “cost of automated driving”,

   (b) Demand side factors including “conditions for establishment of car sharing and ride sharing”, “city structure” , “trip demand” , “consumer mode selection” , and “lifespan of a vehicle ”.

Points to be considered:

- Use of self-driving vehicles by adults not having a driver’s license (Sivak and Schoettle, 2015） .
- Use of self-driving vehicles by persons of ten years and older (one of simulation scenarios in Trommer et al.（2016）)

Simulation of AD vehicle diffusion (2)

2) Development of a prototype simulation model for discarding owned vehicles and new vehicle diffusion

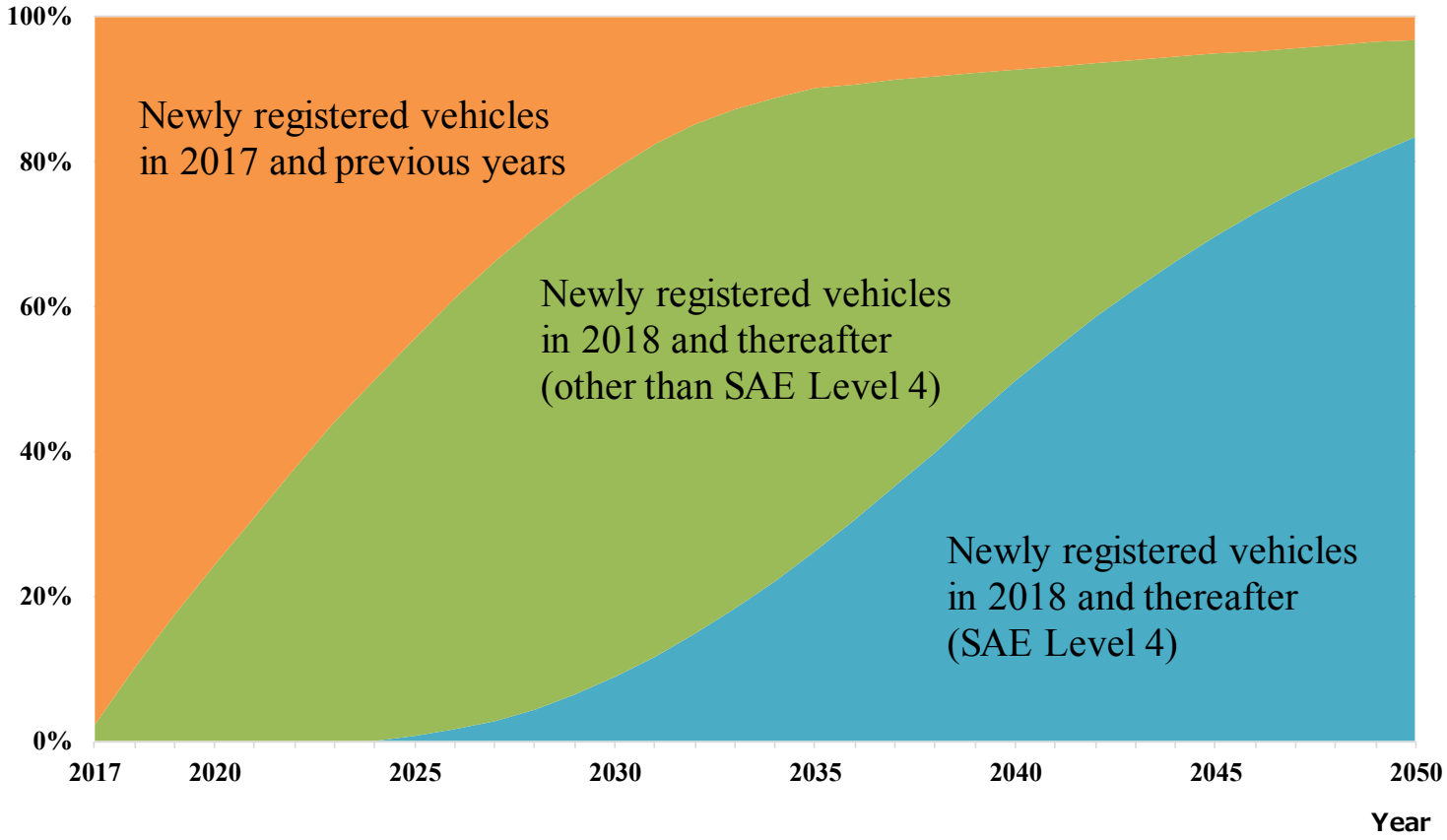
A simulation was conducted for passenger vehicles (standard-sized + small-sized, not including light motor vehicles) based on the following assumptions:

1. The number of owned vehicles is assumed to be constant at the 2017 level,
2. The same number of the vehicles discarded each year is assumed to be replaced with new vehicles,
3. SAE Level 4 passenger vehicles appear on the market in 2025 and consist 90% of annual new vehicle sales by 2040 and 100% by 2050. (The proportion of new vehicle sales increases linearly in 2025 - 2040 and 2040 - 2050.)

The result of the simulations is that the proportion of total passenger vehicles accounted for by SAE Level 4 passenger vehicles would be around 50 % in 2040 and more than 80 % in 2050.

Simulation of AD vehicle diffusion (3)

Provisional estimate based on the conditions noted in the previous slide



Note: This Figure depicts one of the simulation results by the prototype model

Effect on road transport (1)

1) Estimation of effectiveness in reducing traffic accidents

- The logic behind the method of estimation was clarified .
- In this study, the monetary value for the reduction in traffic accidents due to the diffusion of AD vehicles is going to be estimated. In this process, the monetary value for the reduction in “psychological burden of perpetrator” due to avoidance of traffic accidents, for which no monetary valuation had been conducted previously, will be estimated by means of economic experiments.
- In fiscal year of 2018, the method of using the software used for economic experiments, was shared among the members of the research team. The use of web-based experiments in addition to laboratory experiments was also studied.

Effect on road transport (2)

2) Estimation of reduction of traffic congestion and reduction of CO_2 emissions

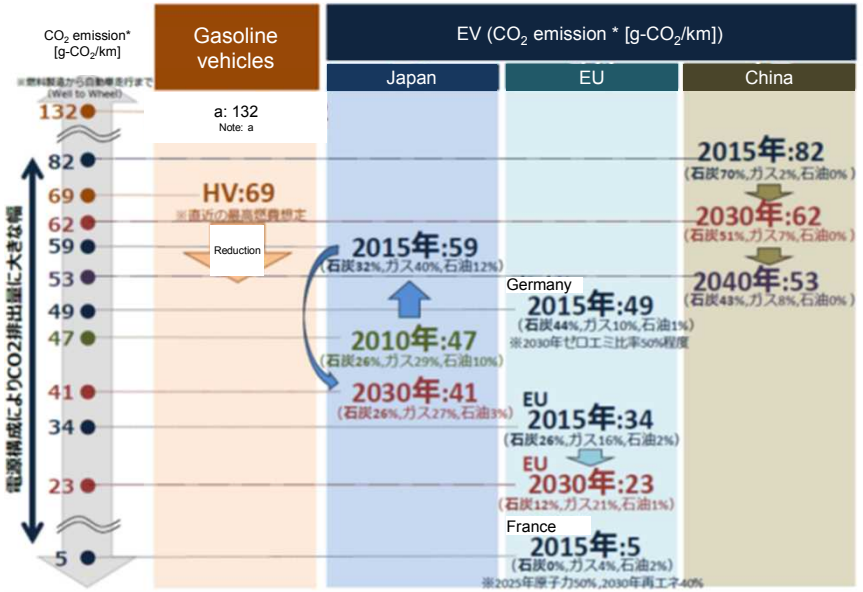
a) Estimation of reduction of traffic congestion

- Data on the effect of adaptive cruise control (ACC) and cooperative adaptive cruise control (CACC) in reducing traffic congestion will be organized, based primarily on Japanese research papers.
- Research papers published in Japan have reported that studies have not always found that existing ACC performance, which stresses riding comfort at high speed, is sufficiently effective in alleviating traffic congestion.
- Among the research papers published in other countries, Hoongendoorn et al. (2014, 2017) and Milakis et al. (2017) found that ACC changed traffic capacity -5% to +10%, and CACC further improved traffic capacity at diffusion rates of 40% or greater.

Effect on road transport (3)

b) Estimation of reduction of CO_2 emissions (CO_2 emission factor for EVs)

- The CO_2 emission factor for EVs in 2015 was less than half that of gasoline vehicles (59 g-CO_2/km). However, it was worse than 2010 (47 g-CO_2/km) due to a change in the power supply configuration.*1 In 2030, the power supply configuration is expected to be changed to a low carbon supply, and the emission factor is expected to improve to 41 g-CO_2/km.
- In Germany, which uses large quantities of coal-fired thermal power, the CO_2 emission factor was 49 g-CO_2/km in 2015. In France, which uses large quantities of nuclear power, it is 5 g-CO_2/km. In the EU overall, it was 34 g-CO_2/km in 2015. This is expected to improve to 23g-CO_2/km by 2030 through a reduction in the use of coal-fired thermal power.



Source: 2nd Roundtable Discussion on the Energy Situation, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry, September 2017

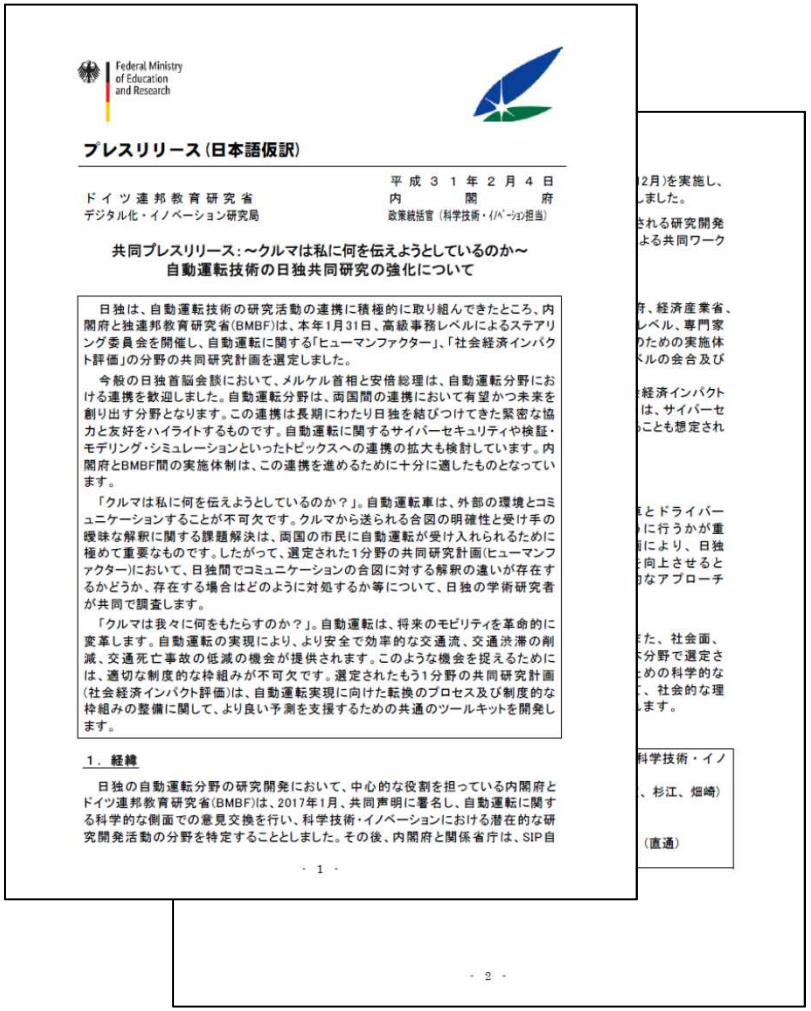
Figure CO_2 emissions by power train configuration

*1: 2nd Roundtable Discussion on the Energy Situation, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry, September 2017

Formation of organization for international cooperation

- Japanese-German cooperation
  - Based on the Joint Declaration of Intent signed on January 12, 2017 by the Cabinet Office of the Japanese government and the German Federal Ministry of Education and Research (BMBF)
  - Japan and Germany will cooperate in the area of “socioeconomic impact assessment.”

    (See joint press release issued on February 4, 2019 by the Cabinet Office and BMBF)



Federal Ministry of Education and Research

プレスリリース（日本語仮訳）

平成３１年２月４日
ドイツ連邦教育研究省
デジタル化・イノベーション研究局
内閣府
政策統括官（科学技術・イノベーション担当）

共同プレスリリース：～クルマは私に何を伝えようとしているのか～
自動運転技術の日独共同研究の強化について

日独は、自動運転技術の研究活動の連携に積極的に取り組んできたところ、内閣府と独連邦教育研究省(BMBF)は、本年1月31日、高級事務レベルによるステアリング委員会を開催し、自動運転に関する「ヒューマンファクター」、「社会経済インパクト評価」の分野の共同研究計画を選定しました。

今般の日独首脳会談において、メルケル首相と安倍総理は、自動運転分野における連携を歓迎しました。自動運転分野は、両国間の連携において有望かつ未来を創り出す分野となります。この連携は長期にわたり日独を結びつけてきた緊密な協力と友好をハイライトするものです。自動運転に関するサイバーセキュリティや検証・モデリング・シミュレーションといったトピックスへの連携の拡大も検討しています。内閣府とBMBF間の実施体制は、この連携を進めるために十分に適したものとなっています。

「クルマは私に何を伝えようとしているのか？」。自動運転車は、外部の環境とコミュニケーションすることが不可欠です。クルマから送られる合図の明確性と受け手の曖昧な解釈に関する課題解決は、両国の市民に自動運転が受け入れられるために極めて重要なものです。したがって、選定された1分野の共同研究計画(ヒューマンファクター)において、日独間でコミュニケーションの合図に対する解釈の違いが存在するかどうか、存在する場合はどのように対処するか等について、日独の学術研究者が共同で調査します。

「クルマは我々に何をもたらすのか？」。自動運転は、将来のモビリティを革命的に変革します。自動運転の実現により、より安全で効率的な交通流、交通渋滞の削減、交通死亡事故の低減の機会が提供されます。このような機会を捉えるためには、適切な制度的な枠組みが不可欠です。選定されたもう1分野の共同研究計画（社会経済インパクト評価）は、自動運転実現に向けた転換のプロセス及び制度的な枠組みの整備に関して、より良い予測を支援するための共通のツールキットを開発します。

1．経緯

日独の自動運転分野の研究開発において、中心的な役割を担っている内閣府とドイツ連邦教育研究省(BMBF)は、2017年1月、共同声明に署名し、自動運転に関する科学的な側面での意見交換を行い、科学技術・イノベーションにおける潜在的な研究開発活動の分野を特定することとしました。その後、内閣府と関係省庁は、SIP自

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February 4, 2019 Joint press release by Japanese Cabinet Office and German BMBF

Convening of Advisory Committee

- The advisory committee will discuss simulation methods and results, the implications of the simulation results, ways of using the results to foster social acceptance and other issues.
- The first meeting of the advisory committee will be held on March 7, 2019.

Members of the Advisory Committee on the Social Impact of Automated Driving Systems

Name	Affiliation	Speciality
Masato Itohisa	Associate Professor, Faculty of Social Science, Hosei University	Technology management
Takeyoshi Imai	Professor, Graduate School of Law, Hosei University	Criminal law
Keisuke Uehara	Associate Professor, Faculty Environment and Information Studies, Keio University	Iinformation technology
○ **Takashi Oguchi**	Professor and Director, Advanced Mobility Research Center, Institute of Industrial Science, The University of Tokyo	Traffic control engineering
Shusuke Kakiuchi	Professor, Faculty of Law, Graduate Schools for Law and Politics, The University of Tokyo	Civil procedure law
Masanobu Kii	Professor, Faculty of Engineering and Design, Kagawa University	Urban and transportation planning
Yuto Kitamura	Associate Professor, Graduate School of Education, The University of Tokyo	Education
Ryo Kurachi	Specially Appointed Associate Professor, Center for Embedded Computing Systems, Graduate School of Informatics, Nagoya University	Cybersecurity
Yasuhiro Shiomi	Associate Professor, Department of Civil and Environmental Engineering, College of Science and Engineering, Ritsumeikan University	Traffic engineering
Naoki Suganuma	Associate Professor, Automated Vehicle Research Unit, Future Society Creation Research Core, Institute for Frontier Science Initiative, Kanazawa University	Robotics engineering
Satoshi Taguchi	Professor, Faculty of Commerce and Director, Institute for Technology, Enterprise and Competitiveness, Doshisha University	Behavioral economics
☆ **Akihiro Nakamura**	Professor, Graduate School of International Management, Yokohama City University	Public economics
Pongsathorn Raksincharoensak	Professor, Department of Mechanical Systems Engineering, Tokyo University of Agriculture and Technology	Machine dynamics and control
Hiroaki Miyoshi	Professor, Faculty of Policy Studies and Director-General, Institute for Technology, Enterprise and Competitiveness, Doshisha University	Technology and public policy
Akinori Morimoto	Professor, Department of Civil and Environmental Engineering, Faculty of Science and Engineering, Waseda University	Urban planning
Goro Yamazaki	Associate Professor, Center for the Study of Co Design, Osaka University	Cultural anthropology

○: Chair ☆: Observer

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