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CONNECTED AUTOMATED VEHICLES AND ITS

Enhancing Transportation Safety with Infrastructure Cooperative Autonomous Driving System

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Abstract
As self-driving cars become a reality, concerns about the safety guarantee of autonomous driving also increase. We propose an autonomous driving system that enhances its vision capacity by leveraging edge infrastructure. This proposed system involves autonomous vehicles participating in V2I broadcasting of the edge infrastructure, which supplies object perception information. The vehicles then form policies from this acquired information. These policies, defined within a set of constraints, enhance safety by impacting the trajectory of the autonomous vehicle. We implemented this system in both real-world and simulated environments. An aggressive scenario at an unsignalized intersection was also performed to evaluate the safety of the proposed system. The results showed that the edge infrastructure improved the safety speed by an average of 17% and averted collisions with objects moving at speeds lower than 25 kph. Therefore, our strategy for enhancing safety by expanding the field of view for self-driving vehicles is successful. The proposed system is expected to be highly utilized as it has an adaptable structure that can be easily expanded from existing autonomous driving systems and can consider various types of traffic participants.

Keywords ICAD system · Autonomous driving · Cooperative perception · V2I communication

Abbreviations

ADS	Autonomous driving system
CP	Conflict point
EPSG	European petroleum survey group
ICAD	Infrastructure cooperative autonomous driving
MDP	Markov decision process
MOT	Multiple object tracking
OBU	On-board unit
POMDP	Partially observable Markov decision process
RSU	Road side unit
SAE	Society of automotive engineers
SP	Safe point
TIM	Traveler information message
TTC	Time to collision
V2I	Vehicle-to-infrastructure
V2V	Vehicle-to-vehicle
V2X	Vehicle-to-everything

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Introduction

Safety is one of the most important factors that autonomous vehicles must achieve. Numerous studies have been conducted with the aim of ensuring this safety. One conventional strategy for enhancing safety is shared control between a human operator and an automated agent (Kim et al., 2023). In the fully autonomous driving approach, TiRL has demonstrated a reinforcement learning self-driving application that is more reliable than rule-based algorithms (Cao et al., 2022). Another method, InterFuser, achieved first place in the CARLA autonomous driving leaderboard by fusing multimodal sensor signals (Chen et al., 2023). However, these achievements have been confined to simulation environments.

Autonomous vehicles operating in real-world environments consider POMDP (Chia et al., 2022). In complex environments, problems such as object detection failure (Miao et al., 2022) and objects hidden from view often occur. To support studies on overcoming the field of view limitations, resources such as the surround-view fisheye camera dataset (Yan & Tabassum, 2022) and multiple vehicle sensor datasets (Jang et al., 2023) are provided. Since visibility is one