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Study of Road Facility's Application to Autonomous Driving

Takeki Ogitsu [1)] Yoshikazu Takahashi [2)] Chihiro Komine [3)]

1) Gunma University (4-2 Aramaki-machi, Maebashi City, Gunma 371-8510)
2) Nippon Paint Industrial Coatings Co. , Ltd.(4-1-15, Minamishinagawa, Shinagawa-ku, Tokyo, 140-8675, Japan)
3) Nippon Mobility Co., Ltd.(15F Maebashi Center Bldg., 2-13-11, Honmachi, Maebashi, Gunma 371-0023)

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In recent years, autonomous driving assistance sytems have been developed and some of them are already in the market. Autonomous driving systems, which complete almost all driving tasks, would be spread gradually from 2025, according to the roadmap by the government. Considering the trends, road infrastructure, as well as vehicles, would be required to be upgraded for the autonomous driving era.

This study is a basic research that enables the road easier to drive for machines, not only for human drivers. This paper firstly shows the concept that humans and machines co-exists, and then explains painting materials that would enhance reflectance of invisible lights. After that, a guardrail using the painting tool is proposed for the evaluation. Evaluation conditions and results are shown in this paper.

In the near future, almost all the vehicle driving tasks would be replaced to machines. Then future city infrastructure would require higher affinity to the machines, as well as humans. Though in the viewpoint of vehicle control, driving environment for machines and humans does not necessarily correspond. Humans use visible light region, while machines use invisible light region for recognition. So far, road facilities have been designed at visible light region, considering traffic safety and landscape, though the design would make machine recognition difficult due to assimilation to the surrounding environment. This study therefore proposes a technical approach to fulfill both needs of humans and machines. As the usecase, guard rails between vehicle and pedestrian road have the problem in the viewpoint of landscape of the city, thus the design is changing to be more human-friendly. Though for the machines, if the color would be changed to the one similar to the environment, the guard rails would become worse condition for recognition.

This study therefore proposes reflective paint for LiDAR, to enhance machine recognition by effectively reflecting radiation (905nm and 1550nm) used for the optical sensors. Visible lights can be seen by humans, and the reflection rate affects on the colors to be seen. On the other hand, as 905nm/1550nm radiation is invisible to the human eye, the reflection rate does not affect on the colors. Therefore, this technology makes it easier to be detected by LiDAR, while scarcely affects color recognition.

In this study, two types of guard rails are prepared to evaluate feasibility of the reflective paint for LiDAR. The one is painted by the proposed paint material, and the other is painted by general paint material. The difference of the two cannot be observed visually.

Experimental evaluations have been conducted using three on-board LiDARs equipped on the engine hood. The two guard rails are put vertically against the vehicle. Distance between the vehicle's front edge and center of the guard rails is 5, 15, 25, 50m. Fig.1 shows the point data. The LiDARs observed the shape of both guard rails in 5m and 15m, though the reflective paint for LiDAR shows higher reflection rate. In 25m, although the general paint is observed with collapsed shape, the proposed paint material shows enough reflection rate for recognizing the characteristics. And in 50m, the proposed paint material still has higher reflection rate, while the general paint cannot be seen clearly. From those results, in vertical direction, the proposed painting material can be recognized from at least 50m, and shows higher effect in recognition by autonomous driving systems or autonomous driving assist systems. Another evaluation shows high performance also in horizontal direction.

Toward the autonomous driving era, reflective painting for LiDAR is expected to be applied to road facilities that consists of the city infrastructure and to help enhancing safety of autonomous driving systems.

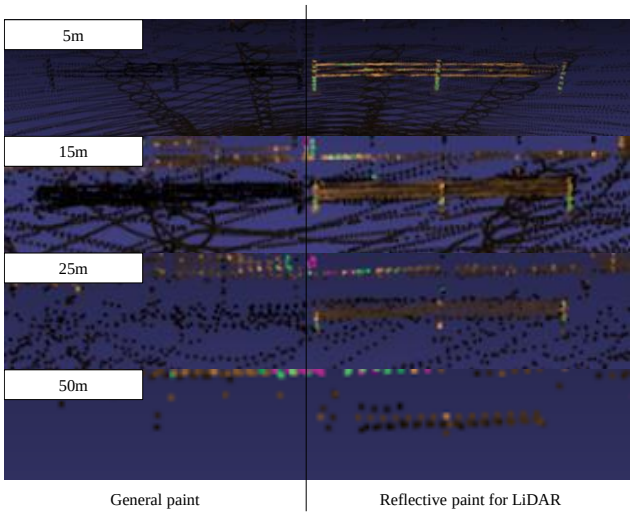

Fig.1 Evaluation result (vertical)