알고리즘 I

온톨로지 기반 시나리오 데이터 베이스와 대리모델을 활용한 테스트 시나리오 생성 및 위험 시나리오 탐색

이세민* · 정선암** · 송봉섭***

Critical Scenario Identification Using Ontology Based Scenario Database and Surrogate Model

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Key Words : Ontology(온톨로지), Surrogate Model(대리 모델), Gradient Descent(경사하강법), Critical scenario Identification(위험 시나리오 탐색)

ABSTRACT

In this paper, we propose a process of critical scenario identification for the longitudinal control algorithm of autonomous vehicles by searching ontologies that represent scenarios stored in a NoSQL database. Then, based on quantitative risk metrics derived from test results, we construct surrogate models to search critical scenarios. Testing the safety of autonomous vehicles through real world road tests requires hundreds of millions of miles of verification, and it is difficult to encounter rare events. Simulation based testing, on the other hand, can generate a significant amount of data but suffers from the curse of dimensionality, leading to excessive and unnecessary data. Towards solving these issues, scenario-based validation methodologies have emerged, and they are being used in autonomous vehicle verification and development by searching critical scenarios. Autonomous vehicle test scenarios are categorized into functional scenarios, logical scenarios, and concrete scenarios based on their level of abstraction. To generate concrete scenarios in a simulation environment, various scenario factors must be considered. These factors include static object information such as road curvature, the presence of intersections, and dynamic object information such as vehicle behavior, position, speed, and acceleration. These concrete scenario factors can valuable not only for post simulation hazard analysis but also for scenario generation itself.

In this study, we selected the Intelligent Driver Model as the testing algorithm which determine the desired acceleration of a vehicle based on the speed and position of preceding vehicle. To create a test suite, we retrieved various files for testable scenarios from a NoSQL database and subsequently simulated each of these scenarios. Finally for each specific scenario, we compute the minimum Time to Collision(TTC) from the simulation results, following that, we trained a surrogate model using this data and employ gradient descent with the trained surrogate model to search critical scenarios within the testing scope.

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고속도로 주행 시 딥러닝 기반 다중 차량 인식 알고리즘에 대한 기초연구

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A Preliminary Study on Deep Learning-Based Multiple Vehicle Recognition on Highway Driving

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Key Words : Vehicle Recognition(차량 인식), Deep learning(심층 학습)

ABSTRACT

This study focuses on advancing the development of driving assistance systems, particularly those progressing towards autonomous vehicles, by adopting a data-driven approach. To achieve this, we require advanced technologies for gathering extensive time series data from real-world driving scenarios and the ability to automatically pinpoint and track primary target vehicles for each lane, based on the reference vehicle. In our research, our primary goal is to identify and track three vehicles in front, two vehicles on each side, and three vehicles behind the reference vehicle in each lane. For the front vehicles, our aim is to identify the closest vehicle in the same lane, the left lane, and the right lane. Similarly, for the rear vehicles, we seek to identify the nearest vehicles in these lanes. For adjacent flacking vehicles, we focus only on identifying those to the left and right. Typically, vehicle recognition algorithms in this context have been rooted in physics-based principles, employing factors like lane curvature and the relative positions, speeds, and accelerations of other vehicles. However, there has been a limited adoption of deep learning approaches for this purpose.

In this research, we propose a multi-vehicle identification algorithm designed for highway scenarios. We leverage YOLO-NAS, a convolutional neural network (CNN), and introduce an abstracted semantic map as input. Consequently, we are working towards developing a deep learning network-based method for multi-vehicle identification, utilizing semantic maps. These maps encompass not only vehicle information like position, orientation, speed, and acceleration but also lane details. Our objective extends to comparing the performance of our deep learning approach with existing physics-based algorithms. Finally, we present the results of multi-vehicle identification in a structured JSON format, which serves as a comprehensive database, enabling exploration of the time series data concerning the driving environment and the behavior of multiple vehicles.

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시계열 데이터 기반 학습 데이터 구축 및 탐색을 통한 차량 검출 네트워크 성능 제고 연구

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A Study on Improving Vehicle Detection Network Performance Through Time-Series Data-Based Training Data Construction and Exploration

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Key Words : Deep learning(심층 학습), Vehicle detection(차량 검출), Data driven(데이터 기반), Lidar(라이다)

ABSTRACT

This paper introduces a training data exploration method to enhance the vehicle detection performance of a lidar-based detection network designed for autonomous driving. The performance of deep learning-based object detection networks depends on the variety and amount of training data. In general, the expansion of training data increases the training time of the network. Therefore, an efficient training strategy is needed, and one of the most popular learning strategies is transfer learning. To efficiently extract datasets for transfer learning, behaviors related to vehicles and road geometries were chosen as events. The datasets are categorized based on these events, and the vehicle detection performance is evaluated for each categorized dataset. Through this evaluation, weaknesses in the existing dataset can be identified, and datasets specified by these events are extracted for use in transfer learning. the proposed method aims to efficiently explore and acquire training data based on events and apply them in transfer learning.

The training data exploration method consists of three steps. First, the vehicle detection network is trained using public datasets and categorized based on data events, which are then evaluated using mean Average Precision (mAP). The data event referred to the behavior of the vehicle based on the Ego vehicle(Vehicle Maneuver) and road geometries. Second, among the mAP results for data events, search the database for data with the same event as the data used for training with poor detection performance. Third, transfer learning is performed using the dataset obtained through exploration in the database. Finally, the performance of the vehicle detection network is compared with the results of transfer learning using a dataset containing the same number of samples randomly selected.

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SVM 기반 위험도 평가를 활용한 후방 접근 차량 충돌 방지 알고리즘 개발

곽제우* · 정용환**

Development of a Rear Approach Vehicle Collision Prevention Algorithm Using SVM-Based Risk Assessment

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Key Words : RBF kernel SVM(방사 기저 함수 커널 서포트 벡터 머신), Anti-RVC(후방 자동차 추돌 방지), V2V communication(차량 대 차량 통신), Lane Keeping Strategy(차선 유지 전략), Lane changing strategy(차선 변경 전략)

ABSTRACT

The Anti-Rear Vehicle Collision (Anti-RVC) algorithm introduced in this paper represents a novel approach to collision avoidance, focusing on preventing collisions with vehicles approaching from the rear. The proposed Anti-RVC algorithm is designed to proactively avoid collisions with vehicles approaching from behind, introducing a unique approach to collision avoidance. The proposed algorithm prioritizes the assessment of risks posed by vehicles accelerating behind the ego vehicle. To estimate the potential danger, the algorithm employs an RBF kernel Support Vector Machine (SVM) using data on relative distance, relative velocity, and relative acceleration between the rear vehicle and the ego vehicle. If the algorithm predicts a risk from a rear-approaching vehicle, the Anti-RVC can employ two primary strategies: lane-keeping and lane-changing. The lane-keeping strategy comes into play when the front clearance of the ego vehicle exceeds the desired clearance of Adaptive Cruise Control (ACC). In this scenario, the ego vehicle accelerates to match the velocity of the rear vehicle. On the other hand, the lane-change strategy is employed when the front clearance falls below the desired clearance of ACC. The Anti-RVC calculates whether the lane change can be executed safely by evaluating the lane change safety distance. If the safety distance is not met, the ego vehicle drives at a weighted average speed between the rear vehicle and the forward vehicle. If the safety distance is met, the ego vehicle proceeds with the lane change. The proposed Anti-RVC system has been verified through co-simulation with SUMO under highway conditions. Simulation results showed the collision prevention of the proposed algorithm on rear approach vehicles.

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자율주행 차량의 사용자 지정 목적지 라우팅을 위한 휴먼-머신 인터페이스 구축

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Establishment of Human-Machine Interface for Custom Destination Routing in Autonomous Vehicles

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Key Words : Autonomous driving (자율 주행), Destination routing (목적지 경로 계획), Human-Machine Interface (휴먼-머신 인터페이스)

ABSTRACT

As autonomous driving technology continues to advance, there is a growing need to transition from fixed routes to user-defined destinations, allowing passengers to set their preferred routes for autonomous vehicles. In response to this demand, we have developed a robust human-machine interface (HMI) that leverages both in-vehicle and external server resources to facilitate seamless communication between users and autonomous driving systems. The conventional approach to autonomous driving predominantly relied on pre-programmed routes and maps, limiting the flexibility for passengers to select their desired destinations. In contrast, our research endeavors to empower passengers with the ability to define their route preferences using a tablet-based interface, thereby enhancing the user experience and making autonomous driving more intuitive and accommodating. This paper presents the technical details of our HMI architecture, including the connection between autonomous driving system and servers, and emphasizes the importance of security, data privacy, and real-time communication between the vehicle and servers.

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