능동안전(제어) III

자율주행 버스의 주행 안전 개선을 위한 V2V 통신 및 모델 예측 제어 기반 종 방향 거동 계획

조아라* · 유진수** · 곽지섭** · 권우진** · 이경수***,†

Proactive Longitudinal Motion Planning for Improving Safety of Automated Bus using Chance-constrained MPC with V2V Communication

Ara Jo*, Michael Jinsoo Yoo**, Jisub Kwak**, Woojin Kwon**, Kyongsu Yi***,†

Key Words : Longitudinal Motion Planning(종 방향 거동 계획), Chance-constrained MPC(기회 제약 모델 예측 제어기), V2V Communication(V2V 통신)

ABSTRACT

This paper presents a proactive longitudinal motion planning algorithm for improving the safety of an automated bus. Since the field of view (FOV) of the autonomous vehicle was limited depending on onboard sensors' performance and surrounding environments, it was necessary to implement vehicle-to-vehicle (V2V) communication for overcoming the limitation. After a virtual V2V-equipped target was constructed considering information obtained from V2V communication, the reference motion of the ego vehicle was determined by considering the state of both the V2V-equipped target and the sensor-detected target. Model predictive control (MPC) was implemented to calculate the optimal motion considering the reference motion and the chance constraint, which was deduced from manual driving data. The improvement in driving safety was confirmed through vehicle tests along actual urban roads.

* 서울대학교 미래혁신연구원/박사후연구원
** 서울대학교 공과대학 기계공학부/박사과정
*** 서울대학교 공과대학 기계공학부/교수
† 교신저자 : kyi@snu.ac.kr
E-mail : arajo@snu.ac.kr

횡방향 안정성 제어를 위한 동적 캠버 시스템 모델링

한창희* · 차현수** · 김자유*** · 이경수****,†

Active Camber System Modeling for Lateral Stability Control

Changhee Han*, Hyunsoo Cha**, Jayu Kim***, Kyongsu Yi****,†

Key Words : Active camber system(동적 캠버 시스템), Variable camber suspension (가변 캠버 시스펜션), Actuator modeling (엑츄에이터 모델링)

ABSTRACT

This paper presents an active camber system modeling for lateral stability control. The proposed active camber system modeling consists of a wheel geometry model, a suspension mapping model, and suspension geometry model. Firstly, the wheel geometry model is devised to describe the change of camber angle due to the vehicle roll angle and tire spring compression. Secondly, the suspension mapping model shows the camber angle change that comes from the wheel stroke variation. Thirdly, using the additional camber angle from the wheel geometry model and suspension mapping model as an input variable, the suspension geometry model reflects the influences of camber angle change on the vertical force at each tire. Lastly, the modified tire model input variables are transferred to the tire mapping model to generate the lateral motion of a vehicle. The integrated active camber system has been evaluated based on the vehicle test data measured from a suspension parameter measure device. The evaluation results show that the proposed active camber system model can successfully describe the vehicle response of an actual test vehicle.

* 서울대학교 기계공학부/석사과정
** 서울대학교 기계공학부/박사과정
*** 서울대학교 기계공학부/박사과정
**** 서울대학교 기계공학부/교수
† 교신저자 : kyi@snu.ac.kr
E-mail : chhan9@snu.ac.kr

실시간 시뮬레이션 환경을 이용한 자율주행 차량의 종 방향 제어 알고리즘 검증

이희성* · 사공성표* · 이경수**,†

Validation of Longitudinal Control Algorithm of Autonomous Vehicles using Real-time Simulation Environment

Heeseong Lee*, Sungpyo Sagong*, Kyongsu Yi**,†

Key Words : Autonomous driving (자율주행), Longitudinal control (종 방향 제어), Hybrid MPC (하이브리드 모델 예측 제어기), Real-time simulation (실시간 시뮬레이션)

ABSTRACT

This paper presents a longitudinal control algorithm of autonomous vehicles using hybrid MPC, and verifies it with simulator. The proposed algorithm is designed to maintain an appropriate distance from the preceding vehicle to ensure safety, and increases computing efficiency by turning on or off the clearance maintenance function depending on the presence or absence of the preceding vehicle, respectively. The algorithm is executed on ROS environment, and control outputs are transmitted to the vehicle through ROS-bridge interface. CARLA, which is a real-time open-source simulation platform is used to validate the performance of the algorithm. In the simulation environment, the performance was tested with Tesla model3 by configuring following three scenarios: 1) Path tracking, 2) Clearance control, 3) Static target, and the results show that the algorithm ensures safety. Also, the parameters tuned in the simulation show similar behavior in actual vehicle experiment.

* 서울대학교 공과대학 기계공학부/석사과정
** 서울대학교 공과대학 기계공학부/교수
† 교신저자 : kyi@snu.ac.kr
E-mail : heesungsung@snu.ac.kr

현가장치 모델 예측 제어를 위한 카메라 정보 기반 방지턱 형상 최적 회귀 알고리즘 개발

이태훈* · 김자유* · 이경수**,† · 김철중***

Development of an Optimal Bump Profile Regression Algorithm based on Camera Information for Model Predictive Suspension Control

Tae Hoon Lee*, Jayu Kim*, Kyongsu Yi**,†, Cheol Joong Kim***

Key Words : Optimal Fitting(최적피팅), Model Predictive Control(모델 예측 제어), Vehicle Suspension(차량 현가장치), Road Preview (도로 프리뷰), Half Car Model(반차량 모델)

ABSTRACT

This paper presents the development of an optimal bump profile regression algorithm based on camera information for model predictive suspension control. With the ever-growing trend in utilizing environmental sensors in vehicles, the mono-camera has shown to be a cost-effective method in recognizing road elevations ahead of the vehicle. However, as all components are, data accuracy comes as a trade-off to reductions in cost. Furthermore, application of model-based filtering methods, such as the Kalman Filter, prove to be extremely difficult for road information as no accurate model currently exists. In this paper, an optimal bump fitting method has been developed to better estimate the shape of bumps based off raw camera information. The algorithm utilizes standard bump shaped regulated by the Ministry of Land, Infrastructure and Transport of South Korea, which is then resized to optimally fit the obtained camera information. Camera information has been accurately mimicked through the addition of normally distributed random noise, with a sampling time of 50ms. The effectiveness of the proposed algorithm has been validated via a model predictive suspension control simulation study using MATLAB/ Simulink. Results of the simulation has shown that the proposed algorithm was able to give significant reductions in the vertical acceleration of the vehicle as compared to that of raw camera data.

* 서울대학교 공과대학 기계공학부/학생
** 서울대학교 공과대학 기계공학부/교수
*** 현대모비스 전자현가제어셀/책임연구원
† 교신저자 : kyi@snu.ac.kr
E-mail : tae.hoon.lee@snu.ac.kr