2022年度
JARI 研究論文集

一般財団法人日本自動車研究所

2022 年度
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Battery Energy, 2023 年 1 月
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＜安全分野＞

(6)　レベル 3 自動運転車の緊急回避制御中におけるドライバの介入行動
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Nobuyuki Uchida(JARI), Jun Tajima(Misaki Design)
IEEE Open Journal of Intelligent Transportation Systems (Volume: 3), 2022 年 4 月
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(13) A Review of Vehicle-to-Vulnerable Road User Collisions on Limited-Access Highways to Support the Development of Automated Vehicle Safety Assessments
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Safety Journal,Vol.8, No. 2, 2022 年 6 月
https://www.mdpi.com/2313-576X/8/2/26

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IEEE Transactions on Vehicular Technology (Volume: 72, Issue: 6), 2023 年 1 月
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アブストラクト

＜環境分野＞

(1) シャシダイナモメータを用いた実路走行環境の再現方法

羽二生 隆宏(JARI), 伊藤 貴之(JARI), 相馬 誠一(JARI), 飯原 和喜(JARI)

自動車技術会論文集 Vol.53, No.3, 2022 年 4 月
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The real driving emission test will be implemented from October 2022 in Japan. For the efficient vehicle evelopment, a test method for reproducing real driving conditions in the test conducted by using a chassis dynamometer is in demand. To replicate the wind speed and wind direction encountered during real driving in the chassis dynamometer test, we investigated a method of replacing the effect of wind condition with road gradients. The exhaust gas and fuel consumption of the vehicle in the chassis dynamometer test was found to be almost equivalent to that during real driving conditions when the vehicle speed, road gradient, ambient environment (temperature, humidity, solar radiation, and wind condition), and usage of air conditioner during real driving were replicated in the chassis dynamometer test.

(2) 硫化物系全固体 LIB のサイクル劣化メカニズム解析

安藤 慧佑(JARI), 松田 智行(JARI), 三輪 託也(LIBTEC),
川合 光幹(LIBTEC), 今村 大地(JARI)

自動車技術会論文集 Vol.53, No.4, 2022 年 7 月
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Herein, we conducted IEC 62660-1 cycle, high-temperature cycle, and high-temperature storage tests on sulfide-based all-solid-state batteries to evaluate their durability and degradation mechanism. On the basis of the high-temperature cycle test and cell analysis, the increase in the resistance of the batteries was attributed to the oxidation of the sulfide electrolyte at the positive electrode. Moreover, the decrease in the capacity caused by the consumption of active Li+ was attributed to the reduction of the sulfide electrolyte at the negative electrode. We also considered that the degradation mechanisms follow the Arrhenius law on the basis of the high-temperature storage tests.

(3) 自動車部門における長期 CO2 削減効果推計とコベネフィット効果の検討

金成修一(JARI), 平井洋(JARI), 鈴木徹也(JARI), 森川多津子(JARI), 小池博(JARI), 伊藤晃佳(JARI)

エネルギー・資源学会誌, 44 巻, 2 号, 2023 年 3 月
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The Japanese government announced its mid-term target of reducing greenhouse gas emissions by 26% from 2013 to 2030 at COP21. In Japan, CO2 emissions from the transport sector account for 18.5% of total CO2 emissions, and it is necessary to implement measures in the automobile sector as soon as possible. On the other hand, cobenefit effects such as changes in emissions and noise levels are obtained when global warming countermeasures are implemented. However, previous studies didn't have mentioned co-benefit effects that based on theoretical method. In this study, the authors developed a method for estimating CO2 emissions of automotive sector to consider integrated approaches, and added the calculation of exhaust emission gas and noise levels. Finally, using the developed method, and assuming four scenarios studied by the authors, the effects of technological progress in automobiles and the effects of measures that may be introduced in the future are considered.

(4) Effect of Properties and Additives of Gasoline on Low-Speed Pre-Ignition in Turbocharged Engines

Tomoya Nakajo (JARI), Ken Matsuura (JARI)
SAE Powertrains, Fuels & Lubricants Conference & Exhibition, 2022 年 6 月
https://doi.org/10.4271/2022-01-1077

Gasoline-related factors that affect low-speed pre-ignition (LSPI) include the distillation properties of gasoline, manganese (Mn), ethanol, diesel fuel, detergent for aftermarket, and iron (Fe). The combined effect of Mn with ethanol or high calcium engine oil (high-Ca oil) has not been sufficiently clarified. Therefore, appropriate countermeasures for LSPI have not yet been implemented. To clarify the effect of the gasoline properties and additives on LSPI, engine tests were conducted using gasoline with different "PM Index" values, an indicator of distillation properties, different concentrations of Mn, ethanol, diesel fuel, detergent, Fe, and high-Ca oil. The results showed that the LSPI frequency tended to increase with the PM Index, Mn up to 60 ppm, diesel fuel up to 2 vol.%, and detergent up to three times the standard amount. Compared with gasoline with 30 ppm Mn, LSPI frequency increased 1.8 times for gasoline with 30 ppm Mn and 20 vol.% ethanol, and 1.2 times for gasoline with 30 ppm Mn and high-Ca oil. Ethanol up to 20 vol.% only and 10 ppm Fe with light gasoline had no effect on the LSPI frequency. There exists a relationship between the particulate number (PN) in the normal combustion and the LSPI frequency. The sensitivity of the PN to the LSPI frequency was approximately 2.0 times greater for the Mn-added gasoline than for the hydrocarbon-based gasoline.

(5) Degradation mechanism of all-solid-state lithium-ion batteries with argyrodite $Li_{7-x}PS_{6-x}Cl_x$ sulfide through high-temperature cycling test

Keisuke Ando(JARI), Tomoyuki Matsuda(JARI),Takuya Miwa(LIBTEC),
Mitsumoto Kawai(LIBTEC), Daichi Imamura (JARI)
Battery Energy, 2023 年 1 月
https://doi.org/10.1002/bte2.20220052

Sulfide - based all - solid - state lithium - ion batteries (LIBs) are promising replacements for conventional liquid electrolyte LIBs. However, their degradation mechanisms and analysis methods are poorly understood. Herein, the degradation mechanism of an argyrodite - type sulfide - based all - solid - state prototype LIB cell is reported. Furthermore, an analysis method for all - solidstate batteries using charge/discharge cycle tests at 100°C followed by the disassembly analysis of cells before and after accelerated degradation tests is reported. Based on the findings of this study, the degradation of the prototype cell is classified as follows: (i) solid electrolyte (SE) oxidation in the positive electrode, which recovers battery capacity and increases resistance; (ii) SE reduction in the negative electrode, which decreases capacity; (iii) lithium deposition on/in the negative electrode, which decreases capacity; and (iv) capacity loss of the positive electrode, which decreases capacity. These degradation reactions appear to occur simultaneously. These findings are expected to aid the development of sulfide - based solid - electrolyte LIBs with improved safety and energy densities.

＜安全分野＞

(6)　レベル 3 自動運転車の緊急回避制御中におけるドライバの介入行動

本間 亮平(JARI), 栗山 あずさ(JARI), 小高 賢二(自工会)
自動車技術会論文集, Vol.53, No.3, 2022 年 5 月
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The interaction between a Society of Automobile Engineers Level-3 automated vehicle and a driver is an important issue in automobile automation. We conducted a driving simulator experiment to investigate driver intervention during the system's emergency manoeuvre (EM) when encountering an imminent collision risk during automated driving. As a result of suspending EM due to driver intervention, collision risk decreased when no vehicles were adjacent. In contrast, collision risk increased when adjacent vehicles existed. Therefore, the results suggest that there are situations in which it is better to inhibit driver intervention during EM, such as when the driver steers toward an adjacent vehicle.

(7)　レベル 3 自動運転車の緊急回避制御中におけるドライバの介入行動（第 2 報）
―操舵による緊急回避制御中におけるドライバ介入行動による影響と対策―

本間 亮平(JARI), 栗山 あずさ(JARI), 小高 賢二(自工会)
自動車技術会論文集, Vol.54, No.1, 2022 年 12 月
https://doi.org/10.11351/jsaeronbun.54.88

The interaction between a Society of Automobile Engineers Level-3 automated vehicle and a fallback ready user is an important issue in automobile automation. We conducted a driving simulator experiment to investigate driver intervention during the system's emergency manoeuvre (EM) by steering when encountering an imminent collision risk during automated driving. As results of the experiment, many drivers intervened during the EM by steering, and drivers who intervened at a point when the lateral control force was particularly high tended to increase the risk. Based on the results of the first report and this experiment, we summarized the items that the system should consider when the driver intervenes during EM.

(8)　高速道路における自動運転車とのインタラクション時の受容性
―周辺交通主体の知識と外向け HMI が不安感に及ぼす影響―

大谷 亮(JARI), 江上 嘉典(JARI), 栗山 あずさ(JARI), 佐藤 健治(JARI), 石井 啓介(自工会)
自動車技術会論文集, Vol.54, No.2, 2022 年 2 月
https://doi.org/10.11351/jsaeronbun.54.390

This study investigated effects of other drivers' knowledge and external HMIs on their acceptances of the automated vehicles (AVs). A driving simulator experiment was conducted, in which 29 drivers experienced 3 different situations where they need to interact with the AVs on motorway, namely, merging, following and cutin scenes. Drivers were instructed to answer their anxiety when they interacted with the AV in each scene. The results showed that in the following scene, drivers' knowledge and external HMI influenced their anxiety toward the interaction with the AV. Drivers' knowledge of the AVs is important to promote the extensive use of them.

(9) レベル 3 自動運転の運転交代場面に対応する支援 HMI 活用時の運転行動分析
—情報伝達手法の違いによる駐車車両回避経路への影響—

長谷川 諒(JARI), 李 柱衡(JARI), 中村 弘毅(JARI), 安部 原也(JARI), 内田 信行(JARI)

自動車技術会論文集, Vol.54, No.2, 2023 年 3 月
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During level 3 automated driving on urban roads, the occurrence of take-over caused by urban domain-specific factors is possible. In this research, we analyzed driver behavior by conducting a take-over experiment. The experimental scenario consisted of the driver passing through an intersection and having to avoid a parked car after take-over. Results show that suggesting to the driver to operate the pedal and steering wheel, in addition to issuing the request to intervene, may facilitate a safe and smooth take-over.

(10) 緊急場面におけるドライバの回避操作に関する研究（第 2 報）
—オーバーラップ率が小さい場合の回避操作—

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味村 寛(自工会), 占部 博之(自工会), 平田 直(自工会)

自動車技術会論文集, Vol.54, No.2, 2023 年 3 月
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With the social demand to reduce traffic accidents, to understand driving behavior in traffic accidents is important not only for the development of automobiles but also for discussion on the standardization of ADAS (Advanced Driver-Assistance Systems). In the previous report, we conducted an experiment using a driving simulator and investigated the characteristics of avoidance operations in emergencies at a large overlap rate for general drivers. We hypothesized that different overlap rates would be in different driver avoidance operations. In this study, we investigated the characteristics of avoidance operations in emergencies at a small overlap rate for general drivers. As a result, it was found that most drivers avoid collisions with steering in small overlap situations compared to large overlap situations. Moreover, we found that some drivers may be able to be assisted in avoidance by ESF (Emergency Steering Function).

(11) 大型車自動運転隊列走行中の瞳孔径によるドライバ精神負担の評価

寺西 翔一朗(JARI), 河島 宏紀(JARI), 安部 原也(JARI), 永塚 満(自工会)

自動車技術会論文集, Vol.54, No.2, 2023 年 3 月
https://doi.org/10.11351/jsaeronbun.54.396

In autonomous truck platoon(SAE level 3), the driver is released from driving operations and constant monitoring of systems under certain driving conditions, so it is expected that driver's mental workload will be reduced compared to manual driving. However, it is not fully known whether driver's mental workload is reduced in autonomous truck platoon. We conducted a driving simulator experiment to evaluate changes in driver's mental workload based on pupil diameter. Results showed that driver's mental workload may be reduced by autonomous truck platoon.

(12) A Nationwide Impact Assessment of Automated Driving Systems on Traffic Safety Using Multiagent Traffic Simulations

Sou Kitajima(JARI), Hanna Chouchane(JARI), Jacobo Antona-Makoshi(JARI), Nobuyuki Uchida(JARI), Jun Tajima(Misaki Design)

IEEE Open Journal of Intelligent Transportation Systems (Volume: 3), 2022 年 4 月

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The objective of this paper is to propose a methodology to estimate nationwide traffic safety impacts of automated vehicle technologies using multi-agent traffic simulations. The influence of three levels of driver trust in the automation system (appropriate, over trust, distrust) is considered in the simulation and takes different transition modes of control between the driver and the system into account. The nationwide estimation of crashes is obtained by projecting results of the simulations using traffic data for three different and representative municipalities. Results indicated that Automated Driving Systems and Advanced Driver Assistance Systems significantly reduced the number of casualties and fatalities compared to manual driving. Simulation results in consideration of the influence of driver trust also found that this reduction may be negatively affected by over- and under-trust parameters. However, even with the introduction of these parameters, the reduction rate was still significant compared to manual driving. The proposed methodology using multi-agent traffic simulations may thus address concerns surrounding the deployment of automated driving systems which is a feature not found in conventional simulations, provide useful insight for interested parties to develop research and policy making strategies that accelerate traffic safety improvements, and to support social acceptance efforts.

(13) A Review of Vehicle-to-Vulnerable Road User Collisions on Limited-Access Highways to Support the Development of Automated Vehicle Safety Assessments

Husam Muslim(JARI), Jacobo Antona-Makoshi(JARI)

Safety Journal,Vol.8, No. 2, 2022 年 6 月

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This study aims to provide evidence to support the development of automated vehicle (AV) safety assessments that consider the possible presence of non-motorized vulnerable road-users (VRUs) on limited-access highways. Although limited-access highways are designed to accommodate high-speed motor vehicles, collisions involving VRUs on such roadways are frequently reported. A narrative review is conducted, covering the epidemiology of VRUs crashes on limited-access highways to identify typical crash patterns considering collisions severity and the underlying reasons for the VRUs to use the highway. The review results show that occupants alighting from a disabled or crashed vehicle, people seeking help or helping others, highway maintenance zones, police stops, and people crossing a highway should be given priority to ensure VRU safety on limited-access highways. The results are summarized in figures with schematic models to generate test scenarios for AV safety assessment. Additionally, the results are discussed using two examples of traffic situations relevant to the potential AV-VRU crashes on highways and the current performance of autonomous emergency braking and autonomous emergency steering systems. These findings have important implications for producing scenarios in which AV may not produce crashes lest it performs worse than human drivers in the proposed scenarios.

(14) Design and Evaluation of Lane-change Collision Avoidance systems in Semi-automated Driving

Husam Muslim(JARI)

IEEE Transactions on Vehicular Technology (Volume: 72, Issue: 6), 2023 年 1 月
https://ieeexplore.ieee.org/document/10019575

Hands on the steering wheel partial driving automation, in which the system controls the lateral and longitudinal vehicle motion while the driver holds the steering wheel, monitors roadway, and intervenes when necessary, is an example of shared control driving. To insure mutual safety in shared control driving, the system also needs to guid the driver's interventions to avoid hazardous actions, such as risky lane changes. This study proposes three steering interventions that activate automatically when the system detects a lane change by monitoring the steering wheel angle inputted by the driver and road section and determining that the two vehicles are on a collision course. A driving simulation experiment with 80 drivers was conducted to compar four conditions: 1) no steering intervention; 2) a haptic steering intervention that increases stiffness against steering toward the lane where a collision may occur; 3) an automatic steering intervention that decouples the driver's steering input and autonomously steered the vehicle away from the hazard; and 4) multiple steering interventions that generate different degrees of haptic and automatic steering interventions based on the time headway and time-to-collision between vehicles. Analysis of driving performance and safety under conditions with and without steering interventions indicate that all participants, at some points, initiated lane changes that are likely to result in a crash during partial driving automation. However, the three interventions effectively reduced lane-change collisions compared to the baseline. While the automatic steering intervention avoided all collisions, the multiple steering interventions were determined to provide sufficient safety while being more thoroughly accepted by the drivers than the haptic and automatic interventions separately. These findings have implications for developing adaptive collision avoidance systems considering user preference and driving performance.

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