Issues and Measures for Smooth Traveling of Autonomous Driving Cars in Hilly and Mountainous Area

(Study period: FY2017 to FY2019)

ITSUBO Shinji (Ph. D.), Senior Researcher, IWASATO Yasuyuki, Researcher,
SEKIYA Hirotaka (Ph. D.), Head,
Road Traffic Department, Intelligent Transport Systems Division

key words: Michi-no-Eki, autonomous driving, demonstration experiment

1. Introduction

In the Second Term / Autonomous Driving (system and service expansion) of the Cabinet Office Cross-ministerial Strategic Innovation Promotion Program (SIP), the Ministry of Land, Infrastructure, Transport and Tourism ("MLIT") has been conducting demonstration experiments since FY2017 aiming for social implementation of autonomous driving service based on "Michi-no-Eki," etc. in order to secure the flow of people and goods in hilly and mountainous area, where the aging of people is growing. In fiscal 2017, the demonstration experiment was conducted at 13 locations in the country and then at additional 5 locations, so that the experiment was conducted at a total of 18 locations in the country.

2. Analysis for smooth autonomous driving

Provision of the autonomous driving vehicles to be used in the demonstration experiment was solicited from the public and four vehicles were chosen (Fig. 1 shows an example). These vehicles travel on the preset locus. When there is an obstacle on the road, such as a parked car, the vehicle detects it with a sensor and automatically stops or a person in the vehicle operates the steering wheel to avoid the obstacle, etc. Reducing the latter operation, called "manual intervention etc." will lead to realization of smooth autonomous driving. For this reason, NILIM analyzed the factors of manual intervention etc. and drafted countermeasures. This paper outlines them. Please refer to Reference 1 for details.

In analyzing manual intervention etc., we grasped the time, place, and factors of manual intervention etc. from the daily driving report, hearings from drivers, and checking with the images obtained from in-vehicle drive recorders.

"Vehicle to infrastructure cooperation type" technology
Travel on the fixed route by detecting magnetic force from the electromagnetic induction lines laid underground.

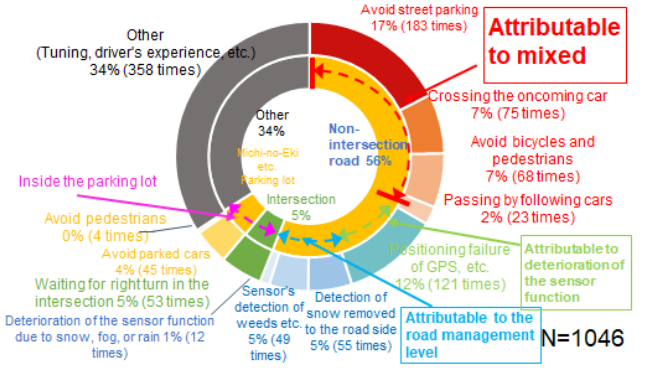
Capacity: 6 persons

Speed: about 12 km/h in autonomous driving
20 km/h in manual driving

Fig. 1 Example of the vehicle used for the experiment (cart type)

3. Results of analysis of manual intervention etc.

The following describes the situations of manual intervention etc. observed in 13 experiments conducted in fiscal 2017. Fig. 2 shows the breakdown of events where autonomous driving was interrupted by manual intervention etc. during traveling in the experiment.



* Results of the traveling distance of 1740 km except events such as an opening ceremony

Fig. 2 Situations of manual intervention etc.

According to Fig. 2, causes of manual intervention etc. are roughly classified into mixed traffic, deterioration of the sensor function, and level of road management. [1)]

The most common cause of manual intervention etc. was to avoid parked cars on the traveling road, as shown in Fig. 3.

Fig. 3 Cars parked on the traveling road.

There are also cases where the vehicle stops traveling when the vehicle sensor detects, as an obstacle, planting on the residential land along the road growing over the road or the road width narrowed by snow removal to the road side, and the person in the vehicle avoids such obstacles by manual driving (Fig. 4). This would suggest the necessity of securing proper road width and proper management level for smooth operation of autonomous driving.

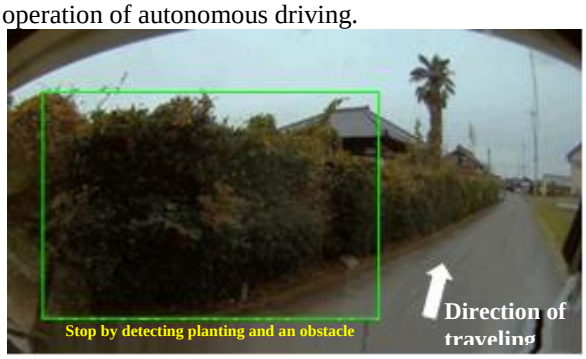


Fig. 4 Detection of planting as an obstacle

4. Drafting of countermeasures for decreasing manual intervention etc.

In the light of such situation of manual intervention etc., the following measures are considered necessary for smooth travelling of autonomous driving cars. [1)]

(1) Secure travelling space and set escape area.
(2) Improve the level of road management.
(3) Support the infrastructure of accident spot identification.

For example, for "(1) Secure travelling space," it is necessary to devise control of parking on the road, complete separation from the pedestrian flow line, etc. Fig. 5 shows an image of the measure using road marking. Additionally, it is necessary to make an escape space for autonomous driving cars so that following ordinary vehicles can smoothly pass by the autonomous driving car.

Fig. 5 Example of securing the travelling space

For "(2) Improve the level of road management," for the impact of planting on the residential land along the road or snow removal to the road side, it would be necessary to set up a road management level considering autonomous driving and set up a traveling position considering the time of snow removal or snowfall, in cooperation with local community. Particularly for snow removal, cooperation of residents along the road is indispensable since expense is required.

5. Conclusion

Based on results of this analysis and drafting of countermeasures by NILIM, an interim report of the workshop on road space responding to autonomous driving was prepared. [2)] In addition, in Kami-Koani-mura, a project for social implementation of autonomous driving service is progressing. We will continue to provide technical support for expansion of social implementation.

☞See the following for details.

1) The 60th Conference of the Committee of Infrastructure Planning and Management, No.7172 Analysis of issues and measures for autonomous driving in hilly and mountainous area through demonstration experiment
2) Interim report of the workshop on road space responding to autonomous driving https://www.mlit.go.jp/road/ir/ir-council/road_space/pdf/chu-matome.pdf