EXPECTATIONS GROW FOR EARLY IMPLEMENTATION OF LEVEL 3 AUTONOMOUS CARS -- KEY LIES IN HUMAN-MACHINE COLLABORATIVE TECHNOLOGY

Shoichiro Hirata
Intellectual Property Dept., Mitsui Global Strategic Studies Institute

In recent years, in addition to leading Japanese and overseas automotive and parts manufacturers, numerous companies from different industries including IT companies have entered the self-driving arena, and competition in technological development is becoming fierce. Against this backdrop, the first ever fatal accident caused by a car in self-drive mode which happened in Florida, U.S.A. in May, involving an electric car manufactured by American company Tesla Motors, has once again focused attention on the challenges faced by autonomous cars, particularly from a technological perspective.

The electric car that caused the accident was a Level 2 autonomous car, combining Active Cruise Control (ACC), which maintains the distance from the car in front, with a Lane Keeping Assist System (LKAS). The accident was thought to be caused by the overconfidence of the driver in the car's self-drive function. Nevertheless, concerns have been voiced about the safety of Level 3 autonomous cars, for which practical implementation is anticipated prior to Level 4 autonomous cars, which still have numerous challenges to overcome, including legislative issues. A shadow has been cast over the momentum for the practical implementation and popularization of Level 3 autonomous cars by the early 2020s.

In this paper, I will set out the international legislative trends in the field of autonomous cars, and discuss the future prospects with a particular focus on the challenges facing practical implementation, specifically in Level 3 autonomous cars, and the initiatives that seek to overcome those challenges.

TRENDS IN INTERNATIONAL LEGISLATION

Autonomous cars are cars that use cameras or radar to recognize conditions surrounding the vehicle and automatically operate the steering wheel or brakes, etc. A more accurate description is provided by the United States' National Highway Traffic Safety Administration (NHTSA), which has set out categories and definitions from Level 0 (Manual Driving) through Level 4. Level 4 autonomous cars mean that driving is controlled by the self-drive system (below, I shall refer to this simply as "the system"), and the driver has no involvement whatsoever in driving (Diagram 1).

It goes without saying that because an autonomous car is still a car, it needs to follow traffic rules when driving on public roads.

Traffic rules in each country are created under the conventions prescribing international road traffic rules, as ratified by each country. These conventions on road traffic include the Geneva Convention (adopted in 1949), which has been ratified by countries such as Japan and the United States, and the Vienna Convention (adopted in 1968), which has been ratified by European and other countries. Article 8 of the Geneva Convention states that "Every vehicle or combination of vehicles proceeding as a unit shall have a driver.", assuming all vehicles, including cars, must have a human driver who is responsible for controlling operation of the vehicle. Accordingly, Level 3 autonomous cars and Level 4 autonomous cars do not satisfy this condition; therefore, as far as the

wording of the convention goes, these cars may not be driven on public roads in countries that have ratified the Geneva Convention.

The definition in Article 8 of the Vienna Convention that "Every moving vehicle or combination of vehicles shall have a driver." was partially amended in 2014 to allow autonomous cars "when such systems can be overridden or switched off by the driver" which, in other words, makes it possible under the Vienna Convention for Level 3 autonomous cars to drive on public roads.

A proposal has been submitted to amend the Geneva Convention along similar lines to the amended Vienna Convention, and work is underway with a view to completing legislation within a few years in order to allow Level 3 autonomous cars prior to Level 4 autonomous cars. As a signatory to the Geneva Convention, Japan is currently carrying out demonstration experiments of Level 3 autonomous cars based on a "broad interpretation" of the relevant domestic laws (the Road Transport Vehicle Act, the Road Traffic Act, the Automobile Liability Security Act, and the Road Act). However, the expectation is that the relevant domestic legislation will be developed in accordance with the amendments to the Geneva Convention, that driving on public roads by Level 3 autonomous cars will be permitted, and that the technology will spread to general users.

Diagram 1 - Levels of Automated Vehicles and Outlines

Level	Outline
Level 0	The driver is in complete and sole control of the primary vehicle controls (acceleration, steering, braking) at all times.
Level 1	The system controls at least one control function - acceleration, steering or braking. Examples: Autonomous Emergency Braking Active Cruise Control (ACC)Note 1 Lane Keeping Assist System (LKAS)Note 2
Level 2	The system controls multiple control functions at the same time - acceleration, steering or braking. Examples: A combination of ACC and LKAS
Level 3	The system controls all control functions - acceleration, steering and braking. * The driver responds when asked by the system to do so in emergency situations, etc.
Level 4	The system controls all control functions - acceleration, steering and braking. * The system even handles emergency situations.

Note 1: ACC: a function for adjusting speed to maintain the distance with the car in front.
Note 2: LKAS: a function for steering the vehicle to remain inside a lane.

THE PROBLEM FACING LEVEL 3 AUTONOMOUS CARS – TRANSITION FROM SELF-DRIVE TO MANUAL MODE

As described above, Level 3 autonomous cars (for which legislation is being developed to assist popularization) are driven automatically by the system. However, when the system's functions reach the limit of their capabilities,

or in the event of an accident, control over driving is switched from the system to the driver; in other words, the system switches from self-driving to manual driving.

These types of Level 3 autonomous cars allow automatic driving to reduce the burden on the driver in operating the vehicle or monitoring traffic conditions; however, the driver still needs to carry out driving in abnormal situations, such as when there is system trouble, and a problem arises as a result. Specifically, there is a significant decrease in the ability of drivers to judge road conditions when they are released from the need to drive when the system is driving automatically because they tend to concentrate on other things (such as using a mobile phone) or they start to feel sleepy. Under these circumstances, the problem arises of a major increase in accident risk arising because it is not possible for drivers to make a sufficient judgment of driving conditions during the limited transition time.

There are strong concerns about these problems, which are unique to Level 3 autonomous cars, and scientific verification is being carried out by research institutions both in Japan and overseas.

OVERCOMING THE CHALLENGES THROUGH HUMAN MACHINE INTERFACES AND NEW INSURANCE

In order to achieve smooth operational intervention of vehicle s s and a smooth driver transition between the driver and the system, technology that achieves collaboration between humans (drivers) and machines (the system) is essential. In human-machine collaborative technology, sensing technology that monitors and identifies the driver's state goes hand in hand with HMIs (Human Machine Interfaces) that rapidly and appropriately display the necessary information to the driver during transition between self-drive and manual modes.

In sensing technology, a system has been developed by OMRON Corporation (Japanese electronics company) that combines sensors installed around the steering wheel with AI (Artificial Intelligence) technology. By detecting the opening and closing of the driver's eyes, the direction of the driver's head and changes in the line of vision or posture, the system infers conditions in the driver, such as looking away from the direction of travel, sleepiness, eating, drinking or illness. The system is then able to make a judgment about how long it would take to return to normal driving based on this inference; if the system judges that it would not be possible to return to normal driving immediately, it can carry out safety measures, such as parking the car by the side of a road.

Many car accidents occur as a result of carelessness or angry emotions on the part of the driver. For this reason, research and development is underway in the United States into sensing technology that detects and infers the driver's emotional state, as well as information related to his or her physical state.

HMI is a general term for the equipment and software, etc. used to communicate information between the driver and the system, including displays that raise the driver's attention or display/transmit warnings, as well as input devices that respond to the driver's voice or gestures. By utilizing HMI, it is possible to make an overall judgment based on information about the driver's state obtained from sensing technology and environmental information, such as traffic conditions, as well as the operation, position and speed of the vehicle, etc.; for example, if the system deems a driver to be capable of returning to driving immediately because he or she is temporarily falling asleep, it could arouse the driver by displaying or transmitting a warning in accordance with the driver's state.

At the same time, it is also important to develop liability insurance products capable of handling accidents by Level 3 autonomous cars in order to handle cases when technological means cannot be used to deal with the risk of accidents occurring during transition from self-drive to manual mode. Currently, liability is determined by making a judgment on whether or not there was negligence on the part of the driver. In the case of accidents arising as a result of automatic driving, it is necessary to consider things such as system faults and cyber-attacks, in addition to driver negligence; the fact that it will become less clear where the liability lies is expected to have a major impact on the assessments of liability insurers. For this reason, liability insurers in Japan and overseas are taking part in demonstration tests on public roads and using the Big Data collected during testing to promote research into the accident risks for automatic cars so that they can develop new liability insurance products.

FUTURE OUTLOOK

The fact that public-private sector collaborative projects have been carried out in different countries for some time now reveals the importance of the collaborative technology between humans and machines described above. For example, debate and testing in the field of sensing technology and HMI have been promoted since 2010 in the United States at the Department of Transportation's Research and Innovative Technology Administration (RITA), and since 2011 in Europe as part of the SMART 64 Project led by the Netherlands Organization for Applied Scientific Research (TNO). In Japan, there have been active developments, including the establishment of an "HMI Taskforce" (December 2015) by the Council for Science, Technology and Innovation (CSTI). International competition in this field of human-machine collaborative technology is becoming increasingly fierce, but there have also been collaborative developments that aim to promote future popularization of the technology. For example, in Japan the Ministry of Land, Infrastructure, Transport and Tourism has worked in partnership with the Ministry of Economy, Trade and Industry to collaborate with the EU via the United Nations Economic Commission for Europe (UNECE) on the formulation of rules aimed at ensuring safety when a driver does not respond to warnings. In order to realize Level 3 autonomous cars at an early stage it is essential to achieve the right balance between competition and collaboration, and close attention will be paid to how much presence Japan is able to display and whether or not it has a role to play. If Japan does show that it has a role to play, it is far from impossible that Level 3 autonomous cars could be realized in Japan in the Olympic year of 2020, and there would then be no doubt that Japan would be able to retain its leading role in the automotive industry. Accordingly, there is a need to play close attention to future developments around the world in the field of human-machine collaborative technology.