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Safety Enhanced Control of Automated Vehicles for Efficient Railway Level Crossing

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Abstract

In recent years, automated driving technology has improved, and in some regions in Japan, automated vehicles (AVs) are being operated to serve the public. However, unlike other countries, Japan has many railway-level crossings in both urban and rural areas, which poses an additional concern for safe AV operation as there are reported failing cases of gate non-closure during train crossings. Therefore, AVs need a system to pass through safely, ensuring no train is approaching even when the gate is open due to malfunctioning the sensing and operating systems. Furthermore, a level crossing often causes traffic bottlenecks since each vehicle must manually ensure safety as per mandatory traffic rules in Japan. This research investigates and summarizes various aspects of traffic flows at an existing railway-level crossing in Kiryu City, Japan, and proposes a safety-ensuring mechanism to enhance the traffic flows and alleviate congestion. Specifically, a camera-based online image processing mechanism for AVs is developed to detect the presence of any approaching or passing rail while driving at a low speed. If safety is ensured, an AV can pass the level crossing swiftly without a complete stop. Based on such an advanced safety ensuring system, we have shown that traffic flows on the model level-crossing at Kiryu are significantly improved, besides reducing fuel consumption, emissions, and vehicle idling time.

Keywords
Railway level crossing, automated vehicles, image processing, optimal control.

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