Use-case Generation and Analysis for Autonomous Driving in Urban Areas

Takuya Nanri1) Fang Fang1) Abdelaziz Khiat1)

1) Mobility & AI Laboratory, Nissan Motor Co., Ltd.
1-1 Morinosato-aoyama, Atsugi, Kanagawa 243-0123 JAPAN
E-mail: {t-nanri, fangfang, khiat}@mail.nissan.co.jp

Received on Nov. 9, 2020

ABSTRACT: Being able to generate adequate test scenarios in order to validate autonomous driving functions is of paramount importance for the deployment of autonomous vehicles. However, asserting the completeness of generated test cases and coverage of all possibilities has proven to be very difficult. Previously, few attempts that tried to generate representative possibilities have all been based on the designer’s experience and thus inherently incomplete. This paper proposes a formal system inspired approach that solves this issue. With this approach, 2,544 basic use-cases were generated from a completeness perspective. Thereafter, for the sake of accelerating the development work of our autonomous vehicle, we used this asset to clarify which use-cases should be solved and in what order.

KEYWORDS: Electronics and control, Autonomous driving, Reliability (E1)

1. Introduction

Background: Autonomous vehicles in urban areas are an important factor in a Mobility-as-a-Service (MaaS) platform such as self-driving taxis[1] and unmanned ground vehicles for logistics[2]. An example of self-driving taxis is Easy Ride[1]; which is a field trial being conducted in Yokohama for a ride-hailing service using autonomous vehicles. Unmanned ground vehicles are being implemented in logistics field trials all over the world, including in Europe, the U.S., China and Japan[2].

A challenge for the introduction of autonomous driving in urban areas is to assure that these vehicle systems behave safely. Being able to generate adequate test scenarios in order to validate autonomous driving functions is of paramount importance for the deployment of autonomous vehicles. However, asserting the completeness of generated test cases and coverage of all possibilities has proven to be very difficult. Moreover, from the viewpoint of development work management, we cannot assess what the requirements are and what should be done to meet them unless test scenarios are first clarified. Therefore, it is hard to judge the progress status of the development work and to decide priorities.

However, different from highway autonomous driving, autonomous vehicles in urban areas face all kinds of use-cases due to many different road geometries and surrounding objects. Previously, few attempts that tried to generate representative possibilities have all been based on the designer’s experience and thus incomplete. To the best of our knowledge, no one has attempted to tackle “complete” use-case generation in urban areas, although an assessment framework called a “scenario-based approach” has been proposed[3] and some highway driving scenarios have been generated[4].

Purpose: In this paper, we propose a formal system inspired approach for generating use-cases for autonomous vehicles in urban areas. Generating use-cases enables us to quantify the coverage of use-cases in urban areas for the development work management and to clarify what use-cases should be considered. Moreover, in order to apply it to Yokohama area for Easy Ride[1], we defined an operational design domain (ODD) with the same ontology dictionary used in our use-case description and narrowed down on the use-cases that correspond to the targeted area. We describe a framework that has been constructed to quantify the coverage of use-cases for the development work management.
Finally, we show that our use-cases described with our ontology have the potential to be applied to logical reasoning about encountered traffic scenes.

**Contributions:** Our contributions are summarized in the following four points: Firstly, the proposed approach generates use-cases for autonomous driving in urban areas considering completeness. This enables us to calculate the coverage from a use-case perspective and to generate complete test scenarios by adding necessary detailed parameters. The second contribution is that we have defined an ontology to describe the generated use-cases. The ontology dictionary reduces the ambiguity of use-case meanings in natural language, making it easy to search for relevant use-cases using human-understandable keywords. Besides, our ontology-based description of use-cases has the potential to be applied to logical reasoning about traffic scenes, especially in complicated situations. The third one is that we have defined a general ODD description based on our ontology dictionary in order to narrow down generated use-cases for corresponding targeted situations. Since the ODD is described using the same ontology, the use-cases corresponding to the ODD can automatically be extracted and can easily be linked to situations that need to be dealt with. The last contribution is the construction of a framework that enables us to calculate and clarify the status of development work by adding more information to the generated use-cases such as the relevant necessary techniques to solve them. Since it can clarify what use-cases should be solved and what techniques should be pursued, it leads to better visibility and acceleration of the development works.

This paper is organized as follows: related studies are summarized in section 2, after which our approach and results for use-case generation are presented, followed by discussions and conclusions.

2. Related studies

In this section, some related studies are first described from a use-case generation perspective. Then, some ontology-related studies in the field of autonomous vehicles are mentioned since ontology is a key component for consistent use-case representation. Moreover, some ODD-related studies are presented. Finally, we clarify the differences between these related studies and our approach.

**Use-case generation:** Autonomous driving (AD) use-cases have been generated by some groups and projects for standardization purposes all over the world. However, to the best of our knowledge there are few activities for generating use-cases completely from an urban area perspective, although some groups have established and utilized an assessment framework referred to as a "scenario-based approach" and have generated use-cases for highway driving based on the framework[3][4].

The PEGASUS project for standards of autonomous driving, in which many OEMs (Original Equipment Manufacturers) and Tier 1 suppliers in Europe participated, proposed an assessment framework called a "scenario-based approach" for autonomous vehicles and generated a limited number of highway driving scenarios to validate the framework[3]. The work done was largely theoretical, and generated a limited number of use-cases for driving on German highways. The Japan Automobile Manufacturers Association (JAMA) has also generated highway driving scenarios using a similar "scenario-based approach" and has derived 32 critical situation scenarios[4] for highways; and has also generated a limited number of use-cases for driving on Japanese highways. Meanwhile, the National Highway Traffic Safety Administration (NHTSA) in the U.S. has reservations about designing guidelines for use-case generation of autonomous vehicles. It requested the Society of Automotive Engineers (SAE) to summarize best practices and would-be de facto standards, although it has proposed several important concepts for representing scenarios, such as ODD and object and event detection and response (OEDR)[5].

**Ontology representation:** Ontology here refers to the representation of knowledge-based systems; which are widely applied in semantic web applications. It is also an important concept for consistent use-case representation because natural language description is too ambiguous to represent use-cases of autonomous driving. There are some studies that have defined ontologies for describing use-cases of autonomous vehicles with consistency. For example, Bagschik et al.[6] defined an ontology in the field of automated vehicles to help experts completely create a wide range of scenarios, and proposed a traffic scene creation approach based on their ontology. They modeled the ontology with 284 classes, 762 logical axioms and 75 semantic web rules to generate scenes for German motorways. They proposed a process for generating traffic scenes by defining an ontology and generated a limited number of scenes only for German motorways for the purpose of validating the process and their ontology. Then, they discussed the requirements for the representation of scenarios in the different process steps defined in ISO 26262, and proposed a consistent terminology to create scenarios[7]. However, they did not consider urban areas. Besides, there are other papers[8][9][10][11] that used ontologies to reason about some driving situations or road structures in autonomous driving application in order to handle specific, complicated, although limited situations, such as a straight
road with crossing, an intersection with traffic light and T-junction. In other words, they created ontologies and rules for a limited application scenario and they did not cover all possible use-cases in urban areas.

**ODD definition:** SAE J3016 provides the following definition of ODD: "Operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics[12]." The use-cases to be dealt with depend on an ODD. Several companies that have been doing a field test of autonomous vehicles have defined their respective ODD[13][14][15]. For example, an OEM in Europe has used the following categories as an ODD for autonomous vehicles: speed range, time-of-day, weather conditions, the presence or absence of certain types of roadway infrastructure and the geographical area in which the automated vehicle is designed to operate[13]. Also, a white paper by several OEMs and Tier 1 suppliers shows the following ODD categories for autonomous vehicles: weather conditions, geographic domain, background scene and dynamic properties of the scene[14]. These ODDs are used as a requirements for autonomous vehicles, but there seems to be no direct link between those requirements and corresponding use-cases.

**Our approach:** Our purpose is to generate complete use-cases for autonomous vehicles in urban areas in the real world. We have generated use-cases in urban areas and confirmed its completeness by describing use-cases with our defined ontology. Moreover, this approach makes it possible to visualize the development work status based on the generated use-cases by adding information on the progress level of each related technical aspect. Afterwards, we introduce an ontology-based ODD definition that enables us to easily narrow down generated use-cases corresponding to a specific ODD and to clarify what use-cases need to be solved.

3. Proposed method

Completeness is the ability to cover all possible use-cases that any autonomous vehicle could encounter. To ensure completeness of use-cases, we define a hierarchical classification axis from a Mutually Exclusive, Collectively Exhaustive (MECE) point of view. We also define the granularity of use-cases in order to clarify how deeply they should be classified. We can alleviate combinatorial explosion and obtain tractable use-cases by defining the granularity. In order to define the granularity of use-cases, we use the following concepts to represent traffic scene: scene, situation, and scenario, proposed by Ulbrich et al[16]. They defined these terms for a consistent representation of traffic scenarios. Then, we define the ontology for autonomous vehicles to achieve a consistent description of use-cases and confirm their completeness. Moreover, we define an ODD with the same ontology as the one used to generate use-cases. By using the same ontology, we can easily link use-cases with ODD and extract use-cases corresponding to an ODD.

In this section, we first describe the hierarchical classification and the granularity of use-cases to generate them. After that, we describe our ontology dictionary used in confirming the completeness of generated use-cases. Finally, we present an ontology-based ODD definition used to narrow down generated use-cases for a specific application.

3.1. Hierarchical classification

In order to assert completeness of use-cases, we define a MECE hierarchical classification axis. The hierarchical classification axis consists of upper and lower levels. The upper level includes basic vehicle behavior (maneuvers) from a lane perspective and the ego vehicle’s pre-planned navigation path. Although geographical road structures can be used as a classification axis such as intersections, straight roads and so on, it is hard to classify use-cases from a MECE point of view because there are too many perspectives to define in one axis. On the other hand, the ego vehicle’s behavior can be treated as a MECE classification axis because the subject of behavior is clear.

The upper level includes keeping lane, changing lane, crossing lane (intersection) and so on. Crossing lane (intersection) means the ego vehicle crosses another lane such as at an intersection. Crossing lane have the other property in the upper level, ego vehicle’s pre-planned navigation path. For example, crossing lane has three possible paths: crossing, which means going straight, driver side turn and passenger side turn. Since we have left-hand traffic and right-hand traffic in the real world, we refer to a right turn in left-hand traffic and a left turn in right-hand traffic as a driver side turn, and a left turn in left-hand traffic and right turn in right-hand traffic as a passenger side turn. Fig.2 shows a part of the upper level of the hierarchical classification, including basic behavior and the ego vehicle’s pre-planned navigation path. Fig.3 shows an example of upper-level classification.

Next, we define the lower level, which includes factors that induce change in the ego vehicle’s basic behavior at upper level. The factors at the lower level consist of three types of attributes: environment, road and object attributes. The first level of environment attributes, for example, is classified into visibility and weather. The first level of road attributes is classified into the road surface
and road furniture. The first level of object attributes is classified into dynamic and static objects. All the factors that induces changes in basic behavior at the upper level are listed in the lower level. Fig.4 shows three types of attributes at the lower level of use-cases.

3.2. Granularity of use-case

The finer the classification axis becomes, the larger is the number of use-cases. The preconditions and the granularity of use-cases are defined in order to alleviate combinatorial explosion of the number of use-cases and to achieve tractable use-cases.

The preconditions are defined as follows:

- The ego vehicle is autonomous.
  - The ego vehicle complies with traffic rules.
  - The ego vehicle displays behavior typical of an average driver.
  - The ego vehicle has a pre-planned navigation path.

Needless to say, the main precondition is that ego vehicle is autonomous. Of the other three preconditions, the first one is that the autonomous vehicle fully complies with traffic rules. This is the most important of the other three preconditions. It is assumed that the autonomous vehicle displays behavior typical of an average human driver. The last precondition is that the ego vehicle always has a defined goal, i.e., it has a pre-planned navigation path. This path is not a lane-level path, but a road-level navigation path.

The granularity of use-cases is defined as follows. The use-case definition used in this paper adopts the relevant concepts for representing the traffic environment proposed by Ulbrich et al., namely, scene, situation and scenario[16]. Before we define the use-cases, these concepts are first defined as follows.

**Scene**: Based on Ulbrich et al’s definition[16], a scene is defined as a snapshot, including the ego vehicle, driving environment, surrounding objects, and the qualitative relationships among them. Fig.5 schematically shows the concept of a scene, including the ego vehicle, objects, environment, and the qualitative relationships between the ego vehicle and objects, between the ego vehicle and the environment, between objects and the environment, and finally among objects. The scene resolution is defined according to whether the information can be distinguished by a snapshot or not.

Examples of each component are as follows:

- **Ego vehicle**: an autonomous vehicle
- **Driving environment**: this includes the number of lanes, presence of traffic lights, traffic signs, etc.
- **Surrounding objects**: they consist of dynamic objects (vehicles, pedestrians), and static objects(parked vehicles, falling objects, construction-related materials)
- **Qualitative relationships between the ego vehicle/objects and driving environment**: this includes a self-driving lane, distance to stop lines (i.e. far, close), logical drivable area (lateral lane width), etc.
- **Qualitative relationships among objects**: this includes their relative orientation (oncoming, crossing), etc.

For example, a scene without pedestrian and another scene with pedestrian are different because the objects differ in terms of the snapshot point of view.

**Situation**: A situation is derived from a scene, including the information, for example, path and vehicle type, needed for the ego vehicle to make an appropriate decision. The following are examples of the components of a situation:

- **Path**: this includes keeping the same lane, changing
Situation: A temporal development between several scenes in a sequence is defined as a situation. A single situation may contain several scenarios. Each node represents scene, and a temporal development between several scenes in a sequence constitutes a scenario. One situation can include several scenarios.

Scenario: A temporal development between several scenes in a sequence is defined as a scenario. A single situation may contain several scenarios. Each node represents scene, and a temporal development between several scenes in a sequence constitutes a scenario. One situation can include several scenarios.

Use-case: A use-case is considered here at the situation level. Situations in which the ego vehicle has the same behavior policy are defined as a single use-case. One use-case may contain several scenarios. Each node represents a use-case, and a temporal development between several use-cases in a sequence constitutes a use-case. One situation can include several use-cases.

3.3. Ontology representation

Although we can generate use-cases using the hierarchical classification axis and the granularity of use-cases, representing use-cases in natural language can lead to ambiguity. Therefore, an ontology is defined that describes all the use-cases. Ontology means a representation of knowledge-based systems, which are widely applied in semantic web applications. Ontology is also an important concept for consistent use-case representation. The ontology defined here consists of six categories: class, entity state, relational element, future behavior element, decision making element, and parameter.

The class category has environment, object and road attributes. These are the same as the lower levels for classifying use-cases. The entity state category is divided into object states and road states. The relational element category shows the relations between objects and between objects and road furniture. The future behavior element shows the behavior of other object entities and road furniture in the future. For example, this category is expressed using the verb "will". The decision making element category shows the behavior of the ego vehicle in the future. The behavior of the ego vehicle can be decided by itself. The parameter category shows the parameters included in each category.

From scene, situation and scenario definition perspective, the first three categories (class, entity state and relational element) include scene-related ontologies. For example, class includes ontologies about the definition of surrounding objects themselves, and entity state includes ontologies about the definition of surrounding objects' states. Also, relational element includes ontologies about the definition of qualitative relationships among the ego vehicle, driving environment and surrounding objects. The next two categories (future behavior element and decision making element) include situation-related ontologies. For example, future behavior element includes ontologies about the definition of surrounding objects' path, and decision making element includes ontologies about the definition of the ego vehicle path. Since the use-case is considered here at the situation level, categories do not include scenario-related ontologies.

Our ontology is based on previous ontologies[8][17] that have been applied for understanding scenes involving au-
4. Application result

In this section, we show the result of use-case generation and confirmation of use-case "completeness". Then, we define an ODD in order to drive autonomously for Easy Ride in Yokohama[1] and narrow down use-cases to correspond to an ODD in Yokohama.

4.1. Use-case generation

An order of priority is defined in order to generate use-cases for autonomous driving. In defining this order of priority, we started with the usual situations, that is, natural environment conditions of sunny or cloudy daytime weather. While other vehicles usually comply with traffic rules, we consider actual frequent deviations from traffic rules, e.g., over-speeding, ignoring stop lines/signs and changing lanes in prohibited areas. At this point, we do not consider parking-related use-cases.

Based on the defined classification, preconditions, order of priority, and granularity, 2,544 use-cases were generated. Table 1 shows a part of the number generated at each upper level.

An example of a use-case is shown in Fig.9. The use-case here is described based on first-order logic format and is classified into three parts: ego vehicle’s decision making based on pre-planned navigation path, future behavior of the other objects and ego vehicle’s decision making considering future behavior of the other objects. The first part is decision making behaviors related to pre-planned navigation path. The second part is future behaviors of the other objects that can be predicted by ego vehicle. The last part is decision making behaviors considering the future behaviors of the other objects. Using this format, we can apply several reasoning methods such as first-order logic and Markov logic. Since it covers all possible use-cases in urban areas, it could reason about all the traffic situations in urban areas.

4.2. Confirmation of use-case completeness

The completeness of the use-cases generated for autonomous driving was also confirmed. AD use-cases can be
Decision making based on pre-planned navigation path
- TurnToDriverSide(EgoVehicle) => ShiftPositionInLaneToDriverSide(EgoVehicle)
- TurnToDriverSide(EgoVehicle) => Decelerate(EgoVehicle)

Future behavior of object
- isPassengerVehicle(V1) & isRespectingLegalSpeed(V1) & PositionInLaneOnCenter(V1) & isOnIntersectionWithTrafficLight(V1) & isTrafficLight_Green(EgoVehicle) => willGoStraight(V1)

Decision making based on future behavior of object
- willGoStraight(V1) & TurnToDriverSide(EgoVehicle) => isBlocking(EgoVehicle, V1) & hasRightOfWayOver(V1, EgoVehicle) & isApproachingTo(EgoVehicle, V1) & hasRightOfWayOver(V1, EgoVehicle) => StopFor(EgoVehicle, V1)

Table 2: The definition of variables

| Symbol | Meaning                  |
|--------|--------------------------|
| $E$    | Set of environment attributes |
| $O$    | Set of object entities   |
| $R$    | Set of road entities     |
| $Os$   | Set of object entity states |
| $Rs$   | Set of road entity states |
| $Rel$  | Set of relational elements |
| $F$    | Set of future behavior elements |
| $Si$   | Set of situations        |
| $U$    | Set of use-cases         |

\[
Si = E \times (R, Rs) \times (O, Os, Rel) \times F \\
U = f(Si)
\]

However, this combination number is too large to treat. Therefore, after considering the order of priority (visibility/weather attributes), we unified the cases where the ego vehicle has the same behavior policy as an autonomous vehicle based on our use-case definition. For example, an oncoming vehicle that will turn to driver side are different situations. However, they are unified into a single use-case from use-case definition perspective if the ego vehicle goes straight because these behaviors of oncoming vehicle do not affect the ego vehicle behavior policy. Equation.2 represents this unifying process. We then eliminated improbable cases among them, for example straight road x turn to driver side. Fig.10 shows the number of cases in each process. The number of use-cases was confirmed as shown in this figure.

Moreover, since we generated use-cases completely, we can automatically narrow down the number of use-cases to be considered by defining an ODD for the target area. When we applied a defined ODD in Yokohama for Easy Ride to the use-cases, 727 use-cases were obtained as shown in Fig.10. We were able to design use-cases to be considered because we defined an ODD with the same ontology as use-cases. Table.3 shows some elements in the defined ODD for Yokohama.

5. Discussion

Based on the tractable use-cases obtained, we can visualize the overall development status by tracking the development status for each use-case. With this framework, we can clarify which use-cases should be considered. In our case, we divided the development status into four technical fields: perception, cognition, decision making and trajectory control in order to follow the progress in details. First of all, all relevant technical elements with the use-cases were listed up in each technical field. We then added the development
status (e.g. done, created, ongoing, not yet) to each technical element in each technical field. After all the technical elements were linked to corresponding use-cases, the development status of use-cases was calculated by using the status of corresponding technical elements. In this case, the development status of a use-case was defined with the slowest status among the ones of corresponding technical elements. The decomposition of development status enabled us to specify what technical elements should be solved by identifying the affected use-cases. Based on the complete use-cases, we can easily extend a development management framework by adding more information to each use-case in this way. Therefore, the obtained AD use-cases have great potential in several applications.

Moreover, we can apply generated use-cases described with our ontology to situation understanding and decision making. Since our use-case description includes the prediction of intention of the other objects, it is quite effective, especially in complicated situations. Although previous methods can cover limited use-cases for specific situations [8][17], our use-cases can cover all possible ones in urban area. Ontology description of use-cases allows us to apply first-order logic, Markov logic or Bayesian networks and to help autonomous vehicles to reason about the behavior of other objects in their surrounding.

Finally, we can create test scenarios based on our use-cases using several detailed parameters. Although test scenarios need more detailed parameters, all the test scenarios can be created by considering careful addition of specific parameters to each corresponding use-case.

6. Conclusion

In order to clarify which use-cases need to be solved for autonomous driving in urban areas, we generated 2,544 canonical use-cases in an exhaustive way using our completeness-based approach. These use-cases, defined with our ontology, enabled us to automatically narrow down the use-cases to consider in a corresponding operational design domain, such as in Yokohama for the Easy Ride project. Consequently, we were able to use it to manage the progress of the development works. These use-cases have great potential because they could be applied directly to situation understanding for autonomous vehicles and they could be used in generating test scenarios by varying relevant parameters. In the future, we would like to pursue some new interesting application domains leveraging the generated use-cases.

Acknowledgement

The authors would like to thank Alexandre Armand and Javier Ibañez-Guzmán for the simulating discussions.

References

(1) Easy ride. https://easy-ride.com (3 Nov. 2020).
(2) Japanese Ministry of Economy, Trade and Industry. Toward social implementation on autonomous driving robot (in Japanese). 2019. https://www.meti.go.jp/shingikai/mono_info_service/jidosoko_robot/pdf/pre_001_04.pdf (3 Nov. 2020).
(3) Roman Henze. Validation of automated driving on highways. In Society of Automotive Engineers of Japan Spring Forum, 2019.
(4) JAMA. Introduction of research results on high automated driving safety validation (in Japanese). In Society of Automotive Engineers of Japan Spring Forum, 2019.
(5) NHTSA. A framework for automated driving system testable cases and scenarios. In U.S. Department of Transportation report, 2018.
(6) Gerrit Bagschik, Till Menzel, and Markus Maurer. Ontology based scene creation for the development of automated vehicles. CoRR, abs/1704.01006, 2017.
(7) Till Menzel, Gerrit Bagschik, and Markus Maurer. Scenarios for development, test and validation of automated vehicles. CoRR, abs/1801.08598, 2018.
(8) A. Armand, D. Filliat, and J. Ibañez-Guzman. Ontology-based context awareness for driving assistance systems. In IEEE IV, pages 227–233, June 2014.
(9) M. Hülsen, J. M. Zöllner, and C. Weiss. Traffic intersection situation description ontology for advanced driver assistance. In IEEE IV, pages 993–999, June 2011.
(10) L. Zhao, R. Ichise, T. Yoshikawa, T. Naito, T. Kakinami, and Y. Sasaki. Ontology-based decision making on uncontrolled intersections and narrow roads. In IEEE IV, pages 83–88, June 2015.
(11) Y. Akagi and T. Morikawa. Simultaneous description of logical design and implementation of automated driving systems. In IEEE IV, pages 1565–1570, June 2019.
(12) Society of Automotive Engineers. J3016: Taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles. 2018.
(13) Mercedes-Benz Research & Development North America, Inc. Reinventing safety: A joint approach to automated driving systems. 2018. https://www.daimler.com/documents/innovation/other/vssa-mercedes-benz-and-bosch.pdf (3 Nov. 2020).
(14) Aptiv et al. Safety first for automated driving. 2019. www.aptiv.com/docs/default-source/white-papers/safety-first-for-automated-driving-aptiv-white-paper.pdf (3 Nov. 2020).
(15) Waymo LLC. On the road to fully self-driving. 2017. www.mtfchallenge.org/wp-content/uploads/2017/02/waymo-safety-report-2017-10.pdf (3 Nov. 2020).
(16) S. Ulbrich, T. Menzel, A. Reschka, F. Schmidl, and M. Maurer. Defining and substantiating the terms scene, situation, and scenario for automated driving. In IEEE ITSC, pages 982–988, Sep. 2015.
(17) F. Fang, S. Yamaguchi, and A. Khiat. Ontology-based reasoning approach for long-term behavior prediction of road users. In IEEE ITSC, pages 2068–2073, Oct 2019.

Copyright © 2021 Society of Automotive Engineers of Japan, Inc. All rights reserved