Request for Research Funding for FY 2021-2022			
Requesting Office	State Traffic Engineering and Operations	**Priority**	1 of 15
Proposed Title	Using Computer Vision and Deep Learning Techniques to Extract Roadway Geometry Features from Aerial Images		
Justification	Rapid advancement on computer vision technology can enable traffic agencies to save money and time in various aspects of data collection. In the past, image processing has been considered a time-consuming and error-prone approach for roadway inventory recording. However, the existing literature suggests that the recent significant improvements on computational power and image pattern recognition algorithms have created new opportunities to detect and map numerous roadway features from various imagery data. To this end, there has not been a study on using the computer vision techniques to extract different roadway geometry data and develop a statewide inventory for roadway geometry data such as school zone markings, lane configurations (i.e., turning lanes lengths, and lane, shoulder and median widths), and sidewalks (i.e., presence or absence of sidewalks) from high resolution aerial images, and a study related to how this can benefit roadway users such as drivers, pedestrians and bicyclists. As such, this project will develop automated tools to detect these roadway features using deep learning-based object detection models. This will be achieved by running a retrained You Only Look Once (YOLO) artificial intelligent model to look for the introduced pavement marking combinations on the high resolution aerial images followed by the GIS-based spatial analyses for both ON and OFF roadways of Florida. This study, with the objective of generating an inventory list of different roadway geometry data for the entire state of Florida, is one of a kind.		
Impact	The overall goal of this project is to develop computer vision tools to extract different roadway geometry data such as school zone markings, lane configurations (i.e., turning lanes lengths, and lane, shoulder and median widths), presence of signals (i.e., identification of signal poles), and sidewalks (i.e., presence or absence of sidewalks) from high resolution aerial images, which can be used by FDOT planners and engineers at various levels of traffic operations and safety analysis. Consistent with this goal, the main objectives of this project are to: (a) examine how traffic data collection can leverage emerging computer vision techniques, in particular, image processing, deep learning, machine learning, and artificial intelligence to develop statewide roadway inventory lists; (b) design an automated signalized intersection geometric data extraction algorithm based on high-resolution images in order to identify roadway geometry data such as school zone markings, lane configurations (i.e., turning lanes and their lengths), and sidewalks (i.e., presence or absence of sidewalks) from high resolution aerial images, and (c) generate a GIS-based inventory list of these roadway geometry features for the entire state of Florida including ON and OFF roadways. This is an innovative solution that employs the computer vision technology to potentially replace traditional manual inventory, which is labor intensive and prone to errors.		
Affected Offices	The proposed project will involve a range of FDOT Offices and Districts, including the Traffic Operations Office, Safety Office, and all the remaining FDOT District Offices.		
Existing Work	There is a small portion (one task) of a project titled "Feasibility Analysis of Real-time Intersection Data Collection and Processing Using Drones" - BDV30 TWO 977-29 that aimed at providing proof of concept on the use of image processing techniques to extract intersection characteristics. The task has been completed and proved the potential of using image processing techniques in extracting roadway geometric features. There is no other work that has been supported by FDOT to extract different roadway geometry data such as school zone markings, lane configurations (i.e., turning lanes and their lengths), and sidewalks (i.e., presence or absence of sidewalks) from high resolution aerial images using computer vision and artificial intelligence techniques. A satisfaction survey among the state DOTs according to a 2015 study [1] indicates that the collection of geometry data with aerial and satellite images happened to be more satisfactory than field observations in terms of equipment cost, data accuracy, crew safety, data collection cost and data collection time. On the other hand, field observations were found to be more satisfactory in terms of data completeness and data reduction time. However, these results have changed in the last six years with the advancement on the computing power and the processing methods of imagery data. The existing literature suggests that the recent significant improvements on computational power and image pattern recognition algorithms have created new opportunities to detect and map numerous roadway features from various imagery data.		
Keywords Used In Existing Work Search	Artificial Intelligence, Computer Vision, Machine Learning, Deep Learning, Image Processing		

[1] Jalayer, M., J. Gong, H. Zhou, and M. Grinter. Evaluation of Remote Sensing Technologies for Collecting Roadside Feature Data to Support Highway Safety Manual Implementation. Journal of Transportation Safety and Security, Vol. 7, No. 4, 2015, pp. 345–357.

(Cannot leave blank)			
Related Contracts (Give contract numbers)	BDV30 TWO 977-29		
Funding Request	$200,000	**Anticipated Duration**	15 months
Project Manager	Alan El-Urfali	**Contracting Method**	Direct contract with the Florida State University (Dr. Ozguven)
Urgency	1	There is an urgent need to utilize the computer vision and artificial intelligence techniques for safer, cheaper and faster identification of roadway geometry data from aerial images.	
Implementability	1	Specific image processing tools developed and inventory lists provided can be used by any FDOT district for roadway feature identification purposes.	

Project Benefits (Succinct, complete explanation)

The overall goal of this project is to develop AI-based algorithms and GIS-based statewide inventory lists of roadway features such as school zone markings, lane configurations (i.e., turning lanes lengths, and lane, shoulder and median widths), and sidewalks (i.e., presence or absence of sidewalks). The products can be used by FDOT planners and engineers at several levels of traffic operations and safety analysis. This is an innovative solution that employs the computer vision technology to potentially replace traditional manual inventory or field works, which are labor intensive and costly. Using freely available high resolution images, the developed AI-based algorithms will be able to extract key roadway features on both ON and OFF roadways of the entire state of Florida.

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**
o Materials Enhancement		
o Materials Savings		
o Time Savings		The findings can help FDOT obtain significant time savings by eliminating a need for a manual inventory process and improved data quality by eliminating human errors due to manual data input.
o Lives Saved/Injuries Prevented		Better and faster roadway geometry feature identification will significantly enhance FDOT's performance in identifying possible traffic conflict points at intersections between vehicles and between vehicles with non-motorists such as bicycles and pedestrians.
o Other (Explain)		The findings can help FDOT improve productivity by eliminating a need for a manual inventory process and improved data quality by eliminating human errors due to manual data input.

*Comments should explain and support urgency, financial benefit, and implementability scores