

Request for Research Funding for FY 2021-2022

Requesting Office	District 7 Traffic Operations	Priority	11 of 15
Proposed Title	Privacy-Aware Artificial Intelligence Based Video Analysis for Better Traffic Management		
Justification	<p>Video surveillance, if properly processed with artificial intelligent techniques, will be quite helpful to identify traffic incidents in a timely manner. Fast identification of traffic incidents is critical to traffic incident management of FDOT in reducing notification time and associated congestion and secondary crashes. With advanced artificial intelligence (AI) technologies, video data (e.g., from stationary CCTVs or mobile drones) can be processed in real time to extract moving object trajectories with their classifications (e.g., heavy-duty vehicles, light-duty vehicles, motor-cycles, bicycles and pedestrians) in real time. Such rich information provides abundant information (e.g., sudden stop of vehicles, trajectories deviating from the road lanes, start of non-recurrent congestion patterns) to automatically identify incidents and evaluate their characteristics (e.g., severity, involved vehicles) in real time. The USF team has successfully applied these AI technologies with their patented tool in extracting long and comprehensive trajectories (e.g., for 2 hour aerial videos on 1.5 mile I-75 segment in Tampa) in an efficient manner in a FHWA research project.</p> <p>However, FDOT currently haven't take full advantage of existing video surveillance infrastructure. FDOT Traffic Management Centers (TMCs) mainly rely on human eyeballing to monitor sampled CCTVs, which may not always identify traffic incidents in real time due to limited highway coverage and human processing difficulty.</p> <p>Possible challenges to apply the advanced AI technologies in video analytics include</p> <ol style="list-style-type: none"> 1. Lack of proper software tools that can identify and classify traffic incidents in real time, with high accuracy. 2. Lack of proper trainings for the TMC crew to use such software tools. 3. Concerns of liabilities and privacy issues of holding such information. <p>This project aims to develop a procedure to integrate AI technologies into FDOT available video feed to improve traffic incident identification efficiency and accuracy. Additional documentation and training modules will be developed to assist TMC crews to get familiar with state-of-art AI tools. Further, the procedure will be designed in a way that will not add additional liabilities or privacy concerns to the existing practice.</p> <p>Note that the benefits of the AI approach are beyond incident management. The obtained information can be automatically processed and send back to road users as real time information. Such information will be very helpful to Cooperative Driving Automation. Especially when not many vehicles are connected vehicles (CVs) and can transmit their real-time states, the traffic information obtained from videos can be transmitted to existing CDA vehicles to supplement of the lack of real-time CV data.</p> <p>The first component is to integrate appropriate AI technologies on video-based object identifications to FDOT CCTV video feed. Video clips from FDOT CCTV feed will be collected as training, validation and test samples. The training video will be semi-manually processed first to label interesting moving objects. These training objects will be used to calibrate existing state-of-the-art AI based open-source video processing tools (e.g., YOLO) and the USF patented software tool. The trained tools will be validated and tested with independent video datasets. Further, automatic incident severity evaluation information (e.g., involved vehicles, crash relative speed, expected injuries and lane closures) will be populated immediately to assistant FDOT make following response decisions (e.g., whether or not to activate RISC).</p> <p>The second component is to develop a user-friendly interface of these tools to help FDOT crews easily access and utilize these technologies. We will interact with the FDOT crew to learn their user preferences of such tools in the best practice. We will develop proper user menus and training sessions to help them be able to use these technologies once available. We will also exploit virtual reality modeling to present the video images and identified information in a more intuitive way. For example, we could stitch all video together and paste them on the corresponding highway 3D model. This way, the monitors can see a real-time version of "google earth" where they may zoom in and out to see the real time traffic and individual vehicles.</p> <p>The third component is to specify treatments needed to eliminate additional liabilities or privacy concerns. We will explore ways of only record interesting anomalous data (e.g., aggregated data associated with incidents</p>		

	<p>that do not yield individual information) while the other detailed data (e.g., video and disaggregated trajectory data) will be only used in real time incident management but not recorded for future uses.</p> <p>The fourth component is to evaluate the benefit of the proposed procedure. We will estimate the reduction of incident identification and response time due to the real-time incident identification and classification capabilities with the proposed AI-based procedure. We will translate the time reductions to benefits in reducing secondary crashes and reducing congestion. This benefit expects to be more prevalent as the incident severity increases.</p> <p>The fifth component is to explore how to generalize this procedure to other emerging technologies such as (1) mounting cameras and sensors on FDOT fleet vehicles (e.g., road rangers) to use these vehicles as probe sensors (this can be tested with our USF connected and automated vehicle fleet first), (2) integrating the video information with the vision of connected infrastructure (e.g., I-4 frame, CARMA eco-system), (3) using drone technologies to scout areas that CCTV cameras may not cover.</p> <p><i>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 video collection & analysis to match this proposed research.</i></p>		
Impact	<p>How shall the results impact practice? Consequences of not doing the research?</p> <p>This project expects to greatly improve road safety by reducing the incident identification and response time. Also, congestion induced by traffic incident will be correspondingly reduced as well.</p>		
Affected Offices	<p>Identify any office that will need to be involved in the scoping or conduct of the research, will be affected by implementation of the results, or will need to participate in the implementation process—including OTIT, if enterprise data/network software application will be a deliverable, and district staff, as appropriate, e.g., through statewide meetings. If the requesting office will not be the implementing office, please identify which office will have to serve in that capacity—has it been involved?</p> <p>Traffic Engineering & Operations Office; Traffic Incident Management</p>		
Existing Work	<p>Li, X., Zhao, D., Video-Based Intelligent Road Traffic Universal Analysis Tool (VIRTUAL). Provisional Patent No., 62/701,978. July 2018.</p> <p>Zhao, D. & Li, X. " Video-Based Intelligent Traffic Analysis System: A Comprehensive and Effective Solution to Extract Trajectories from Aerial Videos." Presented at the 99th TRB Annual Meeting, Washington D.C., January 2020.</p> <p>Kumaran, S. K., Dogra, D. P., & Roy, P. P. (2019). Anomaly detection in road traffic using visual surveillance: A survey. arXiv preprint arXiv:1901.08292.</p>		
Keywords Used In Existing Work Search (Cannot leave blank)	Video analytics, Artificial Intelligence, Incident Detection, Incident Management		
Related Contracts (Give contract numbers)	N/A		
Funding Request	\$100,000	Anticipated Duration	15 months
Project Manager	Ronald Chin Co-PM: Derek Vollmer	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) <ul style="list-style-type: none"> • 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	Travel time improvements due to reduced incident identification and response times. Additional mobility benefits are expected if the video information can be converted to real-time traffic information accessible to road users.	Data: Video clips of roadside sensors. Method: Automatic real-time identification and classification of incident with advanced AI technologies
○ Lives Saved/Injuries Prevented	Reduced response time will reduce fatalities and mitigate injuries Reduction of secondary crashes due to research incident response time.	Data: Historic Secondary crash data Method: Convert reduction of queuing time and length into reduction of secondary crashes
○ Other (Explain)		

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