Center for Advanced Multimodal Mobility Solutions and Education

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Semi-Annual Progress Report #11

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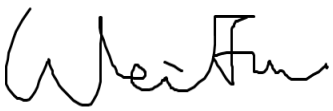
Signature of Submitting Official:	

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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.

1.2. What was accomplished under these goals?

Research

As stated in SAPR#9, the CAMMSE Call for Research Proposals for Year 6 (2021-2023) was developed and officially sent out to all CAMMSE Assistant Directors and researchers internally at UNC Charlotte and Associate Directors at all other member universities on May 31, 2021. Research proposals that were received and rigorous peer-reviews were then conducted. After examining the proposal evaluation comments and review ratings of all proposals, the CAMMSE Research Program Leadership Committee selected several for funding. The appendix contains the list of the funded projects (in Year 6) with respect to each member university. For all research projects that were selected for funding, all the relevant CAMMSE Project Information Forms were posted on the CAMMSE website as well as on RiP as required by OST-R. All funded projects in the sixth year (i.e., in the year of 2021-2023) were expected to be completed within two years.

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 *Conservation and Recycling, Entropy, IEEE Transactions on Automatic Control, IEEE Transactions on Intelligent Transportation Systems, Information Sciences, International Journal of Engineering Education, Journal of Advanced Transportation, Journal of Safety Research, Journal of Transportation Research Part D, Resources, 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 2022 East End Chamber of Commerce Education Symposium, the HBCU-Georgia Tech Transport Researcher Forum, and the 62nd Annual Transportation Research Forum (TRF) that was held at St. Louis, MO on April 8, 2022.

In addition, CAMMSE has completed all research projects of year 5 (2020-2022) and also seven out of seventeen research projects of year 6 (2021-2023) during this reporting period. Those 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 has been serving as an affiliate faculty member in the School of Data Science at UNC Charlotte. During this reporting period, CAMMSE Center Director and Associate Directors have been actively serving on many editorial boards (e.g., Editor-in-Chief of *Journal of Infrastructure Preservation and Resilience*, Guest Editor of *Vehicles, Special Issues on Recent Developments in the Intelligent Transportation System (ITS),* Handling Editor of *TRR Inaugural Editorial Board, Transportation Research Record*, Associate Editor 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,* and *International Journal of Transportation Science and Technology;* Editorial Board of *Asian Transport Studies, International Journal of Transportation Science and Technology*, *Journal of Transportation Research Part D*, *Journal of World Review of Intermodal Transportation Research,* and *Transportation Planning and Technology;* and many professional committees (e.g., General Secretary of Chinese Overseas Transportation Association (COTA), Co-Chair of World Transport Convention Connected Autonomous Vehicles Section, Advisory Board Member of ASCE National Artificial Intelligence (AI) Committee, Member of ASCE National Connected & Autonomous Vehicles Impacts Committee, ASCE Public Transport Committee, ASCE Rail Transportation Committee, NCDOT Fully Autonomous Vehicle (FAV) Research Working Group Committee, NCSITE Scholarship Committee, PENC State Board, TRB Standing Committees (A0020C, ACP60, AHB60, AP075, AT045, AW010, AW010 (2)(3), AW020), Secretary of TRB Standing Committees (A0020C, AP075), World Transport Convention Shared Logistics and Transportation Systems Committee, Head of Publicity for the UT-Austin Student Transportation Council, the Organizing Committee for the 22nd COTA International Conference of Transportation Professionals, Director of Washington State Transportation Center (TRAC), the Lone Star Harbor Safety Committee (LSHSC), and the Pedestrian Advisory Council (PAC) for the City of Austin), as well as several proposal and paper review panels/committees (e.g., Canada Research Chair Renewal Review - Cooperative Transportation Systems, NCHRP (08-157, 17-102, and 17-108), Luxembourg National Research Fund (LNR), Independent Research Fund Denmark, other USDOT Tier 1 UTCs, and the TRB 102nd 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 Staff (Drs. Wei Fan, Martin Kane, and Kim Wilson) have been meeting on a regular basis. Topics discussed among these important regular meetings include, but are not limited to, the annual research symposium, annual transportation summer camp at UNCC, research, education, and outreach as well as technology transfer activities. CAMMSE'S Transportation Engineering Summer Camp was successfully held in the week of June 20-24, 2022 on the campus of UNCC, led by Dr. Martin Kane. 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 had 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 “Transportation Systems Analysis “course in the Fall 2021 semester, the “Connected and Autonomous Vehicles” course in the Spring 2022 semester and “Traffic Flow Theory” course in the Fall 2022 semester to several graduate students who were in attendance. During this reporting period, a total of six students at UNCC have been involved in CAMMSE projects and all of them were directly supported by CAMMSE. Hengcong Guo and Yang Zhao were awarded the prestigious Don Blackburn Memorial Scholarship and the Roy D. Williams Memorial Scholarship, respectively, on July 21, 2022.

At WSU, one female engineering faculty member and two female Ph.D. students in the Department of Civil & Environmental Engineering and one female undergraduate student contributed to the CAMMSE site activities. Mehdi Honarvar Nazari won the Outstanding Research Assistant Award in the Department of Civil & Environmental Engineering at WSU.

At TSU, five undergraduate-level and ten graduate-level transportation-related courses were taught by CAMMSE personnel (Drs. Yi Qi, Mehdi Azimi, Lei Yu, and Ms. Ursurla Williams). During the reporting period, there were a total of eight graduate students and one undergraduate student who participated in CAMMSE research projects and were supported by CAMMSE. Among all students, four were male students and five were female students.

At UT Austin, Drs. Machemehl and Claudel presented research topics and findings from the CAMMSE program to their graduate and undergraduate classes. Dr. Machemehl taught an undergraduate senior elective class with approximately 60 students each spring semester and he discussed all the CAMMSE research efforts during his lectures. There are a total of four active projects sponsoring one master’s student, four Ph.D. students, one undergraduate student, two principal investigators, and one researcher.

Technology Transfer

At UNCC, CAMMSE faculty, staff, researchers, and students have been publishing many journal papers and making presentations at different meetings including the University of Nebraska at Lincoln on May 11, 2022, and the Battery Complexity, Autonomous Vehicle and Electrification (BATT CAVE) Research Center at UNC Charlotte on September 9, 2022.

At TSU, research findings discovered by the CAMMSE team were shared with students, transportation professionals, and the general public through published journal papers and technical reports. During the reporting period, TSU published five peer-reviewed journal papers and three technical reports. In addition, Dr. Yi Qi was invited to present her research at regional or national meetings, such as the 2022 East End Chamber of Commerce Education Symposium and the HBCU-Georgia Tech Transport Researcher Forum.

At UT Austin, one of the best technology transfer tools is the students that work on these 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. 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. 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 the City functions as a partner in the research efforts.

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., NCA&T and NC State University) in co-writing proposals and/or papers. Dr. Kane also collaborated with Charlotte Area Transit System (CATS), Charlotte-Douglas Airport, and Michigan State University for CAMMSE'S Transportation Engineering Summer Camp that was held June 20-24, 2022 on the campus of UNCC.

At UConn, researchers collaborated closely with the Connecticut Transportation Institute (CTI) in their CAMMSE research efforts. In particular, collaborations with the Connecticut Transportation Safety Research (CTSRC) Center and the CTI simulation and virtual reality laboratories were crucial to progress on CAMMSE research. CTSRC provided data analysis and technical assistance to projects 2021-04 and 2022-11 and the CTI VR lab was instrumental in the development of the virtual environment for the 2021-06 project.

At TSU, Dr. Yi Qi collaborated with METRO on her research projects. METRO provided CAMMSE TSU team transit data and offered consultations. Their input helped us validate and refine the research findings. Dr. Mehdi Azimi also worked with the City of Houston on his research project. In addition, Drs. Yi Qi and Mehdi Azimi partnered with several universities to develop new UTC proposals, such as the University of Tennessee, the University of Michigan, the University of Texas at Austin, the University of Arizona, the University of Delaware, and George Washington University.

At UT Austin, researchers 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, six international graduate students (including Mr. Shaojie Liu, Mr. Li Song, Mr. Tianjia Yang, Mr. Chengying Hua, Ms. Yang Zhao, and Mr. Hengcong Guo, all of whom came from P.R.China) joined the INES Ph.D. program and they have been working as CAMMSE research assistants. Two master students, Mr. Kiavash Riahipour from Iran and Ms. Ruth Kandolo from Congo, are currently being advised by Dr. Wei Fan in their study to get a master's degree.

At WSU, one female engineering faculty member and two female Ph.D. students in the Department of Civil & Environmental Engineering and one female undergraduate student contributed to the CAMMSE site activities.

At UConn, researchers have been participants in the INCLUDE program supporting neurodiverse students in Civil and Environmental Engineering. It aims to make systemic changes that range across the entire span of an engineering student's undergraduate experience (https://neurodiversity.engr.uconn.edu/about/).

TSU is one of the nation's largest historically black universities, with most students being minority students. During the reporting period, TSU CAMMSE supported eight graduate students and one undergraduate student with different backgrounds, including four female students and five African American students.

At UT Austin, the CAMMSE funds have supported several undergraduate and graduate students from various countries, such as China. These funds have also supported both male and female students from different ethnic backgrounds. For example, UT Austin has a female Latina 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 the industry practitioners. CAMMSE has also been holding the weekly graduate seminar series at UNCC.

At TSU, CAMMSE team provides research assistantships to both undergraduate and graduate students who are interested in developing their careers in the transportation area. Sponsored students work closely with our faculty members to receive extensive hands-on training by participating in CAMMSE research projects. The team also hosts seminars and workshops to provide more learning opportunities to our students. During the reporting period, one workshop “Traffic Signal Timing and Coordination with TranSync” and one seminar “METRO Rapid Inner Katy Project” were organized.

At UT Austin, CAMMSE research was presented at the TRF Annual Meeting in St. Louis, MO. Most of these students (about 85 percent) graduated in May 2022 becoming new engineers who bring with them results of the CAMMSE research projects. Dr. Mohamed (which received CAMMSE support) interned at Meta (former Facebook) and joined Meta after graduating, where he continues working on prediction of users/pedestrian actions.

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 several journal papers and made many presentations both nationally and internationally. At UConn, the research has been disseminated through scholarly conferences, colloquia and publications in addition to integration with undergraduate and graduate coursework. TSU research results were published in five peer-reviewed journals and three technical reports. The research results were also disseminated through invited presentations that their faculty members gave. UT Austin has presented the results through published papers, technical reports, and technical presentations. Research results are disseminated through the classroom teaching of the principal investigators and their colleagues. Additionally, various papers were submitted to the Transportation Research Board’s Annual Meeting in Washington, D.C. Two papers were presented at the Transportation Research Forum (TRF) Annual Meeting in St. Louis, MO.

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 to be completed for year 5 (2020-2022) and some final project reports to be completed for year 6 (2021-2022) will be 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 North Carolina Section Institute of Transportation Engineers (NCSITE) Annual Meeting on November 17, 2022, and the TRB 102nd Annual Meeting from January 8-12, 2023.
(3) The Fifth Annual CAMMSE Virtual Research Symposium will be held November 10-11, 2022.
(4) WSU researchers will continue their activities in journal article submission/revision and presentations when suitable. One faculty presentation and one graduate student presentation have been scheduled for the upcoming CAMMSE Annual Conference in November 2022.
(5) UConn researchers will make significant efforts to complete development of the empirical environments for 2021-06, recruitment of participants and collection of relevant data.

Researchers plan to have a full dataset and to have begun analysis by the end of the next reporting period.

(6) CAMMSE team at TSU will continue working on currently active projects. The research findings will be summarized and submitted to peer-reviewed journals for publication. In addition, TSU will continue to provide research assistantships to students to encourage them to pursue careers in the transportation area. Finally, TSU will continue hosting transportation-related workshops or seminars for both CAMMSE-supported students and all other students majoring in transportation or interested in pursuing their careers in transportation areas.

(7) UT Austin CAMMSE participants will travel to Washington, D.C. for the TRB Annual Meeting. At the TRB meeting, CAMMSE researchers will present CAMMSE-work and discuss findings/insights with colleagues from all over the world. They are also submitting CAMMSE-related research in an abstract format to the ASCE conference in October. The ASCE conference will take place in Austin, Texas in 2023. They will also continue submitting any finalized research product to journal publications whenever possible.

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
Capital Metro – Austin Public Transit	Government /TX		X	X		
Centralina Council of Governments	MPO /NC		X			
Chang'an University	University				X	

	/China					
Charlotte-Douglas Airport	Government /NC		X			
City of Austin	Government /TX				X	
City of Charlotte	Government /NC		X			
City of Houston	Government /TX				X	
Connecticut Department of Transportation	Government /CT				X	
Connecticut Transportation Institute	Government /CT				X	
George Washington University	University/DC				X	
Houston Bike Share	Non-profit/TX				X	
Houston BCycle	Non-profit/TX				X	
Houston-Galveston Area Council	Non-profit/TX				X	
International Association of Maritime and Port Executives	Non-profit /Intl.				X	
METRO	Government /TX				X	
Michigan State University	University /MI		X			
North Carolina A&T University (NCA&T)	University /NC				X	
North Carolina Department of Transportation	Government /NC		X			
North Carolina State University (NCSU)	University /NC				X	
North Carolina Turnpike Authority Automated Vehicle Proving Ground	Government /NC				X	
Oregon State University	University/OR				X	
PacTrans	UTC/WA				X	
Texas A&M Transportation Institute	University /TX				X	
Texas Department of Transportation	Government /TX		X	X		
Texas Department of Transportation – Austin District	Government /TX				X	
Texas Department of Transportation – Dallas District	Government /TX		X	X		
Texas Southern University	University /TX	X	X	X		
Tongji University	University /China				X	
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		

University of Tennessee	University /TN				X	
University of Michigan	University /MI				X	
University of Arizona	University /AZ				X	
University of Delaware	University /DE				X	
UT's Center for Transportation Research (UT Austin)	University /TX		X	X		
University of Washington	University /WA				X	
Washington Department of Transportation	Government /WA				X	
Washington State University	University /WA	X	X	X		
West Virginia University (WVU)	University /WV				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 and North Carolina State University (on projects sponsored by NCDOT and NCHRP 13-06), as well as working, co-writing, and publishing papers with faculty and researchers from Chang'an University and Tongji University in P.R.China. A collaborative relationship has been successfully developed with those universities. Dr. Martin Kane worked with the Charlotte-Douglas Airport, Charlotte Area Transit System (CATS), and Michigan State University on organizing activities for the CAMMSE's summer camp that was held on UNCC campus in June 2022.

UT Austin collaborated with the Dallas District of TxDOT, City of Austin Transportation Department, and Austin District of TxDOT. At UConn, researchers collaborated with Connecticut DOT and Connecticut Transportation Institute. At WSU, Dr. Shi has met with the Region 10 UTC PacTrans Director and the Director of WSU Vancouver School of Engineering and Computer Science to discuss possible collaboration in mobility solutions. At TSU, CAMMSE faculty members teamed up with several universities (including University of Tennessee, University of Michigan, UT Austin, University of Arizona, University of Delaware, George Washington University, etc.) to develop new UTC proposals.

3. OUTPUTS

3.1. Journal publications, conference papers, and presentations

Journal publications

[1] Hua, C. and Fan, W., Injury Severity Analysis of Time-of-Day Fluctuations and Temporal Volatility in Atypical Sideswipe Collisions: A Random Parameter Model with Heterogeneous Means and Heteroscedastic Variances, Accepted for Publication, *Journal of Safety Research*, July 2022.

[2] Liu, S. and Fan, W., Platooning-Based Trajectory Planning of Connected and Autonomous Vehicles at Superstreets, Accepted for Publication, *Transportation Planning and Technology*, June 2022.

[3] Liu, S. and Fan, W., Evaluating the Performance of Connected and Automated Vehicles in Fixed Signal-Controlled Conventional Intersections and Superstreets with Platooning-Based Trajectory Planning, Accepted for Publication, *Journal of Advanced Transportation*, May 2022.

[4] Willis, O., Zhang, Y., Reed, C., Shi, X., Inspiring Transportation Engineering Curriculum for Middle and High School Students: A Case Study. *International Journal of Engineering Education*, 2022.

[5] Zhao, J. and Lee, J.Y., Effect of Connected and Autonomous Vehicles on Supply Chain Performance, *Transportation Research Record*, August 2022.

[6] Qu, W., Li, J., Song, W., Li, X., Zhao, Y., Dong, H., Wang, Y., Zhao, Q., and Qi, Y., Entropy-Weight Method-Based Integrated Models for Short-Term Intersection Traffic Flow Prediction, *Entropy*, 24(7): 849, June 2022.

[7] Zhao, Q., Qi, Y., and Wali, M. M., A Method for Assessing the COVID-19 Infection Risk of Riding Public Transit, *International Journal of Transportation Science and Technology*, July 2022.

[8] Zhang, Y., Chen, X., Zhao, Y., Ma, J. and Yu, L., A Methodology for Measuring the Environmental Effect of Autonomous Bus Considering Platooning, *Transportation Research Part D: Transport and Environment*, Volume 107, 103300, June 2022.

[9] Du, J., Qiao, F., and Yu, L., Forecasting Ground-Level Ozone Concentration Levels Using Machine Learning, *Resources, Conservation and Recycling*, Volume 184, 106380, September 2022.

[10] Fan, P., Song, G., Zhu, Z., Wu, Y., Zhai, Z. and Yu, L., Road Grade Estimation Based on Large-Scale Fuel Consumption Data of Connected Vehicles. *Transportation Research Part D: Transport and Environment*, Volume 106, 103262, May 2022.

[11] Du, B., Qian, K., Claudel, C., and Sun, D., Jacobi-Style Iteration for Distributed Submodular Maximization, *IEEE Transactions on Automatic Control*, vol. 67, no. 9, pp. 4687-4702, September 2022.

[12] Cohen, J. P., Lownes, N., and Zhang, B., 1960s Interstate Highways and Homeowner Wealth Distribution, *Federal Reserve Bank of St. Louis REVIEW*, September 2022.

Conference papers

[1] Rezwana, S., Jackson, E., Filipovska, M., and Lownes, N., A Modified Social Force Model (SFM) for Pedestrian Behavior in the Presence of Autonomous Vehicles (AVs), International Conference on Transportation and Development, Seattle, WA, June 2022.

Presentations

[1] Fan, W., A New Era in Transportation: Challenges and Opportunities, Invited Inaugural Presentation, Battery Complexity, Autonomous Vehicle and Electrification (BATT CAVE) Research Center, UNC Charlotte, Charlotte, NC, September 9, 2022.

[2] Fan, W., Developing Innovative Solutions to Transportation Problems, University of Nebraska at Lincoln, Lincoln, NE, May 11, 2022.

[3] Qi, Y., Building an Effective Workforce through Collaboration with Industry and Academia, 2022 East End Chamber of Commerce Education Symposium, Houston Community College SE campus, May 25, 2022.
[4] Qi, Y., Impacts of COVID-19 on Public Transit Ridership, HBCU-Georgia Tech Transport Researcher Forum, Georgia Tech Hotel & Conference Center, Atlanta, GA, May 17, 2022.
[5] Baumanis, C., Hall, J., and Machemehl, R., A Machine Learning Approach to Predicting Bicycle Demand During the COVID-19 Pandemic, 62nd Annual Transportation Research Forum, St. Louis, MO, April 8, 2022.

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

The CAMMSE website is located at http://cammse.uncc.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

USDOT CAMMSE UTC Webinar Series, Sponsored by CAMMSE

[1] "Skeleton-Graph: Long-Term 3D Motion Prediction From 2D Observations Using Deep Spatio-Temporal Graph CNNs", presented by Dr. Christian Claudel (Associate Professor, UT Austin), remotely via Zoom, May 19, 2022.

CAMMSE Graduate Seminar Series @ UNCC, Sponsored by CAMMSE

[1] “A Review of Motion Planning for Highway Autonomous Driving”, presented by Mr. Hengcong Guo (CAMMSE INES Ph.D. research assistant), 9-10am, September 28, 2022, EPIC CEE Conference Room 3344.
[2] “Literature Review on Driver behavior identification”, presented by Ms. Yang Zhao (CAMMSE INES Ph.D. research assistant), 9-10am, September 21, 2022, EPIC CEE Conference Room 3344.
[3] “Adaptive Traffic Signal Control with Deep Reinforcement Learning and High Dimensional Sensory Inputs: Case Study and Comprehensive Sensitivity Analyses”, presented by Mr. Tianjia Yang (CAMMSE INES Ph.D. research assistant), 9-10am, September 14, 2022, EPIC CEE Conference Room 3344.
[4] “A Review of Dynamic Speed Harmonization (DSH) Strategy in the Mixed Traffic Environment”, presented by Mr. Chengying Hua (CAMMSE INES Ph.D. research assistant), 9-10am, September 7, 2022, EPIC CEE Conference Room 3344.
[5] “Introduction to graph search methods and motion planning algorithm”, presented by Mr. Hengcong Guo (CAMMSE INES Ph.D. research assistant), 9-10am, August 31, 2022, EPIC CEE Conference Room 3344.
[6] “Spatiotemporal COSTMAP inference for MPC via inverse reinforcement learning”, presented by Ms. Yang Zhao (CAMMSE INES Ph.D. research assistant), 9-10am, August 24, 2022, EPIC CEE Conference Room 3344.
[7] “Deep Reinforcement Learning for Intelligent Transportation Systems: A Survey”, presented by Mr. Tianjia Yang (CAMMSE INES Ph.D. research assistant), 9-10am, August 10, 2022, remotely via Zoom.

[8] "A Deep Learning Perspective on Traffic Speed Prediction under the Intelligent Driving Environment", presented by Mr. Chengying Hua (CAMMSE INES Ph.D. research assistant), 9-10am, July 13, 2022, remotely via Zoom.
[9] "NGSIM Data Configuration", presented by Ms. Yang Zhao (CAMMSE INES Ph.D. research assistant), 9-10:30am, June 8, 2022, remotely via Zoom.
[10] "Impacts of Connected and Automated Vehicles on Deep Reinforcement Learning Controlled Intersection Systems", presented by Mr. Li Song (CAMMSE INES Ph.D. research assistant), 9-10am, May 4, 2022, remotely via Zoom.
[11] "The Impact of Connected and Autonomous Vehicles (CAVs) on the Performance of Superstreets", presented by Mr. Shaojie Liu (CAMMSE INES Ph.D. research assistant), 10-11am, May 4, 2022, remotely via Zoom.
[12] "Transit Signal Priority with CAV: Genetic Algorithm Approach", presented by Mr. Tianjia Yang (CAMMSE INES Ph.D. research assistant), 8-9am, April 27, 2022, remotely via Zoom.
[13] "The Forefront of Methods on Traffic Prediction and Representative Highway Public Datasets", presented by Mr. Chengying Hua (CAMMSE INES Ph.D. research assistant), 9-10am, April 20, 2022, remotely via Zoom.
[14] "Decision Making of Autonomous Vehicles in Lane Change Scenarios: Deep Reinforcement Learning Approaches with Risk Awareness", presented by Ms. Yang Zhao (CAMMSE INES Ph.D. research assistant), 9-10am, April 13, 2022, remotely via Zoom.
[15] "Results and Discussions for Platooning, Trajectory Planning and Adaptive Signal Control in Superstreets", presented by Mr. Shaojie Liu (CAMMSE INES Ph.D. research assistant), 9-10am, April 6, 2022, remotely via Zoom.

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

[1] "Planning Study on Bus Priority Improvements to the CATS Bus System", lectured by Ms. Emily Chen, EI, Transportation Analyst from Kittelson & Associates, Inc., remotely via Zoom, April 7, 2022.
[2] "How to Succeed in Career Development as An Engineer", lectured by Dr. Patrick Madsen, the Director of the University of Career Center at UNC Charlotte, EPIC 3226, September 06, 2022.

CAMMSE Workshop @ TSU, Sponsored by CAMMSE

[1] "Traffic Signal Timing and Coordination with TranSync", presented by Dr. Aobo Wang, a postdoctoral researcher with the University of Nevada, Reno, 9am-5pm, TSU technology building room 261, August 4, 2022.

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

[1] "METRO Rapid Inner Katy Project", lectured By Ms. Amma Cobbinah, Senior Planning Program at Metropolitan Transit Authority of Harris County (METRO), TSU technology building Room 206, September 22, 2022.

Technical Reports

[1] Hall, J., Baumanis C., and Machemehl, R., *Impacts of Dockless Electric Scooter Crashes*, Interim Technical Report for CAMMSE Research 2021 Project 01, U.S. Department of Transportation, September 2022.
[2] Baumanis, C. and Machemehl, R., *Driver Compliance with Pedestrian Crossings at Non-Signalized Intersections*, Technical Report for CAMMSE Research 2021 Project 02, U.S. Department of Transportation, September 2022.
[3] Mohamed, A., Claudel, C., *HAR-GCNN: Deep Graph CNNs for Human Activity Recognition from Highly Unlabeled Mobile Sensor Data*, Technical Report for CAMMSE Research 2021 Project 03, U.S. Department of Transportation, September 2022.
[4] Ivan, J., Burnicki, A., and Packer, Q., *Estimation of Pedestrian Compliance at Signalized Intersections Considering Demographic and Geographic Factors*, Technical Report for CAMMSE Research 2021 Project 04, U.S. Department of Transportation, June 2022.

[5] Atkinson-Palombo, C. and Garrick, N., *Characteristics of Pooled Trips Offered by Ride-sourcing Services in Chicago*, Technical Report for CAMMSE Research 2021 Project 05, U.S. Department of Transportation, September 2022.
[6] Lownes, N., Rezwana, S., Shaon, M.R.R., and Jackson, E., *Pedestrian Behavior and Interaction with Autonomous Vehicles*, Technical Report for CAMMSE Research 2021 Project 06, U.S. Department of Transportation, September 2022.
[7] Azimi, M., Qi, Y., and Li, J., *Studying the Impact of Pandemic Outbreaks on Maritime Transportation and Port Operation*, Technical Report for CAMMSE Research 2021 Project 07, U.S. Department of Transportation, September 2022.
[8] Qi, Y., Zhao, Q., and Azimi, M., *Short Term Intersection Traffic Flow Forecasting*, Technical Report for CAMMSE Research 2021 Project 08, U.S. Department of Transportation, September 2022.
[9] Qi, Y., Liu, J., Tao, T., Zhao, Q., Wali, M., and Li, J., *Impacts of COVID-19 on Public Transit Ridership*, Technical Report for CAMMSE Research 2021 Project 09, U.S. Department of Transportation, September 2022.
[10] Lee, J. Y. and Zhao, J., *Effect of Connected and Autonomous Vehicles on Supply Chain Performance*, Technical Report for CAMMSE Research 2021 Project 10, U.S. Department of Transportation, August 2022.
[11] Fan, W. and Liu, S., *Evaluating and Comparing the Impact of Connected and Autonomous Vehicles on Conventional Intersections and Superstreets*, Technical Report for CAMMSE Research 2022 Project 01, U.S. Department of Transportation, September 2022.
[12] Fan, W. and Hua, C., *Real-Time Freeway Speed Prediction Based on Deep Learning in Connected And Autonomous Vehicles Environment*, Technical Report for CAMMSE Research 2022 Project 02, U.S. Department of Transportation, September 2022.
[13] Fan, W. and Zhao, Y., *Online Cooperative Lane-changing Model of Connected and Autonomous Vehicles*, Technical Report for CAMMSE Research 2022 Project 03, U.S. Department of Transportation, September 2022.
[14] Fan, W. and Yang, T., *Impact of Connected and Autonomous Vehicles on Signalized Intersections with Transit Signal Priority*, Technical Report for CAMMSE Research 2022 Project 04, U.S. Department of Transportation, September 2022.
[15] Ren, Z. and Zhu, J., *Disaster Resilience through Diverse Evacuation and Emergency Transportation System (Phase II)*, Technical Report for CAMMSE Research 2022 Project 10, U.S. Department of Transportation, September 2022.
[16] Ivan, J., Burnicki, A., and Packer, Q., *Estimation of Pedestrian Compliance at Signalized Intersections Considering Demographic and Geographic Factors*, Technical Report for CAMMSE Research 2022 Project 11, U.S. Department of Transportation, June 2022.
[17] Deng, Y., Chen, C., and Shi. X., *Prediction of Traffic Mobility Based on Historical Data and Machine Learning Approaches,* Technical Report for CAMMSE Research 2022 Project 15, U.S. Department of Transportation, August 2022.
Ricketts, L. and Cohen, J.P., *Arrival of Interstate Highway System Brought Housing Wealth, but to Whom?*, Federal Reserve Bank of St. Louis Economic Equity Insights, May 2022.

4. OUTCOMES

4.1. Increased understanding and awareness of transportation issues

TSU's research project "Studying the Impact of Pandemic Outbreaks on Maritime Transportation and Port Operation" investigated the impact of COVID pandemic outbreaks on maritime transportation, especially on the port operation. The results provided the authorities and stakeholders in ports and maritime transportation with a better understanding of the vulnerability of the maritime domain to future pandemic outbreaks and external shocks to the system.

UT Austin's research done under Dr. Randy Machemehl characterizing public transportation during the pandemic in Austin, TX gleaned insights into how public transportation might have failed to supply essential travel to minority groups. Lastly, the scooter project thus far has increased awareness about the dangers of scooters and high speeds by taking inventory of the many cities that have taken measures to reduce speeds.

UConn's CAMMSE research helped update and inform both undergraduate and graduate instruction across civil engineering, geography, business and statistics departments.

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

Nothing to report.

4.3. Increases in the body of knowledge

TSU's research project "Impacts of COVID-19 on Public Transit Ridership" conducted a national-wide study to investigate the impacts of COVID-19 on the public transit ridership in the top twenty metropolitan areas in the U.S. It was found that the areas with higher median household income, a higher percentage of the population with a Bachelor's degree or higher, a higher employment rate, and a higher percentage of the Asian population are more likely to have more reductions in public transit ridership during the COVID-19 pandemic. On the other side, the areas with a higher percentage of the population in poverty, and a higher percentage of the Hispanic population are more likely to experience smaller reductions in public transit ridership.

The bicycle signals research done by UT Austin increased understanding of people's perceptions of bicycle signal faces in terms of comfort and safety, which has been identified as a knowledge gap. This survey pinpointed the characteristics that are associated with a negative or positive view of the signals. The survey also improved our understanding of perceptions of interactions between modes (cyclist-pedestrian & cyclist-vehicle) at intersections with signals.

4.4. Improvement of existing techniques, practices, technologies

TSU's research project "Short Term Intersection Traffic Flow Forecasting" improved KNN methods to more accurately predict short-term traffic flow in the signalized intersection.

Research under Dr. Randy Machemehl (UT Austin) explored a gap in existing traffic volume prediction. Prior research has largely focused on predicting volumes for freeway entrance/exit ramps, but rarely discussed volumes for interchange ramps. Interchange ramps often do not have permanent traffic counters, so this research will provide a useful tool for transportation engineers to estimate interchange ramp volumes without the need to install new traffic counters.

4.5. Enlargement of the pool of trained transportation professionals

At UNCC, CAMMSE supported doctoral student Mr. Li Song and Mr. Shaojie Liu graduated and obtained their Ph.D. degree in May 2022.

At TSU, during the reporting period, CAMMSE supported student Lijie Zhou graduated and received his master's degree in Transportation Planning and Management. He continued his Ph.D. study at Prairie View A&M University.

Karen Kalter graduated with an MS from UT Austin.

4.6. Incorporation of new techniques, practices, technologies

At TSU, in the research project "Short Term Intersection Traffic Flow Forecasting", the CAMMSE team used a new entropy-base integrated method to predict short-term traffic flow forecasting. This method was used by researchers in other areas rather than transportation forecasting.

5. IMPACTS

The CAMMSE is currently 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?

TSU's research project "Short Term Intersection Traffic Flow Forecasting" investigated and compared different methods to predict short-term traffic flow at signalized intersections. With the developed model, accurately predicting traffic congestion in about half-hour advance becomes possible, which is very critical for advanced trip planning and traffic management.

Increasing bicycle travel can reduce congestion, fuel consumption and emissions plus it improves the physical condition of the rider. The only negative aspect of bicycle usage is rider safety. The bicycle signal research done by UT Austin is a step toward making bicycle travel safer and more desirable, thereby increasing bicycle travel.

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?

TSU CAMMSE team works closely with industry and government agencies by collaborating on research projects. TSU CAMMSE team also hosts seminars or workshops that are open to all transportation professionals, which also help the technology transfer.

At UT Austin, the research is performed by students and faculty supervisors who work closely with industry and government entities. As with the traffic volume estimation project, the working relationship with industry and government enables immediate technology transfer, plus the students who develop the new technology carry that knowledge with them into their eventual 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 that work on these 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. They will carry the new technology with them and use it in their new jobs, teach 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?

UNCC organized several transportation seminars which provided students opportunities to communicate with professors and industry experts. What they have learned through these seminars could be of great value for their future works as transportation professionals. In addition, CAMMSE funding provided research assistantships. By participating CAMMSE research, students gained hands-on experience.

At TSU, CAMMSE offers research assistantships to students. By participating in CAMMSE research projects and being mentored by CAMMSE faculty members, students learned first-hand technologies and

new methods on how to analyze transportation-related problems. What they learned from their research project will help them in their future work. In addition, CAMMSE sponsored workshops and seminars provide great opportunities for students to communicate with experts from both industry and academia. They will help them build their future careers.

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 Dallas District of TxDOT 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

At UT Austin, with the proposed scooter crash project, there has been very little scooter activity and therefore crashes on campus since UT Austin no longer allows scooters to park on campus. The lack of data makes the evaluation of the geo-spatial speed reduction on campus difficult to measure. The plan is shifting the scope of the project to find another area that has sufficient scooter data before and after the implementation of a geofence-based speed limit. The goal will be to measure how injuries and crashes have changed pre and post implementation of the speed limit.

6.3. Changes that have a significant impact on expenditures

The COVID pandemic has brought many challenges to all CAMMSE partner institutions. As we are getting back to normal, all CAMMSE partner institutions are actively taking on the challenges and continue working hard to resolve all relevant issues.

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 ad 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

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	Characteristics of Pooled Trips Offered by Ride-sourcing Services 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), Some Completed, Some Ongoing

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 Freeway Speed Prediction Based on Deep Learning 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 (ongoing)
	Wei Fan	Advanced Research	Transit Signal Priority Control with Connected Vehicle Technology: Deep Reinforcement Learning Approach (ongoing)
University of Texas at Austin	Randy Machemehl	Applied Research	Impacts of Speed on Dockless Electric Scooter Crashes (Phase II) (ongoing)
	Randy Machemehl	Applied Research	Optimizing Type and Location of Pedestrian Crossing Signs at Non-signalized Intersections (Phase II) (ongoing)
	Randy Machemehl	Applied Research	Developing Robust Smart Traffic Signal Control (ongoing)
University of Connecticut	Nicholas Lownes	Advanced Research	Prioritizing People - Mixed Equilibrium Assignment for AV Based on Occupancy (Phase II) (ongoing)
	Nicholas Lownes	Advanced Research	Pedestrian Behavior and Interaction with Autonomous Vehicles (Phase II) (ongoing)
	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 (ongoing)

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

Center for Advanced Multimodal Mobility Solutions and Education