Real-Time Work Zone Traffic Management via Unmanned Air Vehicles

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19ITSOSU01

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Principal Investigator(s):
Charles Malveaux
Louisiana State University
cmalve2@lsu.edu
Marcio de Queiroz
Louisiana State University
Mdeque1@lsu.edu
Xin Li
Louisiana State University
xinli@lsu.edu
Hany Hassan
Louisiana State University
Hassan1@lsu.edu

Lead Institution:
Louisiana State University

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$79,991

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Tran-SET
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$81,330

Utilizing an unmanned air vehicle (UAV)-based remote sensing system to minimize highway work zone accidents and traffic flow impacts.

Highway work zones are prone to traffic accidents when congestion and queues develop. Vehicle queues can expand at a rate of 1 mile every 2 minutes. Back-of-queue, rear-end crashes are the most common type of work zone crash, endangering the safety of motorists, passengers, and construction workers. The dynamic nature of queueing in the proximity of highway work zones necessitates traffic management solutions that can monitor and intervene in real time. Fortunately, recent progress in sensor technology, embedded systems, and wireless communication coupled to lower costs are now enabling the development of real-time, automated, "intelligent" traffic management systems that address this problem.

The goal of this project is to introduce and prototype a hybrid (fixed-wing and multi-rotor) unmanned air vehicle (UAV)-based remote sensing system that provides real-time traffic monitoring with high temporal and spatial resolution. The UAV-based system will dynamically manage work zone safety and traffic mobility challenges by interacting in real time with changeable message boards, motorist cellphones, traffic management center, and law enforcement personnel. The main tasks of the proposed system will be to collect traffic data via the UAV camera, analyze data to detect congestion and back-of-queue information, and alert motorists of stopped traffic conditions, delay times, and alternate route options.

Problem Statement

Data shows that the risk of traffic accidents increases when traffic congestion and queues develop in highway work zone areas. The risk of accidents becomes even worse in areas with speeds in excess of 50 mph. Restricted views of the road ahead caused by surface and road features such as hills, and curves along other obstructions can make it hard for motorists to anticipate traffic slowdowns and react accordingly in order to avoid accidents. This contributes to a high number of back-of-queue, rear-end crashes which are the most common type of work zone crash. Finding a way to provide early warnings to motorists, road workers, and emergency personnel to help avoid crashes due to workrelated traffic slowdowns is essential to increase highway work zone safety.

Queuing occurs when traffic demand exceeds the capacity of the roadway. Once queuing occurs, the resulting traffic blockage expands from the site of incidence at a rate of up to 40 miles per hour. This translates to 1 mile of added length for every 2 minutes of queuing. The dynamic nature of highway queueing in the proximity of work zones necessitates traffic management solutions that can monitor and intervene in real time. Fortunately, recent progress in sensor technology, embedded systems, and wireless communication coupled to lower costs are now enabling the investigation of real-time, automated, "intelligent" traffic management systems that address this problem.

In recent years, the use of technology to improve work zone safety has received considerable attention by some state departments of transportation. Among the technology applications are realtime traveler information, queue warning, dynamic lane merge, incident management, variable speed limits, automated enforcement, and entering/exiting construction vehicle notification. However, no unmanned air vehicle (UAV)-based system has been specifically implemented or discussed for work zone traffic management.

Objectives

The goal of this project is to introduce and prototype an unmanned air vehicle (UAV)-based remote sensing system that provides real-time traffic monitoring with high temporal and spatial resolution. Unlike induction loops, overhead radars, and fixed cameras, which are commonly used to monitor traffic and are limited to static point measurements, the UAV provides mobility and range to the monitoring system. The UAV-based system will dynamically manage work zone safety and traffic mobility challenges by interacting in real time with changeable message

boards, motorist cellphones, traffic management station, and law enforcement personnel. The main tasks of the proposed system will be to collect traffic data via the UAV camera, analyze data to detect congestion and back-of-queue information, and alert motorists of stopped traffic conditions, delay times, and alternate route options.

Intended Implementation of Research

Education and Workforce Development: The project will provide the participating graduate student with hands-on experience in UAV systems for traffic management applications. We plan to develop a drone technology professional development course/certificate in partnership with the LSU Office of Digital and Continuing Education. The course will target professionals interested in learning how to design and operate drones for different fields of application, e.g., transportation, construction, environment, entertainment. Finally, the technical results will be disseminated at conferences such as the Intelligent Transportation Society of America Annual Meeting and the National Work Zone Management Conference and submitted to journals such as the Journal of Intelligent Transportation Systems and the IEEE Transactions on Intelligent Transportation Systems.

Outreach Activities: Our outreach plan will seek to promote the participation of under-represented groups in STEM education by targeting two local high-schools that serve such students. First, Lee High School is a public school in Baton Rouge with a high percentage of African American students. Its new, state-of-the-art campus is the first STEM-focused, public school in Baton Rouge. The second school is Saint Joseph's Academy, an all-girls high school in Baton Rouge. We will recruit one student from each school to assist with certain aspects of the project. The students will be recruited from each school's Robotics program (course or club).

Anticipated Impacts/Benefits of Implementation

Actual impacts/benefits of implementation or to be determined.

Web Links

- TranSET's website (https://transet.lsu.edu/research-in-progress/)
- TRB's Research in Progress (RIP) database (https://rip.trb.org/View/1642182)

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 Mr. Christopher Melson (Tran-SET Program Manager) directly at transet@lsu.edu.