A multi-AI-agent framework for vehicle-infrastructure integration and electric vehicle robust charging

Developing a novel multi-AI agent communication and charging system

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$80,000

Transportation systems (fossil fuels in particular) are responsible for over 25% of greenhouse gases (CO_2 emissions) in the U.S. in 2015. Under the Clean Air Act, states are now starting to adopt California's Zero Emission Vehicle (ZEV) regulations. This has led to a rise in electric vehicles (EVs). In addition to the pollution caused by fossil fuels, the transportation system itself has the potential to greatly reduce emissions and energy use by reducing congestion. Traffic congestion not only causes travel delays but also raises fuel consumption and emissions production. A major reason for congestion in urban areas is traffic accidents. The major factor in over 90% of all fatal crashes is human error. Currently, traffic cams and video surveillance are some ways used to monitor traffic. However, this is expensive and useless to travelers. New technologies, such as vehicle to infrastructure (V2I) and vehicle to vehicle (V2V) communication, can greatly lessen congestion. This communication allows real-time congestion detection, which results in quick rerouting of traffic and a more efficient transportation network. Wireless communication technology will enable this and will allow users to make better decisions regarding the transportation system. In this predicted transportation infrastructure, vehicles can communicate with other vehicles, traffic control units, and traffic management centers to make efficient trip decisions. Communication will reduce traffic congestion and help in fast EV charging, saving money. Developing a practical management system that maximizes the limited EV charge stations presently available is critical for transportation infrastructure agents and utility companies to deliver optimal service to travelers.

Problem Statement

Artificial intelligence (AI) brings great benefits to road transport as it can make traffic more efficient and ease congestion while improving air quality, urban planning, and road safety. This section will survey the different AI approaches studied in literature in transportation area and in optimizing emission vehicle (EV) charging and reducing traffic congestion. Algorithms and mechanisms have developed to route EVs to minimize energy loss and maximize energy harvested during a trip. Algorithms for routing EVs to charging stations where there is less congestion exists, considering drivers' destination and amount of electricity to charge were also proposed. Methods have also been developed to schedule and control the charging of the electric vehicles which corresponds to grid-to-vehicle scenario; so that peaks and potential overloads of the electricity network can be avoided, whilst minimizing electricity cost. These areas will be studied in the project and used to develop the proposed multi-AI agent management system.

Figure 1: Vehicle-infrastructure integration

Objectives

The goal of this project is to develop a novel multi-AI agent communication and charging system where traffic control units, traffic management centers, EV charging stations, utility companies, and EVs are AI-powered agents capable of making smart decisions based on real-time traffic conditions. This proposed management system will perform two functions: 1) control traffic congestion, 2) enable robust EV charging. In the first task, the traffic control units will monitor the traffic and provide real-time information to both traffic management centers as well as the EVs. Concurrently, the traffic management centers - AI agents will provide traffic-rerouting options to the EV agents and traffic control commands to the traffic AI-control units. The EV agent can then

select the best route. In the second task, the utility-AI-agent determines the charging station's pricing based on the dynamic demands from EVs at different charging stations, the available charging slots, and potentially real-time local and city-wide power consumption. At the same time, an EV-AI-agent selects the location of a station and charging time slot based on pricing and charging levels of the station, its battery power, acceptance rates and distance to the station, and real-time traffic data.

Intended Implementation of Research

Education and Workforce Development: Graduate students will be able to learn about this research project by integrating the results into graduate level courses.

Outreach: Recruit and engage students from underrepresented groups including Hispanic, Native-American and women (half of the undergraduate population in UTSA are Hispanic and other minority students).

Anticipated Impacts/Benefits of Implementation

The main deliverables from this study are: (1) quarterly reports and a final report containing implementation procedures, data, and results; (2) presentations will be given at annual national conferences

Web links

- Tran-SET's website https://transet.lsu.edu/research-in-progress/

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.