능동안전 II : 제어

레벨5 자율주행을 위한 5세대 이동통신 기반 다차량 원격 관제 시스템 구축

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Establishment of 5G-Based Multi-Vehicle Remote Monitoring System for Level 5 Autonomous Driving

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Key Words : Autonomous driving (자율 주행), Remote monitoring (원격 관제), Remote control (원격 제어), 5G (5세대 이동통신망)

ABSTRACT

This paper presents a fifth-generation mobile communication-based multi-vehicle remote control system for Level 5 autonomous driving. The system is designed to enable bi-directional communication between vehicles, a control room, and a remote control station, all centered around a server. With the system, vehicles can transmit sensor data, including cameras, LiDAR, and chassis, to the server, which can be monitored in the control room. Additionally, the control room can remotely set the destination and initiate the departure of autonomous vehicles. In an emergency situation, the remote control station can take over the control of the vehicle. Experimental verification of the system was conducted, and it demonstrates that the system can monitor multiple autonomous vehicles simultaneously and respond remotely in emergencies, contributing to the safety of Level 5 autonomous vehicles. This research is expected to play an important role in the commercialization of autonomous driving technology.

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첨단운전자지원 시스템 차로 유지 보조 상황에서 운전자 개입 시 발생하는 이질감 최소화를 위한 횡방향 협조제어 시스템 설계

명진희* · 허찬우** · 이득표*** · 고원식**** · 김규원*** · 우승훈***** · 신동훈******,†

Control of Cooperative Lane Following Assist System for Reducing Conflict Between Driver and Automation

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Key Words : Cooperative control(협조제어), Human-machine interaction(인간-기계 상호작용), Steering system conflicts (조향계 시스템의 상충), Controller scheduling(제어기 스케줄링)

ABSTRACT

This paper presents a control of cooperative lane following assist (LFA) system with a controller scheduling method that aims to minimize a conflict between a driver and an automation. The LFA system has been designed with a feedback controller to track the reference steering angle calculated using a vision sensor. In a manual driving mode, a motor driven power steering (MDPS) system based on a torque feedback controller has been implemented to reduce the driver workload by providing the assistance torque. When the driver intervenes with opposing intentions to the automation, the two feedback controllers (steering angle-based feedback controller of LFA and torque feedback controller of MDPS) conflict and cause some shimmy vibration. To alleviate this phenomenon, a feedforward controller has been incorporated into the torque feedback controller of the MDPS system to suppress the vibration resulting from the conflict between the driver and the automation. A transition time among controllers has also been investigated to ensure smooth control transition. The performance of the proposed algorithm has been evaluated via vehicle tests, and the results have been analyzed in two different sections: blending region and driver-take over moment. It has been shown that the proposed cooperative LFA system reduces the peak-to-peak value and the average jerk of the controller torque in both sections compared to the conventional LFA system.

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능동 공력 시스템을 위한 위상도 기반 차량 엔벨로프 제어기

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Phase-Portrait Based Vehicle Envelope Controller for Active Aerodynamic System

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Key Words : Aerodynamic system(능동 제어 시스템), Inverted wing(인버티드 윙), Air damper(에어 댐퍼), Bicycle model(자전거 모델), Brush tire model(브러시 타이어 모델), Phase-portrait(위상도), Envelope control(엔벨로프 제어)

ABSTRACT

This paper presents a phase-portrait based envelope controller for active aerodynamic (AAD) systems. The proposed algorithm is designed to improve lateral stability near the tire friction limits through an on-off control method for front air dampers and rear inverted wings by improving traction. The proposed controller consists of a convergence rate prediction model and selector. First, the convergence rate prediction model predicts the vertical forces for all possible on-off combinations for the aerodynamic system. These forces are then used to estimate lateral forces based on the brush tire model. This prediction is then utilized in conjunction with a 2-DOF bicycle model to predict the convergence speed for the vehicle's yaw rate for all possible control cases. Second, the selector decides whether the lateral state, consisting of the body slip angle and the yaw rate, matches the switching condition on the phase portrait. If the switching conditions are satisfied, an angle of attack for AAD system that showed the fastest convergence for yaw rate is chosen. The proposed approach proves to be advantageous in fast stabilization of the vehicle by considering the lateral stability of the vehicle itself rather than that of each tire. The proposed algorithm has been verified through computer simulation studies based on Carsim/Simulink. Simulation results show that the proposed system is capable of significantly reducing vehicle side-slip angle and increasing yaw rate responsiveness

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5세대 이동통신망을 이용한 저지연 자율주행 차량 원격 제어 방법

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Low-Latency Remote Car Control Method Using 5G Wireless Communications

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Key Words : 5G(5세대 이동통신망), Remote control (원격제어), Autoencoder(오토인코더), Video interpolation(영상 보간)

ABSTRACT

This paper presents the development and implementation of a remote-control system and algorithm for Level 5 autonomous vehicles in hazardous situations, utilizing the 5G mobile communication network. The proposed system features an AI-based interpolation algorithm for video streams, ensuring a consistent video frame rate that provides remote driving operators with a stable sense of speed, contributing to enhanced driving safety. By incorporating the system into urban Level 5 autonomous vehicles, we demonstrate its practicality and effectiveness through experiments in which vehicles autonomously request remote control upon encountering dangerous or malfunctioning situations, successfully transferring control to a safe zone. we expect our findings showcase the potential of the proposed remote-control system to not only improve the overall safety of autonomous vehicles but also serve as a valuable complementary tool for handling hazardous situations that Level 5 autonomy might face, highlighting the importance of further exploration and development of such systems.

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