



Center for Advanced Multimodal Mobility Solutions and Education

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1. ACCOMPLISHMENTS

1.1. What are the major goals and objectives of the program?

The major goals and objectives of the program as outlined in the proposal include the following categories.

Research

CAMMSE will address the FAST Act research priority area of “Improving Mobility of People and Goods” by conducting multi-disciplinary, multi-modal research, education and workforce development, and technology transfer. CAMMSE is motivated by the recent advances in computing, smartphones and communication technologies, and ubiquitous data to create sustainable, efficient, and growth-enabling multimodal transportation systems. Cutting edge analytical methods and models will enhance the effectiveness, efficiency, and reliability of these systems accordingly. Recent technological advancements enable new perspectives and holistic approaches to address the well-known challenges in multimodal transportation systems planning, design, operations, and maintenance. In particular, the following research topic areas will be established to maximize synergy and adaptability across multiple modes and jurisdictions:

- Increase access to opportunities that promote equity in connecting regions and communities, including urban and rural communities;
- Generate innovations in multi-modal planning and modeling for high-growth regions;
- Develop data modeling and analytical tools to optimize passenger and freight movements;
- Innovations to improve multi-modal connections, system integration and security; and
- Smart Cities.

Leadership

The CAMMSE team is nationally and internationally recognized for its contributions to the field of transportation research, and for its deployment of successful solutions to critical, real-world transportation challenges. In addition, team members are committed advocates and longstanding leaders within the multimodal transportation community and the UTC system itself. Through this UTC grant, the Consortium plans to build on its demonstrated experience to mentor future leaders in the field of transportation. CAMMSE plans to nurture students through skill building and professional development activities that promote notable research scholarships and successful transportation careers.

Education and Workforce Development

With years of collective education, research, and UTC experience, CAMMSE will provide a transportation education program through its partner universities. The program will promote creative and multidisciplinary problem-solving and exposure to a myriad of educational and workforce development experiences. The program will serve to attract, educate, and train future and existing transportation professionals with the know-how to undertake and implement innovative projects being or to be conducted.

The workforce development program will leverage the existing training skills and delivery resources available within partner universities. On-line webinars will be designed and delivered using available technical resources, which could provide Continuing Education Credits (CEUs) to interested course participants. In addition, UTC funds will be used to support and host the monthly transportation seminar series, particularly while classes are in session. The target audience is current students and the local university community. UTC funds will also enhance our ability to host nationally and internationally

recognized speakers. The target audience is local and regional (onsite), and national when recording and posting talks online.

CAMMSE will support career-building activities that facilitate student transition from school to the workplace by offering enhanced student research opportunities, research seminars, guest speakers, professional conference travel and other professional networking opportunities. In addition, outreach programs at the pre-collegiate level (elementary to high school) will be designed to spark interest in transportation issues and to encourage youth to consider transportation academic programs and careers. The outreach initiatives will particularly focus on recruiting underrepresented minorities into transportation and other STEM fields.

Technology Transfer

The technology transfer program at CAMMSE is designed to support the USDOT in its objective of “expanding technology transfer to partners and stakeholders” by sharing research results quickly and to the widest possible audience. CAMMSE has demonstrated ability to disseminate research results, spur implementations, and conduct continuing education programs. The technology transfer program is a direct extension of the Center’s research and education programs; in other words, these activities are designed to increase the scope and effectiveness of research accomplishments and education initiatives. General objectives within the technology transfer area in CAMMSE will be to:

- Increase the national visibility of CAMMSE research and education activities.
- Increase the availability and speed at which CAMMSE research results are disseminated.
- Provide technical assistance based on CAMMSE research and development.

Collaboration

CAMMSE has an extensive history of forming collaborative relationships at a variety of technical, fiscal and administrative levels. Across all its activities, from conducting pooled fund studies to hosting tech transfer events, CAMMSE will seek to work with collaborators from all sectors.

Diversity

In order for the transportation workforce to reflect the diversity of the national workforce pool, CAMMSE will continue to pursue the development of innovative programs to encourage new entrants, particularly those from groups currently underrepresented in the field. CAMMSE will actively participate in a number of committed activities through which the CAMMSE will increase interest in STEM disciplines and raise awareness of transportation-related careers amongst underrepresented groups.

1.2. What was accomplished under these goals?

Research

CAMMSE was funded by USDOT in November 2016 under the FAST act. During this reporting period, CAMMSE research results have been published in multiple journals, including *ASCE Journal of Transportation Engineering, Part A: System, Engineering Applications of Artificial Intelligence, IEEE Transactions on Intelligent Transportation Systems, International Journal of Transportation Science and Technology, Transportation Planning and Technology, and Transportation Research Record*. During this reporting period, CAMMSE research results were also presented at several conferences on different occasions, which include the USDOT Future of Transportation Summit at Washington D.C. on August 13-15, the 6th Bridging Transport Researchers Conference on August 7-8, the 2024 Canadian Society for Civil Engineering Annual Meeting Proceedings in June 2024.

In addition, CAMMSE has completed all research projects of year 6 (2021-2023) during this reporting period. All these final project reports have already been posted on the CAMMSE’s website and provided to the Transportation Research Board (Transport Research International Documentation database), the National Transportation Library, the U.S. DOT’s Research Hub, the Transportation Library, the Volpe National Transportation Systems Center, FHWA’s Research Library, and the U.S. Department of

Commerce as required by OST-R. These projects have resulted in valuable findings and advanced models, which will advance both the state of the art and the state of the practice in respective fields.

Leadership

Representing the CAMMSE, Center Director Dr. Wei Fan was listed among the Stanford/Elsevier Top 2% Scientist Rankings 2024 of “Logistics & Transportation” specialty in both “single year 2023” and “Career” categories in the field of “Economics and Business”, “Logistics and Transportation” (1st subfield) and “Civil Engineering” (2nd subfield) in September 2024. Dr. Wei Fan was also an inductee into the Inaugural UNC Charlotte Million Dollar Research Circle in April 2024. He has also been serving as an affiliate faculty in the School of Data Science, UNC Charlotte since August 15, 2022. During this reporting period, CAMMSE Center Director and Associate Directors have been actively serving on many editorial boards (e.g., Editors-in-Chief of *International Journal of Transportation Science and Technology*, and *Journal of Infrastructure Preservation and Resilience*; Handling Editors of *TRR Inaugural Editorial Board*, *Transportation Research Record*; Associate Editors of *Accident Analysis and Prevention*, *ASCE Journal of Transportation Engineering, Part A: Systems, Current Trends in Civil & Structural Engineering*, *IEEE Transactions on Intelligent Transportation Systems*, *International Journal of Transportation Science and Technology*, *Journal of Nondestructive Evaluation*, *Journal of Transportation Safety and Security*, and *Transportation Planning and Technology*; Editorial Boards of *Asian Transport Studies*, *International Journal of Transportation Science and Technology*, *Journal of Transportation Research Part D*, and *Journal of World Review of Intermodal Transportation Research*) and many professional committees (e.g., Vice-Chair of World Transport Convention Cross-Cutting Division, Advisory Board Member of ASCE National Artificial Intelligence (AI) Committee, Corresponding Member of ASCE Data Sensing & Analytics Committee, Member of ASCE Transportation Safety Committee, ASCE National Connected & Autonomous Vehicles Impacts Committee, NCDOT Fully Autonomous Vehicle (FAV) Research Working Group Committee, NCSITE Scholarship Committee, TRB Standing Committees (A0020C, ACP60, AP075, AHB60, AT045, AW010, AW010 (2)(3), AW020), World Transport Convention Shared Logistics and Transportation Systems Committee, Member of Maritime Education, Training, and Outreach Subcommittee of the Lone Star Harbor Safety Committee (LSHSC), as well as several proposal and paper review committees (e.g., NCHRP (17-108, 08-157, 17-102), and the TRB 104th Annual Meeting).

Education and Workforce Development

CAMMSE has been working with the Institute of Transportation Engineers (ITE) Student Chapter at UNCC in supporting and hosting the bi-weekly transportation seminar series in which guest speakers are invited to UNCC to present their current project activities while classes are in session. The target audience is current students and the local university community. Dr. Fan’s transportation research group has also been conducting graduate student seminars on a weekly basis during this reporting period.

CAMMSE Center researchers have been meeting on a regular basis. CAMMSE has provided a medium for sponsored students to develop important soft skills. All these events required that students interact with the local community and think of creative ways to portray complicated concepts in a simple and easy way to understand. CAMMSE has impacted both the local community and the sponsored students by encouraging creativity and enhancing connections.

At UNCC, CAMMSE Center Director Dr. Wei Fan taught the “Advanced Traffic Engineering” course in the Fall 2024 semester, “Connected and Autonomous Vehicles” and “Traffic Engineering” courses in the Spring 2024 semester to several undergraduate and graduate students who were in attendance. He also served as a Committee Member for three Ph.D. candidates. During this reporting period, a total of four students at UNCC have been involved in CAMMSE projects and all of them were directly supported by CAMMSE.

At TSU, nine graduate-level transportation-related courses were taught by CAMMSE personnel (Drs. Yi Qi, Mehdi Azimi, Mr. Vincent L Sanders, and Ms. Sascha S Sabaroch). TSU CAMMSE team shared the research findings with students, transportation professionals, and the public through published papers, presentations, or project final reports. During the reporting period, there were a total of five Workshops and seminars were hosted by the TSU team.

At UT Austin, Jennifer Hall served as head of Publicity for the UT Austin Student Transportation Council. She organized multiple guest lectures, social events, and alumni panels for undergraduate and graduate students. She also managed the bi-weekly newsletter as well as the Instagram account that keeps the UT-Austin transportation program informed of upcoming events. Carolina Baumanis was a member of the City of Austin Pedestrian Advisory Council (PAC). The PAC regularly advises government entities on local planning, policy, education, and enforcement efforts.

Technology Transfer

At UNCC, CAMMSE faculty, staff, researchers, and students have been making presentations at different meetings including the USDOT Future of Transportation Summit by U.S. Department of Transportation Headquarter at Washington D.C. on August 13-15, 2024, and the BTR6 (6th Bridging Transport Researchers Conference) on August 7-8, 2024.

TSU CAMMSE team shared the research findings with students, transportation professionals, and the public through published journal or conference papers, oral presentations, or student thesis works. During the reporting period, TSU published one peer-reviewed conference paper.

At UT Austin, a total of two active projects sponsoring two Ph.D. students, two principal investigators, and one researcher. One of the best technology transfer tools was the students who work on CAMMSE research projects. These UT Austin students are key to the technology development as they will carry the knowledge and technology developed through CAMMSE projects to the transportation engineering industry. Carolina Baumanis has joined the Texas Department of Transportation (TxDOT) Austin District, and Jennifer Hall is a transportation engineer for the consulting firm HDR, Inc. They each carried the new technology with them and used it in their new jobs, teaching peers how to use the technology, and thereby implementing the technology. Most importantly, these new techniques will continue to grow and improve as they are used. The UT Austin professors have used their classes to teach the new techniques developed through the CAMMSE UTC, thereby planting the new technology in students that are not directly supported by the UTC. In addition, information developed through UT Austin's research is being shared with the City of Austin in a research partnership.

Collaboration

CAMMSE created a diverse collaboration network with different state and local government agencies, and educational and professional organizations, as well as community practitioners. CAMMSE also worked to build collaborative relations with international transportation centers and universities.

During the reporting period, CAMMSE Center Director Dr. Wei Fan has been actively collaborating with several other universities across the country and abroad (e.g., NC A&T University) in conducting research and co-writing proposals and/or papers.

At TSU, Dr. Yi Qi and Dr. Mehdi Azimi partnered with several universities to develop new proposals, such as Texas A&M University and Texas State University. In addition, Dr. Yi Qi, Dr. Mehdi Azimi, and their teams also collaborated with the Argonne National Laboratory, Houston BCycle, Houston METRO, and the Texas District of the Institute of Transportation Engineers (ITE) on various research activities.

UT Austin has partnered with the Women in Transportation Seminar Heart of Texas (WTS-HOT) Student Chapter and the Institute of Transportation Engineers (ITE)/ Intelligent Transportation Systems (ITS) Student Chapter.

Diversity

Several Ph.D. students from underrepresented groups have been hired to conduct CAMMSE's research during this reporting period. For example, at UNCC, four international graduate students (including Mr. Tianjia Yang, Mr. Chengying Hua, Mr. Zehao Wang, all of whom came from P.R.China, and Mr. Mujeeb

Abiola Abdulrazaq who came from Nigeria) joined the INES Ph.D. program and they have been working as CAMMSE research assistants.

TSU is one of the nation's largest historically black universities, with most students being minority students.

At UT Austin, the CAMMSE funds have supported several graduate students from various countries, including China. These funds have also supported both male and female students from different ethnic backgrounds. For example, a female Latina at UT Austin was supported by CAMMSE.

1.3. What opportunities for training and professional development has the program provided?

At UNCC, the CAMMSE bi-weekly seminars are open to the general public, particularly to the local and state transportation agencies, as well as industry practitioners. CAMMSE has also been holding the weekly graduate seminar series at UNCC.

At UConn, CAMMSE researchers have organized and participated in a transportation graduate student seminar each week of the past two semesters. In the reporting period, this translates to twelve seminars attended by approximately 300 students, faculty, and visitors in total.

TSU host seminars and workshops to provide more learning opportunities to their students. During the reporting period, four seminars and workshops were organized. In addition, CAMMSE TSU continues to provide research assistantships to students who are interested in developing their careers in the transportation area.

UT Austin presented papers at the Canadian Society for Civil Engineering Annual Meeting. Attending this conference provides students the opportunity to network with practitioners, alumni, and academic professionals. Conferences are incubators for both personal relationships and research ideas and findings, providing rich professional development experiences for students. Drs. Machemehl and Claudel presented research topics and findings from the CAMMSE program to their graduate and undergraduate classes. Dr. Machemehl teaches an undergraduate senior elective class with approximately 60 students each spring semester, and he discusses all the CAMMSE research efforts during his lectures. Most of these students, about 85 percent, graduated in May, becoming new engineers in industry who bring with them results of the CAMMSE research projects.

1.4. How have the results been disseminated?

News items and information about CAMMSE have been regularly posted on the website at <https://cammse.uncc.edu/news>.

In particular, as mentioned before, UNCC has published many journal papers and made many presentations both nationally and internationally. At TSU, CAMMSE research results were published in one peer-reviewed journal paper and three project final reports. UT Austin has presented the results through published papers, technical reports, and technical presentations. Research results are disseminated through the classroom through teaching by the principal investigators and their colleagues. Additionally, various papers were presented at the Transportation Research Board's Annual Meeting in Washington, D.C.

1.5. What do you plan to do during the next reporting period to accomplish the goals and objectives?

The following tasks are planned in order to accomplish the goals and objectives of CAMMSE.

- (1) All final project reports completed for year 6 (2021-2023) have been provided to the Transportation Research Board (Transport Research International Documentation database), the

National Transportation Library, the U.S. DOT's Research Hub, the Transportation Library, the Volpe National Transportation Systems Center, FHWA's Research Library, and the U.S. Department of Commerce as required by OST-R.

- (2) Present papers based on CAMMSE's research on different occasions including the 2024 North Carolina Section Institute of Transportation Engineers (NCSITE) Annual Meeting, and the 2025 TRB 104th Annual Meeting.
- (3) TSU team has successfully completed the three active projects. The research findings have been summarized in project final reports and have been submitted to peer-reviewed journals for publication. In addition, TSU CAMMSE will continue hosting transportation-related seminars or workshops for both students majoring in transportation or interested in pursuing their careers in transportation areas.
- (4) At UT Austin, papers from Jennifer Hall's dissertation have been offered for publication in the Transportation Research Board's Transportation Research Record.

2. PARTICIPANTS AND COLLABORATING ORGANIZATIONS

2.1. Who has worked on the program?

The members of CAMMSE UTC include the University of North Carolina at Charlotte (UNCC); the University of Texas at Austin (UT Austin); the University of Connecticut (UConn); Washington State University – Pullman (WSU); and Texas Southern University (TSU). Table 1 lists the leadership team members who have worked on the program during this reporting period.

Table 1. CAMMSE Staff Working on the Program

Name	Wei Fan	Randy Machemehl	Nicholas Lownes	Xianming Shi	Yi Qi
Program/Project Role	Center Director	Associate Director at UT Austin	Associate Director at UConn	Associate Director at WSU	Associate Director at TSU
Contribution to Program/Project	Oversees overall operations of the program. Responsible for coordinating with stakeholders and developing and implementing the CAMMSE strategic plan	Serves as liaison between CAMMSE and UT Austin	Serves as liaison between CAMMSE and UConn	Serves as liaison between CAMMSE and WSU	Serves as liaison between CAMMSE and TSU
Funding Support	UNCC	UT Austin	UConn	WSU	TSU
Collaborated with Individual(s) in Foreign Country(ies)	Yes	No	Yes	Yes	Yes
Country(ies) of Foreign Collaborator(s)	P.R.China	No	Australia	P.R.China	P.R.China
Traveled to Foreign Country(ies)	N/A	N/A	N/A	N/A	N/A
If traveled to foreign country(ies), duration of stay	N/A	N/A	N/A	N/A	N/A

2.2. What organizations have been involved as partners?

Table 2. A List of Organizations Creating Partnerships with CAMMSE

Organization Name	Type / Location	Partners Contribution to Project				
		Financial Support	In-kind Support	Facilities	Collaborative Research	Personal Exchanges
Argonne National Laboratory	Government /IL				X	
Capital Metro – Austin Public Transit	Government /TX		X	X		

Centralina Council of Governments	MPO /NC		X			
City of Austin	Government /TX				X	
City of Charlotte	Government /NC		X			
City of Houston	Government /TX				X	
Connecticut Transportation Institute	Government /CT				X	
Houston BCycle	Non-profit/ TX				X	
Metropolitan Transit Authority of Harris County (METRO)	Government /TX				X	
North Carolina A&T University	University /NC				X	
North Carolina Department of Transportation	Government /NC		X			
Texas A&M Transportation Institute	University /TX				X	
Texas Department of Transportation	Government /TX		X	X		
Texas District of the Institute of Transportation Engineers (ITE)	Non-profit /TX				X	
Texas Southern University	University /TX	X	X	X		
Texas State University	University /TX				X	
UConn Human Rights Institute	University /CT					
University of Houston	University /TX				X	
University of Connecticut	University /CT	X	X	X		
University of North Carolina at Charlotte	University /NC	X	X	X		
University of Texas at Austin	University /TX	X	X	X		
UT's Center for Transportation Research (UT Austin)	University /TX		X	X		
Washington Department of Transportation	Government /WA				X	
Washington State University	University /WA	X	X	X		

Our CAMMSE UTC has successfully established an external advisory board which contains members from universities and government agencies. The detailed information about all five advisory board members is provided below:

- Dr. Michael Accorsi, Professor and Senior Associate Dean, School of Engineering, University of Connecticut.
Email: michael.accorsi@uconn.edu
- Dr. Amit Bhasin, Director, Center for Transportation Research, Associate Professor, Transportation Engineering, The University of Texas at Austin.
Email: a-bhasin@mail.utexas.edu

- Elizabeth Robbins, Planning Policy & Partnerships Manager, Multimodal Planning Division, Washington State Department of Transportation.
Email: robbins@wsdot.wa.gov
- Neil Mastin, Research and Development Manager, North Carolina Department of Transportation.
Email: jmastin@ncdot.gov
- Wade Odell, Research Engineer, Texas Department of Transportation.
Email: Wade.Odell@txdot

2.3. Have other collaborators or contacts been involved?

Dr. Wei Fan, CAMMSE Director, has been collaborating and conducting research with faculty and researchers from UNCC, North Carolina A&T University. A collaborative relationship has been successfully developed between them. Dr. Fan has been working with other researchers at UNC Charlotte on a research project entitled “Geo-FRIT: A Web-based Geospatial Analytics Tool for Quantifying Freight Risk and Resilience in Transportation”, which was sponsored by NCDOT. Dr. Fan also served as the lead principal investigator on the funded project entitled “Impact of Connected and Automated Vehicles on Work Zones” sponsored by NC-CAV/NCDOT.

TSU CAMMSE faculty members teamed up with professors from different universities to develop new UTC proposals. Collaborators were from the Texas State University, Texas A&M University, and the University of Houston.

UT Austin collaborated with City of Austin Transportation Department and the Austin District of TxDOT.

3. OUTPUTS

3.1. Journal publications, conference papers, and presentations

Journal publications

- [1] Fan, W., Guo, Z.Y., Wang, Y.L. and Sun, Y.N., The Future of AI in Transportation: Challenges and Opportunities?, Accepted for Publication, *International Journal of Transportation Science and Technology*, September 2024.
- [2] Fan, W., CAVs - Will They Ever Be A Mainstream Transport Mode?, Accepted for Publication, *Transportation Planning and Technology*, September 2024.
- [3] Yang, T. and Fan, W., Enhancing Robustness of Deep Reinforcement Learning Based Adaptive Traffic Signal Controllers in Mixed Traffic Environments through Data Fusion and Multi-Discrete Actions, Accepted for Publication, *IEEE Transactions on Intelligent Transportation Systems*, May 2024.
- [4] Li, W., Chen, S., Fan, W. and Luo, Q., Optimization of Periodic Train Schedule with Flexible Train Composition During Off-Peak Periods for Urban Rail Transit, *ASCE Journal of Transportation Engineering, Part A: Systems*, 150 (10), July 2024.
- [5] Hall, J., Sabillon-Orellana, C. A., and Machemehl, R.B., Efficacy or Equity? A Public Transit Operations Method for Balancing Costs and Local Need: A COVID-19 Case Study in Austin, TX, Accepted for Publication, *Transportation Research Record*, September 2024.
- [6] Rezwana, S, and Lownes, N., Interactions and Behaviors of Pedestrians with Autonomous Vehicles: A Synthesis, *Future Transportation*, 4(3), 722-745, July 2024.
- [7] Mantri, S., Bergman, D., and Lownes, N., Evaluation of AV deadheading strategies, *Future Transportation*, 4(3), 1059-1077, September 2024.

Conference papers

- [1] Hall, J., Machemehl, R.B., Optimizing Public Transport Efficiency through Supply-Demand Equilibrium Analysis Post-COVID-19: A Comprehensive Case Study, 2024 Canadian Society for Civil Engineering Annual Meeting Proceedings, Ontario, Canada, June 2024.
- [2] Azimi, M., Zhou, L., Ghaffari, N., and Qi, Y., "Impact of Bike Infrastructures on System-Wide Bike-Share System Ridership: A Longitudinal Analysis Using ARIMA Models in Houston", accepted for presentation, 104th Transportation Research Board Annual Meeting, Washington, DC, January.5-9, 2025.

Presentations

- [1] Fan, W., Transit Signal Priority under Connected Vehicle Environment: Deep Reinforcement Learning Approach, US DOT Future of Transportation Summit, U.S. Department of Transportation Headquarter, Washington D.C., August 13-15, 2024.
- [2] Yang, T. and Fan, W., Transit Signal Priority under Connected Vehicle Environment: Deep Reinforcement Learning Approach, BTR6 (6th Bridging Transport Researchers Conference), Online Meeting, August 7-8, 2024.
- [3] Hall, J., Machemehl, R.B., Optimizing Public Transport Efficiency through Supply-Demand Equilibrium Analysis Post-COVID-19: A Comprehensive Case Study, 2024 Canadian Society for Civil Engineering Annual Meeting Proceedings, Ontario, Canada, June 5-7, 2024.

3.2. Website(s) or other internet site(s)

The CAMMSE website is located at <http://cammse.unccl.edu/>. This website has been used to disseminate any information related to the program. Other internet sites include: <http://sboyles.github.io/>, <https://sites.utexas.edu/machemehl/> and <http://www.mass-lab-ut.com/>.

3.3. Technologies or techniques

Nothing to report.

3.4. Inventions, patent applications, and/or licenses

Nothing to report.

3.5. Other outputs

CAMMSE Graduate Seminar Series @ UNCC, Sponsored by CAMMSE

- [1] “Analyzing Seasonal Variations in Factors Influencing Pedestrian-Vehicle Crash Severity: A Random Parameter Logit Approach”, Presented by Mr. Mujeeb Abiola Abdulrazaq (CAMMSE INES Ph.D. research assistant), April 5, 2024, EPIC CEE Conference Room 3344.
- [2] “MADSH: Multi-Agent Dynamic Speed Harmonization in a CAV Environment”, Presented by Mr. Chengying Hua (CAMMSE INES Ph.D. research assistant), April 12, 2024, EPIC CEE Conference Room 3344.
- [3] “Advances, Challenges, and Future Research Needs in Machine Learning-Based Crash Prediction Models: A Systematic Review”, Presented by Mr. Zehao Wang (CAMMSE INES Ph.D. research assistant), April 26, 2024, EPIC CEE Conference Room 3344.
- [4] “Levels of AGI: Operationalizing Progress on the Path to AGI”, Presented by Mr. Tianjia Yang (CAMMSE INES Ph.D. research assistant), May 3, 2024, EPIC CEE Conference Room 3344.
- [5] “Pedestrian injury Severities Resulting from intersection Crashes: An Assessment of COVID-Contributing Temporal Shifts”, Presented by Mr. Mujeeb Abiola Abdulrazaq (CAMMSE INES Ph.D. research assistant), May 10, 2024, EPIC CEE Conference Room 3344.
- [6] “Sources and Strategies for Selecting a Potential Real-world Work Zone”, Presented by Mr. Mujeeb Abiola Abdulrazaq (CAMMSE INES Ph.D. research assistant), September 3, 2024, EPIC CEE Conference Room 3226.
- [7] “Calibrating Parameters for W-99”, Presented by Mr. Mujeeb Abiola Abdulrazaq (CAMMSE INES Ph.D. research assistant), September 10, 2024, EPIC CEE Conference Room 3226.
- [8] “A Priority-Based Multi-Level Heterogeneity Modeling Framework for Vulnerable Road Users”, Presented by Mr. Mujeeb Abiola Abdulrazaq (CAMMSE INES Ph.D. research assistant), September 17, 2024, EPIC CEE Conference Room 3226.
- [9] “An Enhanced Machine Learning Approach for Pedestrian Injury Severities with Imbalanced and High Dimensional Crash Data”, Presented by Mr. Zehao Wang (CAMMSE INES Ph.D. research assistant), September 24, 2024, EPIC CEE Conference Room 3226.

ITE Seminar Series @ TSU, Co-organized and sponsored by TSU ITE Student Chapter and CAMMSE

- [1] Improving Safety and Mobility through Technology, Duane Hartmann, PE, Associate Vice President, Iteris.
- [2] HCS Analysis of Unsignalized Intersections, Roundabouts, and Signalized Intersections, Fabio Sasahara, PhD, McTrans Center of the University of Florida.
- [3] Traffic Signal Analysis using Synshro, Kishore Juluru, PE, PTOE, and Amit Kumar Singh, PE, PTOE, Consor Engineers.
- [4] Traffic Signal Timing and Coordination with WaySync, Zong Tian, PhD, PE, University of Nevada, Reno.
- [5] Establishing A Professional Career: Insights From TSU And Essential Steps To Engineer Licensure In Texas, Sayed Abuzar Kazimi, PE, PTOE, Project Engineer, AIG Technical Services.

Technical Reports

- [1] Fan, W. and Hua, C., *Dynamic Coordinated Speed Control and Synergistic Performance Evaluation in Connected and Automated Vehicle Environment*, Technical Report for CAMMSE Research 2022 Project 16, U.S. Department of Transportation, September 2024.

- [2] Fan, W. and Yang, T., *Transit Signal Priority Control with Connected Vehicle Technology: Deep Reinforcement Learning Approach*, Technical Report for CAMMSE Research 2022 Project 17, U.S. Department of Transportation, September 2024.
- [3] Hall, J., and Machemehl, R.B., *Effectiveness of Safety Countermeasures on Dockless E-Scooter Crashes (Phase II)*, Technical Report for CAMMSE Research 2022 Project 05, U.S. Department of Transportation, September 2024.
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4. OUTCOMES

4.1. Increased understanding and awareness of transportation issues

Project 13 “Countermeasures for Maintaining Safe and Effective Public Transit Service in the Post-COVID-19 Era” first developed a model to quantitatively evaluate the infection risk of riding public transit. During the COVID pandemic, to prevent the spread of the virus, countries adopted various safety measures, including masking, social distancing, and vaccination. However, there was a lack of methods that can quantitatively evaluate the effectiveness of these countermeasures. This research filled this gap.

Project 14 “Investigate Age Impacts on Controlled Flight into Terrain (CFIT) Crashes in General Aviation” identified the contributing factors and recommend countermeasures to prevent or mitigate CFIT crashes. By analyzing the CFIT accidents in General Aviation from 2016-2018, it was found that pilots aged 60 and over were disproportionately involved in more CFIT accidents compared to other age groups. It was also found that most flights involved in CFIT accidents were operated by a single pilot. It also found that pilots of most of the accidents were non-occupational pilots. Note that occupational pilots include commercial airplane pilots and airline transport pilots.

Research done under Dr. Randy Machemehl characterizing public transportation during the pandemic in Austin, Texas, gleaned insights into how public transportation might have failed to supply essential travel to minority groups. The scooter project increased awareness about the dangers of scooters and high speeds by taking inventory of the many cities that have taken measures improve safety through reduced speeds.

4.2. Passage of new policies, regulation, rulemaking, or legislation

Nothing to report.

4.3. Increases in the body of knowledge

In Project 13 “Countermeasures for Maintaining Safe and Effective Public Transit Service in the Post-COVID-19 Era”, by utilizing the developed model, the effectiveness of different countermeasures could be evaluated and compared. The modeling results showed that masking, social distancing and vaccination can all reduce the infection risk for passengers. And among all these countermeasures, face masking was the most effective one. In addition, model results also proved that the COVID-19 infection risk is highly related to the exposure time and the risk can be controlled by reducing the exposure time.

Project 14, “Investigate Age Impacts on Controlled Flight into Terrain (CFIT) Crashes in General Aviation,” found that Pilot age, types of pilots, pilot license type, pilot medical certificates and number of pilots are the factors that have significant impacts on CFIT Crashes.

4.4. Improvement of existing techniques, practices, technologies

The findings of Project 13 “Countermeasures for Maintaining Safe and Effective Public Transit Service in the Post-COVID-19 Era” indicated that more public education or campaigns are needed to raise awareness of the importance of wearing masks. In addition, since COVID-19 infection risk is highly correlated to exposure time, more strategies aimed at reducing exposure time should be considered. Finally, since the developed model considers various factors that affect the infection risk, including social distance, ventilation rate, air distribution effectiveness, masking, vaccination, and exposure time, it can be used for assessing the effectiveness of different countermeasures and operational strategies that aim at reducing the COVID-19 infection risk of riding public transit. Thus, it will help public transit agencies maintain safe and effective public transit services during the post-COVID-19 era.

According to the findings of project 14, “Investigate age impacts on controlled flight into terrain (CFIT) crashes in general aviation,” various policy recommendations were provided, including implementing mandatory enhanced training for older pilots, increased oversight and training for non-occupational pilots, reviewing and revising certification standards, promoting two-pilot operations, focusing on high-risk flight phases, strengthening medical certification requirements, and annual flight review.

4.5. Enlargement of the pool of trained transportation professionals

At UNCC, CAMMSE supported doctoral students, Mr. Tianjia Yang and Mr. Chengying Hua graduated and obtained their Ph.D. degrees.

Jennifer Hall and Carolina Baumanis each completed work on their doctoral programs at UT Austin, and both entered the pool of trained transportation professionals.

4.6. Incorporation of new techniques, practices, technologies

Nothing to report.

5. IMPACTS

The CAMMSE has conducted and still been conducting a variety of research, education and outreach, technology transfer, and diversity activities and as such, the impact of this program cannot be comprehensively measured during this reporting period.

5.1. What is the impact on the effectiveness of the transportation system?

In Project 12 “Investigating the Impact of COVID-19 Pandemic Outbreak on Bike Share Usage and Ridership”, by highlighting the increase in bikeshare ridership during the COVID-19 pandemic, the project emphasized the potential for bikeshare programs to serve as flexible and adaptive modes of transportation during times of disruption. This adaptability can reduce pressure on traditional transportation modes, such as public transit and private vehicles, leading to more efficient use of urban infrastructure. Moreover, the study underlines the role of bikeshare in providing critical first-mile/last-mile connectivity, which enhances overall network efficiency by improving access to public transit and reducing car dependency.

In project 14, “Investigate age impacts on controlled flight into terrain (CFIT) crashes in general aviation,” the study’s results can lead to more informed policymaking and regulatory updates, helping aviation authorities and stakeholders implement targeted safety interventions, particularly for aging pilots. This might include enhanced training programs, periodic proficiency checks, or technology adaptations designed to assist pilots in high-risk age groups. Such measures could reduce the occurrence of CFIT crashes, ultimately improving overall safety in the general aviation sector. By mitigating the risks associated with CFIT, this project contributes to a more effective aviation system where crashes are less frequent and fatalities are minimized. This, in turn, enhances public confidence in aviation safety, supports more efficient airspace management, and reduces the economic and social costs associated with aviation accidents.

The research conducted at UT Austin revealed that increasing pedestrian safety and an understanding of the impacts of dockless electric scooters are significant priorities. Work done during this reporting period provided insights into both these topical areas.

5.2. What is the impact of technology transfer on industry and government entities, on the adoption of new practices, or on research outcomes which have led to initiating a start-up company?

The research is performed by students and faculty supervisors who work closely with industry and government entities. The working relationship with industry and government enables immediate technology transfer; an added benefit is the students who develop the new technology carry that knowledge with them into their transportation sector employment.

5.3. What is the impact on the body of scientific knowledge?

The research findings from conducting CAMMSE projects increased the body of scientific knowledge. One of the best technology transfer tools is the students who work on these CAMMSE research projects. These students are key to the technology development as they will carry the knowledge and technology developed through CAMMSE projects to the Transportation Engineering industry. They will carry the new technology with them and use it in their new jobs, teaching peers how to use the technology, thereby implementing the technology. Most importantly, these new techniques will continue to grow and improve as they are used.

5.4. What is the impact on transportation workforce development?

Engaging in CAMMSE's research initiatives allows students to gain firsthand experience with cutting-edge technologies and innovative methodologies for analyzing transportation-related challenges. This hands-on learning experience, guided by the mentorship of CAMMSE faculty members, equips students with the knowledge and skills that are essential for their future professional endeavors in the field.

Furthermore, CAMMSE's sponsorship of workshops and seminars presents invaluable opportunities for students to engage in dialogue with leading experts from both industry and academic spheres. These interactions not only enhance their understanding of the transportation sector but also significantly contribute to their career development by expanding their professional networks and exposing them to current trends and challenges in the field.

The professors at UT Austin have also used their classes to teach the new techniques developed through the CAMMSE UTC, therefore planting the new technology in students that are not directly supported by the UTC. In addition, information developed through UT Austin's research is being shared with the City of Austin as a partner in the research efforts.

6. CHANGES AND PROBLEMS

6.1. Changes in approach and reasons for change

Nothing to report.

6.2. Actual or anticipated problems or delays and actions or plans to resolve them

Nothing to report.

6.3. Changes that have a significant impact on expenditures

Nothing to report.

6.4. Significant change in use or care of animals, human subjects, and/or biohazards

Nothing to report.

6.5. Changes of primary performance site location from that originally proposed

Nothing to report.

6.6. Additional information regarding products and impacts

Nothing to report.

7. SPECIAL REPORTING REQUIREMENTS

- (1) **External Advisory Board:** Available on the program website:
<https://cammse.uncc.edu/directory/external-advisory-board>
- (2) **Financial and Annual Recipient Share Reports:** The SF 425 requirements will be met by separate reports.

APPENDIX

CAMMSE @ UNC Charlotte Funded Projects, 2016-2018 (Year 1), All Completed

University	Principle Investigator	Category	Title of the Funded Project
University of North Carolina at Charlotte	Wei Fan	Advanced Research	Estimation of Origin-Destination Matrix and Identification of User Activities Using Public Transit Smart Card Data
	Wei Fan	Applied Research	Improving the Movements of People and Freight: A Case Study of the Piedmont Atlantic Megaregion
University of Texas at Austin	Randy Machemehl	Applied Research	Forecasting Ridership for Commuter Rail in Austin
	Randy Machemehl	Advanced Research	Corridor Level Adaptive Signal Control
University of Connecticut	Nicholas Lownes	Basic Research	Stochastic Multimodal Network Modeling
	Nicholas Lownes	Basic Research	Robust Routing, Assignment, and Simulation of Transit Systems
Washington State University	Xianming Shi	Applied Research	The Use of Connected Vehicle Technology to Facilitate Multimodal Winter Travel
	Jia Yan	Applied Research	The Effect of Competition of Transport Modes on Mobility
Texas Southern University	Mehdi Azimi Yi Qi	Applied Research	Use of Vessel Automatic Information System Data to Improve Multi-modal Transportation in and around the Ports
	Yi Qi	Applied Research	Use of Innovative Intersection Designs for Improving Mobility and Reducing Roadway Traffic Congestion

CAMMSE @ UNC Charlotte Funded Projects, 2017-2019 (Year 2), All Completed

University	Principle Investigator(s)	Category	Title of the Funded Project
University of North Carolina at Charlotte	Wei Fan	Advanced Research	Use of Multisensor Data in Modeling Freeway Travel Time Reliability
	Wei Fan Martin Kane	Applied Research	Using General Transit Feed Specification (GTFS) Data as a Basis for Evaluating and Improving Public Transit Equity
	Wei Fan Yu Wang	Applied Research	Evaluating the Potential Use of Crowdsourced Bicycle Data in North Carolina
	Wei Fan	Advanced Research	Impact of Connected and Automated Vehicles (CAVs) on Freeway Capacity
	Wei Fan	Advanced Research	Optimal Variable Speed Limit Control for the Mixed Traffic Flows in a Connected and Autonomous Vehicle Environment
University of Texas at Austin	Randy Machemehl	Applied Research	Characterization of Bicycle Rider Behavior among Various Street Environments
	Randy Machemehl	Applied Research	Evolution of Advanced Transit Signal Priority with Gap-Based Signal Recovery Strategy
	Stephen Boyles	Applied Research	Assessment of Parcel Delivery Systems Using Unmanned Aerial Vehicles
	Christian Claudel	Advanced Research	Deep-learning Based Trajectory Forecast for Safety of Intersections with Multimodal Traffic
University of Connecticut	Nicholas Lownes Charles Patton Kelly Bertolaccini	Applied Research	Investigating the Linkage between Transit Access to Services and Affordable Housing Availability
	Karthik Charan Konduri	Advanced Research	Development of Continuous Time, Temporally Constrained and Behaviorally Consistent Tour Pattern Generation System for Modeling the Impacts of Autonomous Vehicle Future
	Norman Garrick Carol Atkinson - Palombo	Applied Research	What Do We Want from Autonomous Vehicles (AVs)? Using Participatory Planning and Scenario Analysis of Alternative Futures to Identify Stakeholders' Desired Outcomes from the Strategic Deployment of Emerging Transportation Technology
Washington State University	Xianming Shi	Applied Research	Developing Friction Data to Support the Optimal Use of Pre-wet Deicing Salt for Enhanced Winter Mobility
	Xianming Shi	Applied Research	Modeling the Macroscopic Effects of Winter Maintenance Operations on Traffic Mobility on Washington Highways
Texas Southern University	Yi Qi Mehdi Azimi Qun Zhao	Applied Research	Determination of Freeway Acceleration Lane Length for Smooth and Safe Truck Merging
	Yi Qi Mehdi Azimi Qun Zhao	Applied Research	Innovative Countermeasures for Reducing the Truck Waiting Time at Marine Terminals

	Mehdi Azimi Yi Qi Qun Zhao	Applied Research	Investigating the Impact of Different Attributes on Bicycling Mode Share as A Multimodal Connectivity Strategy in Large Cities: A Case Study in Houston
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CAMMSE @ UNC Charlotte Funded Projects, 2018-2020 (Year 3), All Completed

University	Principle Investigator(s)	Category	Title of the Funded Project
University of North Carolina at Charlotte	Wei Fan	Applied Research	Predicting Travel Time on Freeway Corridors: Machine Learning Approach
	Wei Fan Martin Kane	Applied Research	Optimizing Transit Equity and Accessibility by Integrating Relevant GTFS Data Performance Metrics
	Wei Fan Yu Wang	Applied Research	Analyzing Cycling Behavior during Different Time Periods Using Crowdsourced Bicycle Data
	Wei Fan	Applied Research	Trajectory Optimization of Connected and Autonomous Vehicles (CAVs) at Signalized Intersections
University of Texas at Austin	Randy Machemehl	Applied Research	Forecasting Bicycle Facility Demand to Estimate Societal Impacts
	Randy Machemehl	Applied Research	Corridor Level Adaptive Signal Control (Phase II)
	Stephen Boyles	Applied Research	Assessment of Parcel Delivery Systems Using Unmanned Aerial Vehicles (Phase II)
	Christian Claudel	Advanced Research	Deep-learning Based Trajectory Forecast for Safety of Intersections with Multimodal Traffic (Phase II)
University of Connecticut	Jeffrey Cohen Nicholas Lownes	Applied Research	Highways and Wealth Distribution: A Geospatial Analysis
	Karthik Konduri Nalini Ravishanker	Applied Research	Are Transportation Network Companies Synergistic with Other Shared Ride Mode Offerings? An Exploratory Analysis of Demand Data from NYC Utilizing High Resolution Spatiotemporal Models
	Norman Garrick Carol Atkinson - Palombo	Applied Research	Understanding the Surprising and Oversized Use of Ridesourcing Services in Poorer Neighborhoods in NYC
Washington State University	Michelle Akin Xianming Shi	Educational Research	Multimodal Transportation Engineering Curriculum for Middle and High School Students
	Xianming Shi	Applied Research	Effects of Incorporating Connected Vehicle Technologies into No-Notice Emergency Evacuation during Winter Weather
	Ali Hajbabaie	Applied Research	Dynamic Speed Harmonization in Connected Urban Street Networks: Improving Mobility
Texas Southern University	Yi Qi Mehdi Azimi Qun Zhao	Applied Research	Development of Guidelines for Implementation of Contraflow Left-Turn Lanes at Signalized Intersections
	Yi Qi Qun Zhao Mehdi Azimi	Applied Research	Signal Timing Strategy for Displaced Left Turn Intersections
	Mehdi Azimi Yi Qi	Applied Research	Impacts of Bicycling Corridor Improvements on Users' Behaviors in Large Cities

CAMMSE @ UNC Charlotte Funded Projects, 2019-2021 (Year 4), All Completed

University	Principle Investigator(s)	Category	Title of the Funded Project
University of North Carolina at Charlotte	Wei Fan	Applied Research	Travel Time Forecasting on a Freeway Corridor: a Dynamic Information Fusion Model Based on the Random Forests Approach
	Wei Fan Martin Kane	Applied Research	Optimization of Long-Term Highway Work Zone Scheduling
	Wei Fan	Applied Research	Impact of Connected and Autonomous Vehicles on Nontraditional Intersection Design: Superstreets
	Wei Fan	Applied Research	Machine Learning-based Trajectory Optimization of Connected and Autonomous Vehicles
University of Texas at Austin	Randy Machemehl	Applied Research	Quantification of Societal Bicycle Impacts (Phase III)
	Randy Machemehl	Applied Research	Corridor Level Adaptive Signal Control (Phase III)
	Stephen Boyles	Applied Research	Assessment of Parcel Delivery Systems Using Unmanned Aerial Vehicles (Phase III)
	Christian Claudel	Advanced Research	Deep-learning Based Trajectory Forecast for Safety of Intersections with Multimodal Traffic (Phase III)
University of Connecticut	Nicholas Lownes	Advanced Research	Prioritizing People - Mixed Equilibrium Assignment for AV Based on Occupancy
	Nicholas Lownes Timothy Becker	Advanced Research	Using Computational Biology to Mitigate Path Overlap in Transit Assignment
	Jin Zhu	Applied Research	Disaster Resilience through Diverse Evacuation and Emergency Transportation Systems
	John Ivan Amy Burnicki	Applied Research	Estimation of Pedestrian Volume Using Geospatial and Traffic Conflict Data
Washington State University	Xianming Shi	Applied Research	Multimodal Connected Vehicle Pilot for Winter Travel
Texas Southern University	Yi Qi Mehdi Azimi Qun Zhao	Applied Research	A New Method for Estimating Truck Queue Length at Marine Terminal Gates
	Mehdi Azimi Yi Qi	Applied Research	Analysis of Intermodal Vessel-to-Rail Connectivity
	Mehdi Azimi Yi Qi	Applied Research	Bicycle Network Connectivity and Accessibility: A Study on the Effects of Bike Infrastructures on Bicycle Sharing System Demand

CAMMSE @ UNC Charlotte Funded Projects, 2020-2022 (Year 5), All Completed

University	Principle Investigator(s)	Category	Title of the Funded Project
University of Texas at Austin	Randy Machemehl	Applied Research	Impacts of Speed on Dockless Electric Scooter Crashes
	Randy Machemehl	Applied Research	Optimizing Type and Location of Pedestrian Crossing Signs at Non-signalized Intersections
	Christian Claudel	Advanced Research	Predicting Paths of Controlled Pedestrians at Intersections Using Deep Learning Models
University of Connecticut	John Ivan Amy Burnicki	Applied Research	Estimation of Pedestrian Compliance at Signalized Intersections Considering Demographic and Geographic Factors
	Carol Atkinson Palombo Norman Garrick	Applied Research	An Evaluation of the Transportation Equity Impacts of Uber and Lyft Usage in Chicago
	Nicholas Lownes	Applied Research	Pedestrian Behavior and Interaction with Autonomous Vehicles
Washington State University	Ji Yun Lee	Advanced Research	Effect of Connected and Autonomous Vehicles on Supply Chain Performance
Texas Southern University	Mehdi Azimi Yi Qi	Applied Research	Studying the Impact of Pandemic Outbreaks on Maritime Transportation and Port Operation
	Yi Qi Mehdi Azimi Qun Zhao	Applied Research	Short Term Intersection Traffic Flow Forecasting
	Yi Qi Mehdi Azimi Qun Zhao	Applied Research	The Impacts of COVID-19 on Public Transit

CAMMSE @ UNC Charlotte Funded Projects, 2021-2023 (Year 6), All Completed

University	Principle Investigator(s)	Category	Title of the Funded Project
University of North Carolina at Charlotte	Wei Fan	Applied Research	Evaluating and Comparing the Impact of Connected and Autonomous Vehicles on Conventional Intersections and Superstreets (completed)
	Wei Fan	Advanced Research	Real-time Traffic Flow Prediction based on Spatiotemporal Patterns in Connected and Autonomous Vehicles Environment (completed)
	Wei Fan	Advanced Research	Online Cooperative Lane-changing Model of Connected and Autonomous Vehicles (completed)
	Wei Fan	Applied Research	Impact of Connected and Autonomous Vehicles on Signalized Intersections with Transit Signal Priority (completed)
	Wei Fan	Advanced Research	Dynamic Coordinated Speed Control and Synergistic Performance Evaluation in Connected and Automated Vehicle Environment (completed)
	Wei Fan	Advanced Research	Transit Signal Priority Control with Connected Vehicle Technology: Deep Reinforcement Learning Approach (completed)
University of Texas at Austin	Randy Machemehl	Applied Research	Effectiveness of Safety Countermeasures on Dockless E-Scooter Crashes (Phase II) (completed)
	Randy Machemehl	Applied Research	Choosing Locations for Installation of Pedestrian Crossing Signs and Safety Measures at Non-signalized Intersections (Phase II) (completed)
	Randy Machemehl	Applied Research	Developing Robust Smart Traffic Signal Control (completed)
University of Connecticut	Nicholas Lownes	Advanced Research	Prioritizing People - Mixed Equilibrium Assignment for AV Based on Occupancy (Phase II) (completed)
	Nicholas Lownes	Advanced Research	Pedestrian Behavior and Interaction with Autonomous Vehicles (Phase II) (completed)
	Jin Zhu	Applied Research	Disaster Resilience through Diverse Evacuation and Emergency Transportation Systems (Phase II) (completed)
	John Ivan Amy Burnicki	Applied Research	Estimation of Pedestrian Compliance at Signalized Intersections Considering Demographic and Geographic Factors (Phase II) (completed)
Washington State University	Xianming Shi	Applied Research	Prediction of Traffic Mobility Based on Historical Data and Machine Learning Approaches (completed)
Texas Southern University	Mehdi Azimi Yi Qi	Applied Research	Investigating the Impact of COVID-19 Pandemic Outbreak on Bike Share

			Usage and Ridership: A Case Study in Houston (completed)
	Yi Qi Mehdi Azimi Qun Zhao	Applied Research	Countermeasures for Maintaining Safe and Effective Public Transit Service in the Post-COVID-19 Era (completed)
	Yi Qi Qun Zhao Mehdi Azimi	Applied Research	Investigate Age Impacts on Controlled Flight into Terrain (CFIT) Crashes in General Aviation (completed)



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