2019 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is <u>Feb. 6, 2019</u>. Submit statements to UTRAC@utah.gov. ******

Title: Prepare Utah for Demonstrating Connected Automated Vehicles on Arterials **No. (Office Use):** 19.03.11

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Select <u>ONE</u> Subject Area
- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Structures/Geotech
- ☐ Planning
- ☐ Perf Mgmt/Data Analytics
- ☐ Public Transportation
- ☐ Other

1. Describe the problem to be addressed:

With recent advancements in communication and vehicle automation technologies, connected automated vehicles (CAVs) provide new definitions of next generation intelligent transportation systems (ITS). The Utah Department of Transportation (UDOT) has been recognized as a leading state government implementing CAV technologies. For example, UDOT has built a full Dedicated-Short-Range-Communications (DSRC) corridor for connected vehicle (CV) technology implementation. The deployment site is located along Redwood Road in Salt Lake City and started with the installation of roadside units (RSUs) on 30 signalized intersections. As an initial application, this CV deployment equipped transit vehicles with onboard processors (OBP) and on-board DSRC communication units (OBUs) for V2I communications, which can provide transit signal priority (TSP) to buses running behind schedule. Later on, this CV corridor has been extended to involve more intersections and the TSP control algorithm has been expanded to provide signal pre-emption to UDOT snow plows when they are actually plowing.

More recently, UDOT started to devote efforts to implementing the other element of CAV - automated vehicles (AV). For instance, UDOT is about to test autonomous shuttles along the Wasatch Front. Demonstration of AVs focuses specifically on safety, reduced crashes, public trust, and improved access. Since AVs typically only rely on data collected from on-board sensors, it has been suggested by many studies that combining AV and CV technologies, specifically adding V2I communication to the on-board sensor suite, improved safety and operational performance will result. With this synergy, the CAV speed/trajectory control becomes a top-priority for deploying CAV technology, and the current CV corridor is the logical location for evaluating this. CAVs can leverage their capability on the arterial by communicating with roadside infrastructures to maintain an optimal speed profile for receiving the benefits of signal progression.

This project focuses on preparing Utah for CAV applications with three main research tasks: 1) develop CAV trajectory control algorithms for maintaining an optimal speed profile based on the received signal information via V2I; 2) establish a hardware-in-the-loop simulation platform for assessing the effectiveness of the control system; and 3) study the benefit and cost of demonstrating CAVs on the Redwood Road CV corridor.

2. Write the project objective (25 words or less):

Develop a CAV trajectory control algorithm, study the application benefits and implementation challenges, and prepare Redwood Road for future CAV demonstrations.

3. Explain why this research is important:
(In response, consider addressing specific UDOT goals, applicability in Utah or other states, etc.)

After the initial demonstration of CAV technology led by USDOT, many state DOTs have been planning to test various CAV applications. Through the current efforts of operating the CV corridor, UDOT has gained valuable experience for implementing CV technologies. A next logical step is the demonstration of combined CAV technology. This research will be a pilot study which aims to address the difficulties in developing vehicle control algorithms. The corresponding feasibility analysis with hardware will investigate the feasibility of testing CAVs in Salt Lake City.

4. List the major tasks:

1. Develop CAV trajectory control algorithms and design both safety and operational metrics for performance assessments;
2. Develop a microscopic simulation model for evaluating the efficiency of the control algorithms;
3. Build hardware-in-the-loop simulation platform to assess the feasibility of integrating CV and AV technologies;
4. Investigate the potential benefits and challenges of implementing CAV applications on Redwood Road and work with UDOT to develop future CAV demonstration plans;
5. Prepare a final project report.

5. List the expected deliverables (reports, manual, specification, design method, training, etc.):

1. Source code of CAV trajectory control algorithms;
2. Microscopic simulation tool for testing CAV applications;
3. Extended hardware-in-the-loop simulation platform;
4. Report on the benefit/cost analysis and future demonstration plan;
5. Final project report.

6. Describe how the research results will be implemented:
(In response, consider addressing UDOT leader support, process or standard improvement, etc.)

This project will use the hardware-in-the-loop simulation platform to ensure the feasibility of the developed control algorithms. The outcomes of this project will serve as the foundation for future field deployment of CAVs. The research results will directly support UDOT's goal of becoming a national leader in CAV technology by implementing CAV technology and providing pilot studies before field implementation.

7. Requested from UDOT: $50,000 **Other/Matching Funds:** $40,000 (UTC funds) **Total Cost:** $90,000
(or UTA for Public Transportation)

8. Outline the proposed schedule, including start and major event dates:

The schedule assumes an Oct 2019 start day and an 18-month project period:

Oct 2019: project kick off meeting.
Nov 2019 – Oct 2019: Task 1.
Apr 2019 – Jun 2019: Task 2.
July 2019 – Oct 2019: Task 3.
Nov 2019 – Dec 2019: Task 5.
Jan 2021 – Mar 2021: Final report preparation