Combining Virtual Reality and Machine Learning for Enhancing the Resiliency of Transportation Infrastructure in Extreme Events

Developing a framework that combines virtual reality with preexisting traffic data to aid transportation infrastructure during extreme weather events

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$60,000

Extreme weather events often result in the failure of certain links of a road network. This puts regular drivers of the area in a new route choice decision-making context when traveling between any given origin and destination. For example, a driver in Denham Springs heading to LSU may not be aware that a portion of I-12 is flooded and thus may not know the alternate routes to consider. But as the situation unfolds and the driver runs into a road closure situation, it puts him/her in a choice context where many factors are evolving in real time. For example, many dynamic and emergent contextual conditions such as remaining time for travel, area familiarity, personality traits (risk-taking or risk averse), and the proximity to nearest alternative routes constitute a decision-making environment that is very different from when the driver starts driving. A better understanding of factors influencing the driver's impromptu decisions and messages delivered to drivers for optimizing road network conditions are crucial to managing traffic flow in the road network.

Problem Statement

Route choice models are the spine of traffic management systems. High Fidelity models that are based on rapidly evolving contextual conditions that can greatly impact smart, energy efficient transportation. Existing route choice models are generic and are calibrated using static contextual data. These models do not consider dynamic contextual conditions such as dynamic travel time, accessibility to nearest freeways, traffic incidents, and emergency road closure. Consequently, they can only predict at aggregate levels and for a generic set of contextual factors (even when they predict at disaggregate level). There is a clear need to develop route choice models that consider local contexts and are closer to ground reality to allow government agencies to make well-informed model-based decisions and policies.

Objectives

The objective of this study is to draft a novel context-aware framework that integrates virtual reality with causal machine learning to enhance our understanding about driver's decision-making in relation to route selection and prediction of roadway congestion in extreme events. The overarching aim of this study is to develop a robust computations/analytic framework that integrates causal machine learning-based models with virtual reality to improve the predictions of existing models for traffic routing and resource allocation and deployment of resources (sensors, personnel, etc.) by taking into account contextual variables regarding human interaction with highway infrastructure. The proposal brings together an multidisciplinary team that will capture time and context-sensitive traffic data and use it to develop and field-test new context-aware parameterized models for smarter, resilient, energy-efficient traffic management.

Intended Implementation of Research

Education and Workforce Development: The PIs will conduct the following education and workforce development activities.

1) Involve, engage, and interact with undergraduate students in research initiatives related to the proposal. In the past, the PI has been successful in attracting excellent undergraduate students to the research program. One such student received a Goldwater Scholarship while another two received honorable mentions in the annual CRA Undergraduate Research Award Competitions.

2) The PI will organize a study group (Traffic Prediction Study Group) that will include both undergraduate and graduate students meeting weekly to discuss and present recent papers in VR and machine learning applications in traffic management.

3) Developing new courses as well as revising existing course content with technical research proposed. The PI created and teaches an undergraduate course titled "Autonomous Vehicles" course (ENGG 4200) at LSU. Research results from the project will be incorporated in the material of this course.

4) Involve graduate and undergraduate students in the research. A Ph.D student and an undergraduate student (volunteers) will be involved in the project. The project will supply the thesis topic for the PhD student.

5) The PIs will attempt to recruit women and minority groups for both undergraduate research opportunities and graduate research assistantships.

Outreach: The prediction system will be displayed on a poster explaining it and will be showcased at the Glasgow Middle School as well as at Southern University (HBCU) and Baton Rouge Community College (BRCC).

Anticipated Impacts/Benefits of Implementation

The main deliverables of the research will be a more economical and energy-efficient, commuter-friendly, and intelligent traffic management system that will be able to handle extreme events efficiently and allow government agencies to make better-informed, model-based decisions. The main deliverables of this project are 1) a final report containing the problem, procedures, data, and recommendations 2) journal publications and presentations to be given at conferences.

Figure 1: Driving simulator

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

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.