Real-time work zone speed management with multi-source data

Overview

Background

In 2021, the U.S. witnessed a staggering 954 fatalities and 42,151 injuries due to work zone crashes. While work zone safety remains a significant concern nationally, Maryland is not an exception. Between 2017 and 2021, Maryland recorded 7,521 work zone-related accidents, averaging 1,500 annually. These incidents led to 3,059 injuries and 46 deaths, encompassing highway workers, drivers, and passengers alike. Preliminary data for 2022 indicates 1,239 work zone-related crashes in Maryland, with 412 injuries and 11 fatalities. Tragically, an accident on I-695 in early 2023 claimed the lives of six workers. As the nation's roadway infrastructure continues to age, the prevalence of work zones is poised to increase, not decrease. This upward trend underscores the urgent need for increasing attention to work zone safety.

Recognizing that inappropriate speeds, among a large of number of factors, can significantly heighten the risk of accidents, potentially leading to severe injuries or fatalities, transportation authorities have explored various measures to manage and control speeds effectively. Among these, the Variable Speed Limit (VSL) stands out as a promising solution, which adjusts the speed limits upstream, within and downstream the work zone based on real-time traffic conditions. VSL at work zones offers several benefits:

- **Enhanced Safety**: VSL can reduce the risk of accidents caused by sudden traffic slowdowns, weather conditions, or construction activities.
- **Smooth Traffic Flow**: VSLs can help reduce traffic congestion by adjusting speeds to prevent bottlenecks. For example, if congestion is building up downstream in a work zone, VSLs can gradually reduce speed limits upstream to prevent further congestion and ensure a steady flow of traffic.
- **Increased Worker Safety**: With adjustable speed limits, vehicles can be slowed appropriately when they approach the work areas, reducing the risk of accidents involving construction workers.
- **Flexibility**: VSLs can be adjusted for various factors, including weather conditions, visibility, road surface conditions, and the specific type of work being carried out.

Currently, the decision-making process behind the most real-time VSL strategies—like determining where to place speed limit signs, when to modify speed limits, or how to calibrate real-time control parameters—traditionally relies on data sourced from roadside sensors and probe vehicles. However, while these traditional data sources are invaluable, they are not without limitations. The roadside sensors can only detect volume and speed at prespecified locations, thus not sufficiently sensitive to traffic fluctuations. Probe vehicle data does not account for the measures of individual vehicles and are often recorded by segments with considerable lengths. Therefore, the traditional data sources for VSL might face difficulty in capturing the nuanced dynamics of traffic flow, such as speed disparities between different work zone segments or individual lanes. Their nature might also render them ineffective in identifying those individual aggressive speeders, or in capturing critical data on locations witnessing hard decelerations or near-miss events. Pinpointing exact spots of frequent lane changes, a crucial parameter for understanding and managing traffic patterns, might also lie beyond their purview.

Objective

This project aims to investigate the potential of incorporating drone data into the design and implementation of VSL. Drones offer a bird's eye view, coupled with the ability to move across varied locations. This unique combination allows them to track individual vehicle speeds and accelerations, offering insights that are granular and comprehensive. They excel in capturing both temporal and spatial speed variations anytime and anywhere, ensuring that no critical data point is missed. Furthermore, by gauging traffic density, drones can provide early warnings about potential bottlenecks or congestion points. Their ability to be deployed wherever necessary, based on real-time conditions, ensures that the VSL system is fed with the most accurate and timely data, facilitating the decision-making process that leads to a not just efficient, but more importantly, safe work zone.

In phase 1 of the proposed project, we will develop a VSL control strategy leveraging multi-source real-time data, with its pivotal modules illustrated in Figure 1. As depicted in the figure, raw data gathered from multiple drones will first be processed to generate vehicle trajectory data. This data will subsequently be integrated with speed and volume metrics sourced from roadside sensors and probe data. This aggregated dataset will serve as the input for a meticulously developed traffic control model designed to optimize the VSL control strategy, balancing both efficiency and safety considerations. The derived control parameters will be relayed to the devices positioned within and before the work zone. Concurrently, based on anticipated traffic fluctuations, we will optimized locations for drone deployments in the next time interval. The data accumulated from these spots will be incorporated in the subsequent operational timestep.

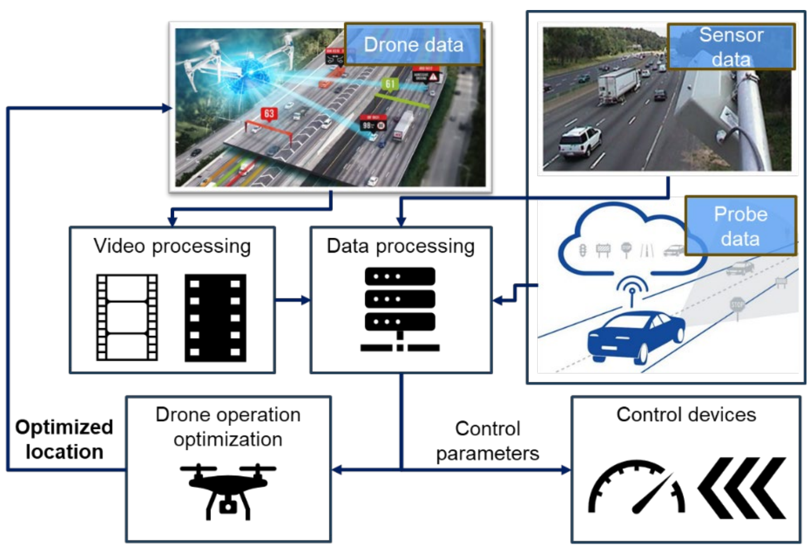

Figure 1. The proposed real-time work zone speed management system with multi-source data

To assess the efficacy of the proposed concept, a multi-faceted evaluation framework will be established. Initially, baseline metrics, such as current traffic flow rates, average speeds, speed variance and near-miss events in work zones will be documented prior to the implementation of the new strategy. Post-deployment, these metrics will be continuously monitored and compared against the baseline. Key indicators like speed compliance rates, speed variance reductions, and the frequency of hard decelerations will be analyzed to determine the system's impact on traffic behavior. Additionally, safety metrics—including actual incidents if there is any—will be closely observed to gauge improvements in work zone safety. Data discrepancies between traditional methods and drone-sourced data will be examined to validate the accuracy and added value of the new system.

<u>Desired Outcomes for Stage 2 Project</u>

If the effectiveness of and proposed data integration is verified in the first stage of this project, such a VSL system can be scaled up in the entire state of Maryland. Potential deployment sites would be selected based on history crash statistics and engineering judgement. Such a widespread deployment will help us understand the most applicable scenarios of the proposed system. By integrating multi-source real-time data, especially from drones, we anticipate a more fluid, responsive, and safer work zone environment.

<u>Alignment with the SMART Grants Program Goals</u>

This initiative resonates with the SMART grant's emphasis on safety and the promotion of Intelligent, Sensor-Based Infrastructure. By leveraging cutting-edge technology, we aim to revolutionize work zone safety, setting a benchmark for nationwide jurisdictions at various levels.

Project location:

The designated location for the proposed project is the work zones on I-695, the belt freeway encircling Baltimore City (See Figure 2). The exact locations will be determined based on the work zone schedules. This freeway serves as a significant transportation corridor, facilitating the movement of residents, visitors, goods, and services throughout the Baltimore metropolitan area during both commuting and non-commuting hours. A preliminary analysis shows that I-695 experienced more than 3,500 lane blockage crashes and the work zone crash taking six workers' lives in early 2023 brought additional public attention to the beltway.

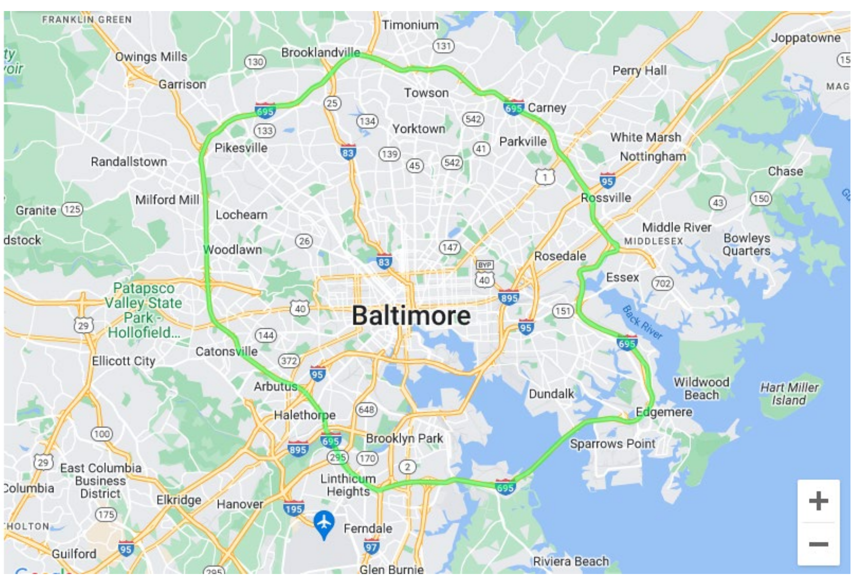

Figure 2. Baltimore City and I-695 (in green)

Notably, the region within I-695 comprises numerous disadvantaged communities. Historically, these communities have faced challenges related to accessibility, safety, and economic mobility, issues that are intrinsically linked to transportation and infrastructure. Implementing the proposed traffic control measures on I-695, therefore, not only serves the broader objective of improving transportation efficiency and safety but also underlines our commitment to ensuring equitable transportation solutions for all residents of Baltimore City.

Community Impact

The implementation of our proposed project on I-695 is designed with a central focus on elevating travel efficiency and safety for the disadvantaged communities situated within the belt freeway's loop. Anticipated benefits include:

- **Augmented safety**, stemming from streamlined traffic patterns and minimized unnecessary lane changes
- **Alleviation of traffic congestion** by addressing and mitigating bottlenecks
- **Diminished carbon emissions**, attributed to decreased instances of abrupt braking

While the primary focus is on the communities within the I-695 loop, similar disadvantaged neighborhoods outside this specific zone might also benefit indirectly from reduced traffic spill-overs and enhanced inter-connectivity with the central city. These benefits directly align with the goals of Justice 40, aiming to deliver 40% of the overall benefits of federal investment to disadvantaged communities.

Nevertheless, it's imperative to consider potential constraints, predominantly arising from drone operational restrictions. As we contemplate expanding this initiative statewide, it's essential to be cognizant of areas near Washington DC and certain local airports due to airspace limitations.

Technical Merit Overview

The proposed project is to investigate the potential of drones to address the limitations of existing data sources for VSL control strategies at work zones. Such limitations can be summarized into below aspects:

- **Inaccurate Detection**: Existing sensors and probe data might not accurately detect speed variance among segments and lanes. Such inaccuracies can lead to VSLs that do not truly reflect the current state of traffic, thereby reducing their efficacy.
- **Missed Speeding Events**: Aggressively speeding drivers or zones with hard decelerations might not be identified promptly or accurately, leading to the suboptimal control strategies.
- **Limited Spatial Insight**: Existing data tools may not capture spots with frequent near-misses or lane changes, both critical points of interest when optimizing VSL implementation.
- **Low spatial flexibility**: Traditional road sensors are fixed in position, and thus cannot be relocated to adapt to evolving traffic patterns or new work zone configurations. Similarly, probe vehicle data are constrained to pre-specified segments, restricting their adaptability to dynamic traffic conditions.

<u>Appropriateness of Proposed Solution:</u>

The success of a solution is largely determined by its ability to address the intricacies of the problem at hand while offering adaptability for unforeseen challenges. Our proposed utilization of drones in corporation of existing data sources with Variable Speed Limits (VSL) within work zones embodies this principle. Here's a breakdown of its appropriateness:

- **Adaptive Monitoring Angles**: Drones are not constrained like fixed cameras or sensors. They can be strategically positioned anywhere within the work zone, allowing for versatile observation points. This flexibility is paramount in work zones where designs can change from segment to segment. Critical locations, such as the beginning of the warning area or the transition from warning to merging zones, often influence speed adjustments and consequently safety risks. Drones enable real-time monitoring of these vital points.
- **Thorough Traffic Analysis**: With a broad detection radius, drones ensure a holistic capture of all vehicular activities. This comprehensive view is crucial for fine-tuning VSL parameters, as it provides insights into speed variations and adherence rates, which are foundational for parameter design.
- **Accurate Risk Assessment with Video Documentation**: Equipped with high-definition cameras, drones can document inter-vehicle conflicts. This capability not only facilitates post-event analysis but also aids in proactively identifying high-risk areas. Instead of relying on estimations, traffic managers can directly pinpoint areas of concern, streamlining safety enhancements.
- **Unobtrusive Surveillance**: Drones, while advanced, remain unnoticeable to the general motorist. This minimizes the potential distractions that other visible monitoring systems might introduce, especially critical in areas where drivers need to focus most.
- **Adaptable to Dynamic Work Zone Conditions**: Work zones are not static; they evolve based on the phase of construction or maintenance, changes in traffic patterns, and even daily weather conditions. Unlike traditional sensor systems, drones can be repositioned easily, ensuring that monitoring remains optimal irrespective of how work zones change.
- **Cost-Efficiency in the Long Run**: While the upfront costs of drone systems, including the data collection effort, might be higher than traditional sensors, the long-term benefits, in terms of reduced need for physical infrastructure, manpower, and maintenance, make drones a cost-effective solution in the longer perspective.
- **Scalability and Versatility**: The proposed solution is not restricted to just one type of work zone or a particular region. Given the mobile nature of drones and their adaptability to different terrains and traffic scenarios, our approach can be scaled up or down and can be modified to fit different work zone scenarios, ensuring broader applicability, as long as the airspace restriction does not apply.

Expected Benefits

In addition to the expected improvement on traffic efficiency and safety, which have been elaborated above, the proposed VSL implementation is expected to demonstrate below benefits:

- **Real-time Compliance Feedback**: One of the most distinct advantages of our approach is the capability to receive instantaneous feedback on speed limit compliance. Such a feature ensures that traffic control measures can be dynamically adjusted, fostering better adherence to the set parameters.

- **Gradual Harmonization Across Work Zone Segments**: By leveraging drone data, we can ensure a phased and coherent VSL application across different work zone segments. This results in a more predictable and consistent driving experience, reducing the likelihood of sudden, unsafe driving maneuvers.
- **Environmental Condition Consideration**: Optimizing traffic flow will lead to fewer emissions, contributing to cleaner air.

Overall, this project aims to lead a new era of responsive, data-driven, and safer work zone traffic management, ultimately benefiting drivers, construction workers, and the broader community.

Project Readiness Overview

Work Plan and Timeline

- Task 1. Stakeholder Engagement and Site Selection
  - Engage with local transportation agencies, work zone contractors, drone operators, and other relevant parties.
  - Identify the scope of the demonstration: specific work zones and drone operational areas.
  - List down the required hardware and software resources.
- Task 2: Equipment Procurement
  - Identify and list essential equipment, including drones, variable speed limit signs, trailers and communication tools.
  - Identify the data processing platform for drone data and integrated data from multiple sources.
  - Source and purchase the necessary equipment and platform from reliable vendors.
- Task 3: Operational Training
  - Organize training sessions for team members and contractors on equipment usage, especially drone operations.
  - Provide software training for those interfacing data integration and VSL algorithms.
  - Ensure compatibility of different equipment pieces with each other and the data communication and storage platforms.
- Task 4. Pre-demonstration Data Collection
  - Utilize existing traffic sensors and drones to gather baseline data for evaluation purposes.
  - Conduct mock drills to ensure the team is well-prepared for real-time scenarios.
- Task 5. System Design & Development
  - Design VSL algorithms based on real-time traffic conditions and behaviors to determine the activation conditions and parameters of the VSL strategy.
  - Develop optimization algorithm for drone relocation.
- Task 6. Prototype Testing with Simulation
  - Simulate work zone conditions and evaluate the drone-involved VSL system in simulation environments.
  - Analyze data for efficiency and safety improvements and refine the algorithms as needed.
- Test 7. Field Deployment & Demonstration

- ○ Deploy the integrated system in a selected work zone.
  - ○ Monitor and adjust VSL in real-time based on drone feedback.
  - ○ Collect traffic efficiency and safety data for evaluation
- Task 8. Post-deployment Evaluation
  - Evaluate the effectiveness of the proposed VSL system with multi-source data on traffic efficiency, safety and work zone operator awareness.
  - Organize sessions with stakeholders to gather feedback on the demonstration.
- Task 9. Refinement and Iteration
  - Based on feedback, make necessary adjustments to the system.
  - Repeat the demonstration if needed, to showcase the refined system's effectiveness.

Those tasks will be conducted following the timeline below:

	Month																	
Task	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Task 1: Stakeholder Engagement and Site Selection	■																	
Task 2: Equipment Procurement		■																
Task 3: Operational Training			■	■	■													
Task 4: Pre-demonstration Data Collection					■	■												
Task 5: System Design & Development							■	■	■									
Task 6: Prototype Testing with Simulation										■	■	■						
Task 7: Field Deployment & Demonstration													■	■	■	■		
Task 8: Post-deployment Evaluation															■	■		
Task 9: Refinement and Iteration																■	■	
Kick-off meeting	■																	
Quarterly reports				■			■			■			■			■		
Final presentation and final report																		■

<u>Community Engagement and Partnerships:</u>

Historically, our projects in Office of Traffic and Safety (OOTS) at Maryland State Highway Administration (MSHA) have thrived due to active community engagement. We have held public forums, gathered feedback, and used this input to shape our initiatives. For this project, we have already secured partnerships with University of Maryland who will play a pivotal role in publicizing, giving feedback, and assisting in the effective deployment of our proposed system.

<u>Leadership and Qualifications:</u>

Dr. Sung Yoon Park, Division Chief of OOTS at MSHA, holds a Ph.D. in Civil Engineering and has participated in the development of various successful work zone and intersection safety improvement strategies, giving him an unparalleled grasp on traffic operation and safety concerns. Dr. Yao Cheng, the principal investigator from the University of Maryland, holds a Ph.D. in Civil Engineering. His vast portfolio spans diverse transportation topics, including traffic control, transit operations, and safety. Saed Rahwanji, a faculty specialist at the University of Maryland, and a former Assistant Division Chief/Transportation Engineering Manager with the Maryland State Highway Administration for over 30 years, offers invaluable expertise in traffic operations.

Appendix I Resumes

Sung Yoon Park Resume

Division Chief
Traffic Development & Support Division (TDSD)
Office of Traffic & Safety (OOTS)
Maryland Department of Transportation State Highway Administration (SHA)
Email: spark@mdot.maryland.gov
Phone: (410)787-5855, Cell: (301)523-1412

Education

Ph.D.	Civil Engineering, Department of Civil and Environmental Engineering University of Maryland, College Park	***2017***
M.S.	Civil Engineering, Department of Civil and Environmental Engineering University of Maryland, College Park	***2011***
B.S.	Civil Engineering, Department of Civil and Environmental Engineering University of Maryland, College Park	***2008***

Academic and Professional Positions

Division Chief ***Aug. 2023 – Present***
TDSD, OOTS, Maryland SHA
Team Leader ***Nov. 2021 – Aug. 2023***
Traffic Policy and Management Team, TDSD, OOTS, Maryland SHA
Transportation Engineer ***Jul. 2018 – Nov. 2021***
Research & ITS Team, TDSD, OOTS, Maryland SHA
Post-Doc Research Associate **May** ***2017 – Jul. 2018***
Traffic Safety and Operations Lab, University of Maryland, College Park
Research Assistant ***May 2013 – May 2017***
Department of Civil and Environmental Engineering, University of Maryland, College Park

Research Interests

Transportation Systems Control and Operations, Traffic Safety, Intersection Safety Improvements, Work Zone Safety, Emergency Evacuations, Public Transportation, Driving Behavior, Traffic Efficiency

Projects

- ITS Applications in Work Zones to Improve Traffic Operations and Performance Measurements (2008)
- Eastern Shore Traffic Monitoring System (2008 – 2018)
- Maryland SHA's Applied Technology and Traffic Analysis Program (2008-2018)
- ITS: Variable Speed Limit Demonstration (2009)
- Design and Deployment of an Intelligent Dilemma Zone Protection System at High-Speed Intersections (2014-2016)
- Evaluation of the impacts of Red-Light camera deployment on intersection safety (2017-2018)
- An Integrated Intelligent Intersection Control System (III-CS) for Safety Improvement and Delay Minimization (2019- 2021)

Award

Recognized "Partners In Quality Award" – Federal Highway Administration Maryland Division, Baltimore, MD. February 1. 2023

Yao Cheng — Resume

Faculty Specialist
Jeong H. Kim Engineering Building, Room 1136
University of Maryland, College Park, MD 20742
Email: ycheng09@umd.edu
Phone: (301)405-6959, Cell: (760)277-1117

Education

Ph.D. Transportation Engineering, Department of Civil and Environmental Engineering
The University of Maryland, College Park, MD — ***May 2020***
Dissertation: *A Multi-Modal Signal Progression System for Congested Arterials*; advised by Dr. Gang-Len Chang

M.S. Transportation Engineering, Department of Civil and Environmental Engineering
The University of Maryland, College Park, MD — ***December 2014***
Thesis: *An Integrated Bus-Based Progression System for Arterials Having Heavy Transit Flows*; advised by Dr. Gang-Len Chang

B.S. Traffic and Transportation Engineering, College of Transportation Engineering
Tongji University, Shanghai, China — ***June 2012***

Academic Positions

Faculty Specialist — ***Feb. 2023 – Present***
Department of Civil and Environmental Engineering, University of Maryland, College Park

Faculty Assistant — ***Feb. 2020 – Present***
Department of Civil and Environmental Engineering, University of Maryland, College Park

Future Faculty Fellow — ***Jan. 2018 – May 2019***
Clark School of Engineering, University of Maryland, College Park

Research Assistant — ***May 2013 – Jan. 2020***
Department of Civil and Environmental Engineering, University of Maryland, College Park

Research Interests

Traffic signal, unconventional intersection/interchange design, freeway integrated control, transit signal design, transit signal priority, traffic safety, pedestrian safety

Sponsored Research Programs

Sponsor	Dates	Project Title	PI and Co-PI
MDOT SHA	01/2022-09/2022	Developing a Systemic Safety Project Selection Tool for Maryland Implementation – Stage 2	Gang- Len Chang (PI); Yao Cheng (Co-PI)
MDOT SHA	01/2022-03/2023	Development of an Evaluation Tool for MDOT SHA's Safety Improvement Projects	Gang- Len Chang (PI); Yao Cheng (Co-PI)
Baltimore City DOT	04/2023-04/2024	Mobility, Safety, and Infrastructure Data Collection for Developing A Comprehensive Baltimore City Safety Action Plan	Xianfeng Yang (PI); Yao Cheng (Co-PI)
MDOT SHA	05/2023-06/2024	Developing a Comprehensive System to Illustrate the Career Pathways with MDOT SHA	Yao Cheng (PI); Xianfeng Yang (Co-PI);
MDOT SHA	04/2023-10/2024	Developing a Knowledge-based System for Guiding Design, Operations and Evaluation of Highway Work zones	Gang- Len Chang (PI); Yao Cheng (Co-PI)

Awards

- Ann G. Wylie Fellowship, University of Maryland, 2018 ($15,000)
- Future Faculty Fellowship, University of Maryland, 2018

Attachment II Budget narrative

1. Personnel
2. Fringe Benefit
3. Travel
4. Equipment
5. Supplies
6. Contractual

   The University of Maryland commits to the following tasks with the budget of $350,000:
   - Utilizing our expertise in data analysis to meticulously determine optimal work zone sites for system deployment.
   - Assessing the precision of the processed vehicular volume and speed data sourced from drone footage.
   - Overseeing the real-time transmission and secure storage of drone data.
   - Developing a state-of-the-art Variable Speed Limit algorithm that takes advantage of data from both traditional sources and drones.
   - Conducting rigorous evaluations on the multi-source system's effectiveness on traffic efficiency, safety, and environmental considerations
   - Providing technical support throughout the project, closely collaborating with vendors to ensure challenges are promptly identified and resolved

   A detailed budget justification from UMD is attached.

   Below tasks will be contracted to other contractors with the budget of $1,260,000, with the estimated justification in Table 1.

   - Operating drones at selected deployment locations.
   - Processing the real-time drone video to extract vehicle volume, speed, trajectory and near miss information
   - Establishing the data transmission and storage platform
   - Setting up the variable speed limit signs and establishing the real-time control function
   - Operating the variable speed limit system based on the decisions made by the developed algorithm

Table 1. Estimated budget justification

Service	Qty	Unit Cost	Total Cost	Basis of Cost	Justification of need
Drone operation	800 (200 hr x 4 drones)	$400 per drone per hour	$320,000	Estimate based on similar project costs	Data collection for VSL operation
Drone video processing	800 (200 hr x 4 drones)	$350 per drone per hour	$280,000	Estimate based on similar project costs	Data processing for VSL operation
Other data collection	200 hr	$500 per hour	$100,000	Estimate based on similar purchases	Data collection for VSL operation
Multi-source data processing	200 hr	$1,000 per hours	$200,000	Estimate based on similar purchases	Data processing for VSL operation
VSL deployment	2 locations	$180,000 per location	$360,000	Estimate based on similar purchases	VSL deployment

7. Construction
8. Other
9. Indirect charges

UMD Budget

BUDGET

				% Effort					
Budget Categories	Titles	HRS	RATES	12 MONTH	9 MONTH	SUMM	Project Year 1	Project Year 2	Total
Personnel									
Senior Personnel									
Yao Cheng	PI		$ 87,601	**50%**			$ 43,800	$ 22,995	$ 66,796
Other Professionals								$ -	$ -
Saed Rahwanji	Faculty Specialist	322	$45/hour				$ 14,486	$ 7,605	$ 22,091
GRAII (9-month f/t)			$ 26,038		**100%**		$ 26,038	$ 13,670	$ 39,708
GRAII (half summer)			$ 8,680			**100%**	$ 8,680	$ 4,557	$ 13,237
Undergraduate student		800	$15				$ 12,000	$ 6,300	$ 18,300
Fringe Benefits								$ -	$ -
Yao Cheng	30.7%						$ 13,447	$ 7,060	$ 20,506
Saed Rahwanji	6.4%						$ 927	$ 487	$ 1,414
GRAII (9-month f/t)	25.5%						$ 6,640	$ 3,486	$ 10,126
GRAII (summer)	6.4%						$ 556	$ 292	$ 847
Undergraduate student	6.4%						$ 768	$ 403	$ 1,171
Travel								$ -	$ -
Local							$ -	$ -	$ -
Domestic							$ 5,000	$ 2,500	$ 7,500
International							$ -	$ -	$ -
Equipment								$ -	$ -
							$ -	$ -	$ -
							$ -	$ -	$ -
Supplies							$ -		$ -
Contractual Services								$ -	$ -
							$ -	$ -	$ -
Other								$ -	$ -
							$ -	$ -	$ -
							$ -	$ -	$ -
Tuition Remission								$ -	$ -
GRAII (9-month f/t)		24	828				$ 19,872	$ 10,433	$ 30,305
GRAII (summer)		4	828				$ 3,312	$ 1,739	$ 5,051
Total Direct Costs							$ 155,525	$ 81,526	$ 237,051
Indirect Costs	56.0%						74,111	38,838	$ 112,949
Total Costs							$ 229,636	$ 120,364	$ 350,000

Inflation (Salary)	1.05	Inflation (TR)	1.05

Inflation use between 3-5%, depending on potential COLA merit

UMD Budget justification
Personnel
Funds are requested for the Principal Investigator for 6 calendar months effort in project period 1 and 3 calendar months in project period 2.
Funds are requested for one GRA for 20 hours per week or 6 calendar months effort in project period 1 and 3 calendar months in project period 2.
Funds for the Faculty Specialist is requested for approximately 322 hours in project period 1 and 161 hours in project period 2 at $45/hour.
Funds are requested for an hourly undergraduate student for 800 hours in project period 1 and 400 hours in project period 2 at $15/hour.
All salaries are increased by 5% in project year 2 to account for merit and COLA increases.

Fringe Benefits
Fringe benefits include health insurance, FICA, unemployment, workers' compensation, retirement, terminal leave payout and employee assistance. Amounts for the sponsor's contribution to employee fringe benefits are calculated using UMD's U.S. Department of Health and Human Services (DHHS) approved Fringe Benefit Rates effective July 1, 2022. The approved rates are as follows: 30.7% for Faculty, 36.9% for Staff, 25.5% for Graduate Assistant and 6.4% for Contractual Faculty/Staff, hourly students and most Faculty/Staff additional pays. Tuition Remission is a UMD fringe benefit but is not included in the fringe calculation and is budgeted separately as applicable.

Travel
$5,000 is requested in project period 1 and $2,500 in project period 2 for two in-person trips to Washington DC for meetings with USDOT and for visits to the system deployment sites and MSHA.

Other Costs
Tuition for the Graduate Research Assistants is $828 per credit. A total of 28 credits is requested in project period 1 and 14 credits requested in project period 2. Tuition remission cost per credit is increased by 5% in project year 2 due to inflation.

Facilities and Administrative (F & A) Costs
The indirect cost rate effective from 7/1/23-6/30/26 for on-campus organized research is 56% of the Modified Total Direct Costs (MTDC) base. The MTDC base excludes tuition remission, equipment over $5,000, rental costs of off-campus facilities, and the portion of individual subcontracts over $25,000. This rate has been approved by the cognizant government agency, Department of Health and Human Services. This rate was approved on June 23, 2022, and is effective until amended.

UNIVERSITY OF MARYLAND

Pete Buttigieg

Secretary of Transportation

U.S. Department of Transportation

1200 New Jersey Ave, SE

Washington, DC 20590

Dear Secretary Buttigieg,

I am writing on behalf of the University of Maryland's Department of Civil and Environmental Engineering, a leading academic institution at the forefront of pioneering research in the fields of transportation and safety. We commit to collaborating with Maryland State Highway Administration (MSHA) on the "Real-time work zone speed management with multi-source data" project, should it be awarded.

To support the project and its partners, the University of Maryland commits to the following tasks:

- Utilizing our expertise in data analysis to meticulously determine optimal work zone sites for system deployment.
- Assessing the precision of the processed vehicular volume and speed data sourced from drone footage.
- Overseeing the real-time transmission and secure storage of drone data.
- Developing a state-of-the-art Variable Speed Limit algorithm that takes advantage of data from both traditional sources and drones.
- Conducting rigorous evaluations on the multi-source system's effectiveness on traffic efficiency, safety, and environmental considerations
- Providing technical support throughout the project, closely collaborating with vendors to ensure challenges are promptly identified and resolved

This commitment is new, specific, and measurable in the following ways:

- Relevant – With the University of Maryland's profound experience and knowledge in transportation, safety, and technology deployment, our involvement strengthens MSHA's initiative. We are dedicated to ensuring MSHA receives unparalleled technical and research assistance.

- Public - Our partnership will be consistently communicated through academic channels, research publications, and public outreach. By making our collaborative efforts widely known, we aim to highlight our joint ambition to advance work zone safety.
- High Impact – We aim at enhancing the project's efficacy by delving deep into the potential of drone integration in work zone management and disseminating our findings within the broader transportation sector. We foresee a reduction in work zone-related incidents and envision this system as a blueprint for other regions.

We are enthusiastic about this collective endeavor and are convinced of the revolutionary change it promises for work zone safety. The University of Maryland stands steadfast in its mission to champion the success of this collaborative venture.

Sincerely,

Yao Cheng

Faculty Specialist

Department of Civil and Environmental Engineering, University of Maryland

8228 Paint Branch Dr

Room 1136

College Park, MD 20742