Request for Research Funding for FY 2021-2022			
Requesting Office	District 7 Traffic Ops	**Priority**	10 of 15
Proposed Title	Infrastructure Enablers for Reliable Cooperative Driving Automation (CDA) Phase I: Existing Infrastructure Evaluation		
Justification	In the year of 2019, over 400,000 crashes were reported in Florida, causing over 240,000 injuries and nearly 3,000 fatalities (https://www.flhsmv.gov/resources/crash-citation-reports/). Every year, over $8 billion are wasted in congestion in major cities in Florida (https://www.fdot.gov/docs/default-source/planning/trends/special/flcongestion.pdf). Cooperative Driving Automation (CDA) technology holds the promise of improving traffic safety and mobility. Now 7.2% of produced vehicles worldwide are featured with CDA functions (e.g., adaptive cruise control) and the CDA market penetration grows at an annual rate around 20%. It is expected that CDA technologies can largely improve safety (e.g., reducing 80% of non-impaired collisions) and mobility (e.g., doubling capacity with platooning). However, real-world CDA deployment has been relatively slow in the past two decades (which unfortunately also led to FCC's vote on reuse the 5.9 GHz communication bands allocated for CDA communications). One key reason is that CDA vehicles require many expensive sensors (e.g., Lidar, high precision navigation system, high end computers, etc.) to be able to reliably operate on existing infrastructure that is designed. Whereas cheaper options (e.g., video alone) that are adopted by existing commercial automated vehicles (e.g., Tesla autopilot, lane keep functions by many automakers) may not be reliable and bear substantial safety risks to human drivers. This research explores a new concept of infrastructure-enabled CDA that aims to improves the existing infrastructure considering not only human drivers but also CAV vehicles. This new concept aims to design infrastructure features that are easy to be detected with inexpensive sensors (e.g., video cameras) or received (e.g., with connected vehicles) in a mixed traffic environment. The approaches include improving road coatings and surface markings to improve CDA detection rates, adding special static information signages that can transmit relatively complicated information (e.g., curves, grade changes, work zones) to CDAs (USF is collaborating with a Florida vendor on CDA signages for rural areas and work zones), and passing real-time traffic information (queue warning, incident warning) to CDA vehicles with proper CV communications. With these infrastructure improvements, it is expected that CDA vehicles, including existing commercial automated vehicles, will much better sense the infrastructure environment and improve their safety. Further, such infrastructure improvements may reduce the costs of CDA vehicles and will incentivize more people to benefit from the CDA technology. The overall vision of this study is to help FDOT identify candidate treatments to the existing infrastructure to suit CDA vehicles, estimate the cost of benefits of these treatments, and eventually help design guidelines for roadway design to supplement those for human drivers alone, in the midst of rapid federal CDA developments (e.g., cooperative classes defined by SAE J3216, CARMA ecosystem). In the first phase, we propose to identify a set of infrastructure features (e.g., lane markings, signs, traffic lights, traffic conditions, etc.) to estimate how well CDA vehicles can sense them. We will test the CDA features of mainstream commercial vehicles (e.g., Ford, GM, Toyota, Honda, etc.) and also our lab vehicles that have installed CARMA 3 in processing these infrastructure features. The test will be conducted on Suntrax and we will report their performance such as false positives and negatives in recognizing these features, delay, errors, etc. By the end of the project, we will be able to identify a candidate list of infrastructure features that are challenging existing CDA vehicles (or require expensive sensors). This list will be used to propose corresponding infrastructure treatment measures and estimate their costs and benefits in the next phase. *The proposers include the director and faculty members of the National University Center housed at the University of South Florida, National Institute for Congestion Reduction (NICR). We expect to have projects from NICR on connected automated vehicles to match this proposed research.*		
Impact	The project will provide guidance for proper infrastructure design that accommodate not only human drivers but also CDA vehicles that drive themselves. If not implemented, existing and future CDA vehicles may have safety and mobility challenges in operating in the existing infrastructure.		
Affected Offices	Traffic Engineering & Operations Office; Roadway Design office		

Existing Work	The relevant literature is scarce since the proposed system is a new concept. Lu, M., Blokpoel, R., & Schindler, J. (2017, October). Infrastructure-based cooperative, connected and automated driving in a transition phase. In 24th ITS World Conference Montréal.
Keywords Used In Existing Work Search **(Cannot leave blank)**	Cooperative Driving Automation. Infrastructure.
Related Contracts (Give contract numbers)	N/A

Funding Request	$120,000	**Anticipated Duration**	12 months
Project Manager	Ronald Chin Co-PM: Raj Ponnaluri	**Contracting Method**	RFP

Urgency	1	Comments* (elaborate as appropriate on justification/impact comments to explain the urgency of the need . . . is a solution needed immediately, needed within a certain period of time or by a known or anticipated deadline, desired for enhancement, etc.)
Implementability	1	Comments* (consider both the likelihood of implementation and the length of time and resources required to implement the results of the research.) Identify any prerequisites to, requirements for, or barriers to implementing the anticipated results of this research (e.g., new or change to existing specifications, development of production units of prototype device, legislative change); please indicate if multiple phases of work shall be required

Project Benefits (Succinct, complete explanation)

- Improve safety against inclement weather on a real-time basis
- Improve mobility with warning and guidance information
- Establish the Florida's leadership on CV and sensing technologies

Project Benefits (Select all that apply and explain)	**Quantifiable Benefits (units, dollars, etc…if applicable)**	**Methodology or Data Sources Used to Determine Quantifiable Benefits. If not applicable, please give justification of project benefits**
○ Materials Enhancement		
○ Materials Savings		
○ Time Savings	Reduce congestion due to better control of CDA vehicles (e.g., reduced headway) due to the infrastructure support	Data: Vehicle sensing data and OBD performance data Method: Test CDA vehicles on real-world road infrastructures.
○ Lives Saved/Injuries Prevented	Reduction of safety risks of CDA driving	Data: Vehicle sensing data and OBD performance data Method: Test CDA vehicles on real-world road infrastructures.
○ Other (Explain)	Improve Florida's preparedness for and leadership on emerging CAVs and smart cities infrastructure	Data: Infrastructure design guidelines Method: Evaluation by stakeholders and experts