커넥티드 자동차의 교통신호 제어를 위한 게임이론 기반 협상전략 수립: 선행연구

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Towards Game-Theoretic Negotiation for Traffic Light Control on Connected Cars: Preliminary Study

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요 약

본 연구에서는 커넥티드 자동차(Connected Car, ConnCar)의 주행 효율 향상을 위한 교통신호 제어에 초점을 맞추고 있다. 이를 위한 세부 연구 범위는 다음과 같다. i) ConnCar 간의 상황 정보 공유, ii) 게임이론 기반의 협상을 통한 의사결정

ABSTRACT

In this study, we take into account in improving traffic flow in real-time problem. In order to solve the problem, we propose a new approach to manage traffic flow at the intersection in real-time via controlling by traffic light scheduling. In particular, the proposed method is based on process synchronization theory and connected vehicle technology where each vehicle is able to communicate with others. The traffic deadlock is also taken into consideration in case of high traffic volume. The simulation shows the potential results comparing with the existing traffic management system.

키워드

Connected vehicles, Game theory, Negotiation, Internet of things.

Ⅰ. 서 론

사물인터넷(Internet of Things) 기술 기반의 커넥티드 자동차(Connected Car, ConnCar) 연구와 관련한 다양한 이슈가 대두되었다. 기본적으로 ConnCar는 서로간의 상황 정보 공유를 통하여 주행 효율 향상을 위한 의사결정이 가능할 것으로 보인다. 이를 위하여 본 연구에서는 지능형 교통신호 제어 최적화를 위한 ConnCar 통신을 통한 게임이론 기반 협상 모델(Game-theoretic negotiation model)을 제안하고자 한다.

이와 같은 게임 이론은 게임에 참여(Players)하는 모든 ConnCar들이 가장 이성적인 판단을 한다는 전제하에 최대의 보상(Payoff)을 얻을 수 있는 평형 상태(Nash equilibrium)에 수렴하는 전략을 찾는 것이다.

우선 ConnCar들간의 게임의 유형을 다음과 같이 분류할 수 있다.

* Players의 유형
  - Negotiation between vehicles (distributed approach)
  - Negotiation between infrastructure and vehicles (centralized approach)
* 협업 유형
  - Cooperative negotiation

- Competitive negotiation

II. 게임이론 기반 협상을 통한 최적화 전략

In connected vehicle concept, the vehicles can be identified based on their ID (e.g., the plate number of the vehicle). The vehicle communicate with infrastructure (V2I) and other vehicles (V2V) under the ID as the address.

Each vehicle is equipped the positioning system (VPS) to determine its location.

In this regards, the traffic management system which located in the intersection is able to get the information of vehicles in term of their location and directions when they move into the intersection area.

It shows the architecture of the traffic connected-vehicle at intersection. Sensors are developed in each path to determine the vehicles move into the simulation area which follow a certain random distribution [1].

The wireless communication devices (Cellular Base Station) are designed in the intersection to enable the communications between vehicle and others. We assume that the transmission range of wireless devices are able to cover all of the intersection area. Moreover, the wireless channel is FIFO channel, it means the traffic management system will receive the request from vehicles as FIFO model [2].

As we mention above, the existing approaches for management traffic flow at intersection still have some problems, especially in case of high traffic volume such as traffic congestion, the large number of waiting vehicles in queue lanes, and vehicle crash at intersection because of conflict directions of vehicles. In this paper, we propose a new approach to deal with those problems based on recent advanced vehicle technologies.

The idea of the proposed approach based on synchronization theory. In computer science, process synchronization refers to the idea that multiple processes are to join up at a certain point, in order to reach an agreement or commit to a certain sequence of action. This approach can use for controlling the traffic flow at intersection when multiple vehicles pass the intersection at the same time. It shows the interaction between vehicle and controller for passing the intersection of vehicle. By this way, when a vehicle want to pass the intersection, they have to send a request to the controller. Based on the traffic flow at intersection, the controller will reply the permit passing message to vehicle or put the request in the pending list, and the vehicle have to wait until receive reply from controller.

After passing the intersection, the vehicle has to send the release message to Controller. The algorithms for this process are proposed in below.

III. 결 론

In this paper, inspired of advanced vehicle technologies, we introduce a new approach for real-time management the traffic flow based on process synchronization approach. In this regards, when the vehicle passes into the intersection area, they can communicate with others to avoid the conflict between them, so that they are able to improve their waiting time in case of high traffic flow. Moreover, in this work, we also propose a new algorithm for avoiding the traffic deadlock which was not considered in existing systems. The results show that our approach can reduce the waiting time of vehicles when they pass into the intersection. The proposed system is feasible and flexible for development based on advanced vehicle technologies. However, to implement in reality where there have various shapes of intersections. In this regards, for our future works, we are interested to extend the model to the multiple crossroads e.g. multiple intersections, roundabout-intersection model and so on.

참고문헌

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