C^2M^2 NEWS

December, 2017

USDOT CENTER FOR CONNECTED MULTIMODAL MOBILITY

AN INNOVATION CENTER FOR TRANSFORMING MULTIMODAL TRANSPORTATION THROUGH CONNECTIVITY, DATA ANALYTICS, AND AUTOMATION

In this issue:

Editors: Charlotte Ryggs and Dr. Eric Morris

Letter from the Director

Welcome to our USDOT Center for Connected Multimodal Mobility (C^2M^2) newsletter. It has been an exciting and productive fall here, and we are advancing towards our vision to be "an innovation center for transforming multimodal mobility through connectivity, data analytics, and automation."

We have selected 12 research projects for funding through our Center. These cover topics as diverse as rail; freight and goods movement; pedestrian planning; transportation security; shared mobility; transit; and autonomous vehicles. Each project is a collaboration between at least two of our partner institutions. Our minority-focused institutions (South Carolina State University and Benedict College) are involved in eight of these projects. Several of these projects are already underway, and those that remain will start soon.

Further, we hosted our first Advisory Board meeting on November 2nd, 2017. Our Board members, who include diverse participants drawn from various transportation organizations, provided valuable guidance to our Center administrators. Ms. Jennifer Johnson was selected as the Chair of the Advisory Board.

Dr. Mashrur "Ronnie" Chowdhury

The following day, November 3rd, we hosted our first major C^2M^2 conference at the Madren Conference Center in Clemson, South Carolina. There was a distinguished keynote speaker, Dr. Chris Hendrickson of Carnegie Mellon University, who spoke on "Transformational Transportation Technologies." Dr. Hendrickson was the second keynote speaker C^2M^2 has hosted, following up on a successful talk from Dr. Essam Radwan of University of Central Florida who presented to our Center's faculty and students on September 8th, 2017.

Our demonstrations of the connected vehicle (CV) technology developed through our Center have been successes. The first demonstration took place at our Fall Conference, and the second was at the 5th Annual University Transportation Center (UTC) Conference for the Southeastern Region in Gainesville, Florida. Our demonstrations have included work on cyber-physical systems (CPS) using edge computing techniques, heterogeneous wireless communication technology, and a new software-based vehicle-to-infrastructure (V2I) cybersecurity platform.

The uniqueness of our edge-centric CPS is that it is easily scalable depending on the deployment area and penetration level of CVs. Thus the edge-computing technique is applicable for future large-scale CV deployment. Proximity to the edge provides the flexibility to communicate efficiently with the immediate edge layers, and reduces data loss and delivery delay. The computation functions can be distributed between different edge layers of edge-centric CPS to reduce the processing time for applications that require high computational power requirements.

We have demonstrated that the heterogeneous wireless technology we have developed can enable multiple wireless networking options (e.g., dedicated short-range ommunication (DSRC), Wi-Fi, LTE) simultaneously based on availability, accessibility, and data-delivery delay requirements of the CV applications as well as the

communication coverage area. The use of this heterogeneous network technology can expand and improve the safety, mobility, and positive environmental impacts of connected and autonomous vehicles.

We have also demonstrated CVGuard, which is a new software-based security architecture designed to protect CVs in a V2I communication environment. V2I interfaces must be analyzed for developing security controls that can provide the right level of protection given the data and means of transmission in a V2I environment. CVGuard can detect and isolate any cyberattacks in a V2I environment before they can adversely affect vehicles or transportation networks, potentially causing crashes and impeding the adoption of CV technologies. We demonstrated a V2I application, Stop Sign Gap Assist (SSGA) under a distributed denial of service (DDoS), and we found that CVGuard was effective in detecting a DDoS attack.

We are very excited to continue our quest to make multimodal transportation the best it can be, developing new technology, studying the ways in which this technology can serve businesses and the public, and educating and training students and professionals to carry the torch forward. We hope you will continue to accompany us on our journey.

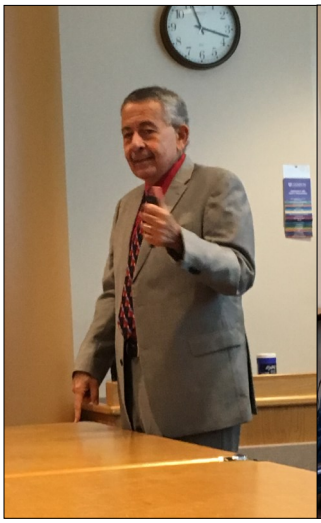
Dr. Mashrur "Ronnie" Chowdhury

C²M² SPEAKER SERIES

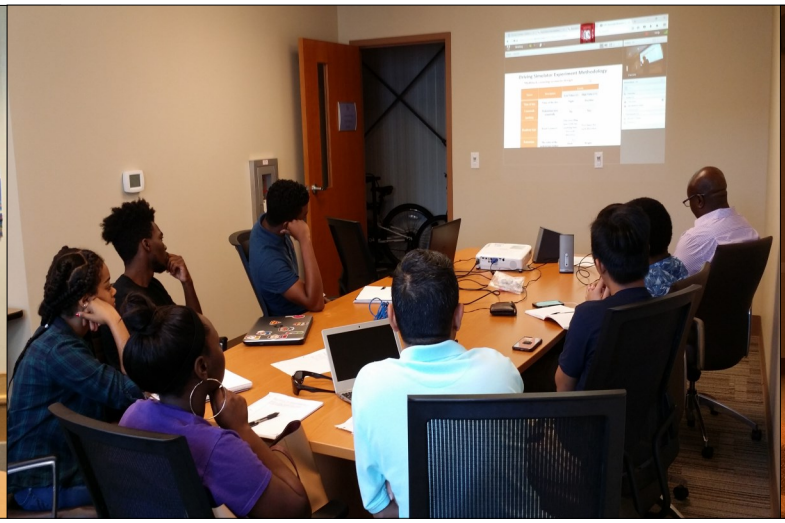
On September 8th, 2017, C²M² hosted its first University Transportation Center (UTC) speaker, launching a series of talks that will be offered every quarter. Our Center will invite speakers with both academic and industry backgrounds to speak to students and other interested participants on a wide range of transportation-related topics, such as the advancement of connected and autonomous vehicles, and the future of transportation. These talks will be offered as free webinars via our website and will be posted to our YouTube channel. The talks will be promoted on our social media outlets and through an email sent out to subscribers.

Dr. Essam Radwan of the University of Central Florida was our first speaker. His talk in September was well received, with over 35 attendees. Our second speaker was Dr. Chris Hendrickson of Carnegie Mellon University and the Traffic21 Institute. Dr. Hendrickson was also the keynote speaker at our Fall Conference. We will be hosting our next speaker in February, 2018.

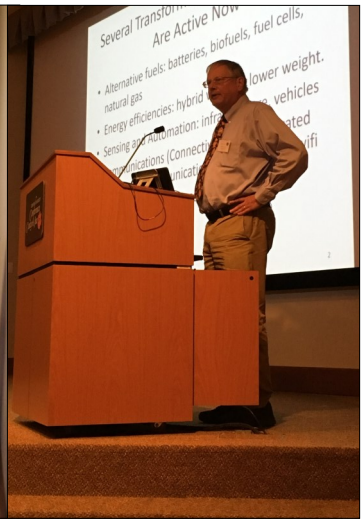
Check out our website at cecas.clemson.edu/c2m2 for updates on our C²M² Speakers Series and other Center events.



Dr. Essam Radwan in Clemson



Students from Benedict College joining via webinar



Dr. Chris Hendrickson in Clemson

Photo Credit : Charlotte Ryggs, Dr. Gurcan Comert

2017 FUNDED RESEARCH PROJECTS

In June of 2017, C²M² sent out a call for proposals (CFP) for our first round of research funding. This CFP was sent out to C²M² faculty members in relevant fields at all five of the consortium's universities. The Center received 15 proposals covering a wide array of topics, featuring proposed research on V2V (vehicle-to-vehicle) and V2I communication related data infrastructure, pedestrian safety, transportation cybersecurity, and dynamic ridesharing, among much else. Many of these proposals featured collaborative research among multiple universities, combining their expertise for a more comprehensive perspective, and several had the backing of the South Carolina Department of Transportation (SCDOT) and local communities for research support. These proposals were sent out to reviewers in academia and the industry for blind evaluation, and 12 of the 15 proposals were selected by our Board of Directors to receive funding. Principal Investigators of the selected projects were informed in September, and projects began in October 2017. Descriptions of the projects we are undertaking follow.

C²M² Board of Directors evaluating proposals in Columbia, South Carolina

Photo Credit : Dr. Gurcan Comert

Adaptive Signal Control Algorithms for Connected Systems

Lead Principal Investigator – Dr. Gurcan Comert, Benedict College
Co-Principal Investigator – Dr. Mashrur Chowdhury, Clemson University

Description: The research will explore the deployment of CV data for traffic signal control. It will develop communication protocols based on connectivity, type of data, data security, and detection. Parameter estimation models will be based on CV market penetration, coverage, and inferences about circumstances like delay and queues. Event-based data will be investigated to improve computational efficiency. Different information types will be researched to help develop reliable and robust control. The research will also investigate what other redundant systems may be necessary for short- to mid-term deployment, what type of coverage is needed, and what the estimated cost of purchasing the necessary infrastructure will be. The research will also examine the interaction of CVs with other modes such as trucks, transit, pedestrians, bikes, and emergency vehicles. It will develop implementation-ready signal control algorithms in a CV environment, develop algorithms with data defined under current architecture, address computational efficiency, test algorithms using microscopic simulations, and test results using experiments on our testbed.

Intellectual Merit: This project proposes to develop signal control algorithms from connected roadway users (motorized and nonmotorized) using the information shared in two way communications (i.e., V2I, Infrastructure to vehicle (I2V), Infrastructure to infrastructure (I2I), and vehicle to vehicle (V2V)).

Broader Impacts: The research may lead to improved functioning of traffic signals, which would mean less delay, fuel consumption, and emissions.

Impact of Transportation on Air Quality at Elementary and Middle Schools in South Carolina

Lead Principal Investigator – Dr. Gurcan Comert, Benedict College
Co-Principal Investigators – Dr. Samuel Darko, Benedict College; Dr. Nathan Huynh, University of South Carolina

Description: There is a strong correlation between traffic volume and the amount of air pollutants emitted into the environment. This project will use a combination of connected vehicles and environmental sensors to monitor traffic flow and air pollutants at strategically selected schools in and around the state of South Carolina. Using connected systems (e.g., CVs, drones) fitted with sensors, data on real-time traffic vol-

ume and emitted pollutants will be collected. These observations will be used to develop plans for better vehicle management at schools, particularly during drop-off and pick-up times. Moreover, the data will be used improve forecasting models for land use and planning purposes. For instance, it will be able to determine the emissions that a planned school with a certain number of students would generate given the volume of traffic it would produce, the composition of vehicle types that would be used, and characteristics of its location.

Intellectual Merit: This research proposes to model and monitor real-time vehicle emissions and develop better control schemes in the context of "low emission zones" at schools.

Broader Impacts: Real-time data from connected systems can improve user decision-making and school transportation policies to benefit the environment, fuel efficiency, and mobility, for example by minimizing unnecessary stops. The results will thus serve as an important decision-making tool.

Real-Time and Secure Analysis of Data for Connected Vehicles

Lead Principal Investigator – Dr. Amy Apon, Clemson University
Co-Principal Investigators – Dr. Gurcan Comert, Benedict College; Dr. Mashrur Chowdhury, Clemson University

Description: As the sources of CV data become more diverse and plentiful, infrastructure must scale to handle very large amounts of data; must support data of many types, including sensor data, text, and images; must securely support real-time processing for many applications; and must be trustworthy and privacy-preserving. Public cloud infrastructure has advanced so that it now offers promising technologies for addressing these requirements. This project has two aims: 1) to investigate the effectiveness of public cloud infrastructure for the secure real-time processing of streaming data from CVs, and 2) to design and implement two key applications of CV systems using a streaming data model. Target applications include the real-time processing of CV data and traffic prediction, which is a critical component for many intelligent transportation systems (ITS) applications, such as advanced traveler information systems, real-time route guidance, and emergency response systems planning.

Intellectual Merit: This project will improve the science of collecting, managing, and processing the huge amounts of data that will be generated in a CV environment.

Broader Impacts: The outcomes of this research will include developed infrastructure along with best practice recommendations for several connected vehicle applications, and will lay the computing and technology groundwork for significant collaboration on smart cities, intelligent transportation systems, and smart factories, along with CV applications.

Uncertainty Quantification of Cyber Attacks on Intelligent Traffic Signals

Lead Principal Investigator – Dr. Jim Martin, Clemson University
Co-Principal Investigator – Dr. Gurcan Comert, Benedict College

Description: The primary goal for the project is to develop and validate detection models for system control failures involving CV applications. The secondary goal is to establish long-term collaborative research between the C^2M^2 partners and Benedict College to provide research and career opportunities for underrepresented minority students. The project will 1) develop an appropriate system model representation of intelligent traffic signals, including a characterization of a set of anomalies; 2) develop predictive methods and training sets such that anomalies can be classified quickly by vehicles or edge nodes; and 3) create a working group of interested faculty and students at participating universities to engage undergraduate students to participate in educational activities that are synergistic and supportive of the project's goals and objectives.

Intellectual Merit: The project will advance our ability to identify and respond to failures, including cyber attacks, on traffic signals in a V2V, V2I, I2V, and I2I communications environment.

Broader Impacts: The models developed can be extended to autonomous vehicles and different traffic systems. Although signalized networks are the focus of the project, any other CV application can be analyzed similarly: vulnerabilities can be identified and detection tools/sensors can be deployed to maintain system reliability.

Assessing the Experience of Providers and Users of Transportation Network Company Ridersharing Services

Lead Principal Investigator – Dr. Eric Morris, Clemson University
Co-Principal Investigators – Dr. Mashrur Chowdhury, Clemson University; Sakib Khan, Clemson University; Dr. Judith Mwakalonge, South Carolina State University

Description: Many foresee a future of shared mobility, where transportation network companies (TNCs) match passengers with similar origins and destinations on the fly so they can rideshare. If feasible, shared mobility has the potential to reduce vehicle-miles-traveled, helping the environment, reducing congestion, and reducing crash damage and injuries. Shared mobility may also provide lower-cost transportation that will particularly benefit those with low incomes. However, it is unclear whether many consumers will accept shared mobility for reasons of convenience and comfort. Further, many drivers who work for TNCs that provide these services (such as UberPool and Lyft Line) have expressed dissatisfaction with them, for example due to low compensation and high stress. This research will examine in depth how TNC ridesharing services are serving customers and drivers using a review of existing literature, social media mining, and surveys of providers and travelers.

Intellectual Merit: The study will be the first systematic and publicly available analysis of the TNC ridesharing experience from the perspective of both drivers and passengers.

Broader Impacts: The results will help inform us about the potential for ridesharing services like UberPool or Lyft Line to serve a large share of travel and will produce ideas about ways in which such services

Assessment of the Safety Benefits of Technologies to Reduce Pedestrian Crossing Fatalities at Mid-Block Locations

Lead Principal Investigator – Dr. Jennifer Ogle, Clemson University
Co-Principal Investigators – Dr. Mashrur Chowdhury, Clemson University; Dr. Kweku Brown, The Citadel; Dr. Judith Mwakalonge, South Carolina State University

Description: One issue that is faced in all pedestrian studies is the lack of exposure data for pedestrians. This study will gather such data in order to develop safety prediction models. Using data from a pedestrian crash characterization, the researchers will deploy image detection technology on corridors with frequent pedestrian crashes to determine the extent of the crossing maneuvers. Simultaneously, they will conduct an assessment of existing vehicle-based detection technologies to determine the efficacy of these systems for managing vehicle and pedestrian interactions. Similar assessments will also cover pedestrian-to-vehicle technologies. The final step will be to conduct simulations to determine the possible safety gains from various levels of penetration of pedestrian-sensing technologies based on their efficacy for different types of crashes. The researchers will particularly assess the consequences and advantages of these systems for individuals with physical and cognitive disabilities. Finally, the research will identify gaps in current sensing technologies and will develop suggestions for future research.

Intellectual Merit: This research will assess safety benefits and shortcomings of new sensing technologies. The goal will be to reduce pedestrian crossing fatalities at midblock locations where pedestrians are most vulnerable to injury and death from motor vehicle crashes. Using novel data and techniques, the outcomes of this analysis will help to identify where the problem areas are around the state of South Carolina, what roadway design features are most common at crash sites, and which population demographics are most at risk.

Broader Impacts: The study will provide recommendations for cost-effective short-term infrastructure and technology investments and interventions which will improve pedestrian and motorist safety.

Active Traffic Monitoring through Camera Networks with Automatic Camera Calibration for Pan-Tilt-Zoom Cameras

Lead Principal Investigator – Dr. Wayne Sarasua, Clemson University
Co-Principal Investigators – Dr. Kweku Brown, The Citadel; Dr. William J. Davis, The Citadel; Dr. Dimitra Michalaka, The Citadel

Description: This research proposes a network of distributed pan-tilt-zoom (PTZ) cameras acting as active vehicle sensors. These will map the location of vehicles throughout a network in real time. Precise mapping of vehicles, combined with vehicle-to-camera communication, will allow one-to-one correspondence whereby the active camera will be able to connect with a vehicle and monitor its movement throughout a camera network. Once the connection is established, camera hand-off will be possible, allowing a vehicle to be tracked over several miles. The individual vehicle mapping approach will take advantage of existing PTZ infrastructure while providing a robust set of traffic parameters for use by a variety of applications including real-time traffic prediction, erratic maneuver/dangerous driver identification, incident management, and transportation network security. The research will also potentially provide new insights into driver behavior. With one-to-one correspondence between cameras and connected vehicles, system feedback can cater to individual vehicles. This feedback will be based on tracked trajectories rather than from discrete points.

Intellectual Merit: The research will develop a novel active computer-vision-based traffic monitoring system that has the potential to lead to a shift in the paradigm of collecting traffic data in the near-term, while supporting CV applications in the long-term.

Broader Impacts: The ability to identify and track vehicles throughout a network of cameras will take incident detection to a new level while increasing the robustness of data being collected. Vehicles will be able to be tracked for longer distances across distributed cameras, which will allow new possibilities in traffic monitoring, management, and prediction.

Infrastructure and Policy Needs for Personal Electric Mobility Devices in the Connected Vehicle World

Lead Principal Investigator – Dr. Judith Mwakalonge, South Carolina State University
Co-Principal Investigators – Dr. Mashrur Chowdhury, Clemson University; Dr. Jae Dong Hong, South Carolina State University

Description: The research team will conduct a comprehensive search of the literature about personal electric mobility devices (PEMDs) on the market, how PEMDs operate in different countries, and what rules govern PEMDs' operations. The findings will reveal the safety hazards and operational benefits associated with PEMD use, and uncover effective measures to ensure the safe inclusion of PEMDs within the existing transportation environment. Further, the research will document safety issues involving PEMDs over the past 10 years by utilizing the National Electronic Injury Surveillance System (NEISS). The research team plans to conduct two field experiments, one under traditional (current) operating conditions and the other in a non-traditional connected environment. The field experiments will identify any potential conflicts between PEMD users and the general travelling public. They will also help us learn how the PEMDs interact with pedestrians, how safe PEMDs are in urban areas, and how PEMDs operate in different environments including different road geometries, lighting conditions (day/night), and weather conditions (wind, rain, cold).

Intellectual Merit: This research will document the different types of PEMDs currently used by the public and will advance knowledge on how PEMDs can be made more safe for users and society.

Broader Impacts: The research findings will help transportation planners and public officials to decide how to manage non-motorized facilities (walkways, sidewalks, paths and trails) to maximize PEMDs' benefits while minimizing any negative effects. Further, the research results will shed light on infrastructure needs as we evolve into the connected transportation environment.

Developing a Tool to Assess the Effectiveness of Intermodal Facility Locations and Designs

Lead Principal Investigator – Dr. Nathan Huynh, University of South Carolina
Co-Principal Investigator – Dr. William Ferrell, Clemson University

Description: Current logistics systems are inefficient, resulting in wasted fuel, increased costs, and escalating congestion along roads and within urban centers. This project will explore innovative infrastructure that could be part of a connected logistics system, and the functional features that will be required to support a future paradigm based on on-demand logistics. The research will begin with a literature review focusing especially on collaborative logistics and multimodal facilities that use connectivity in any form (e.g., autonomous material handling devices to move freight). Next, it will use South Carolina as a case study to investigate the location and functional requirements for freight transfer terminals, as well as explore the effectiveness of on-

demand logistics. To accomplish this, real-world data will be used to quantify and estimate future freight flows. Then several types of freight transfer facilities will be identified that support short- and long-term improvements. Models will be developed that capture key parameters of freight flows and provide strategic insight into possible locations and functional requirements for multimodal freight terminals.

Intellectual Merit: A practical and user-oriented tool will be developed based on insights from the models. It will assist decision makers in assessing the effectiveness of different intermodal facility locations and designs with respect to different freight movement strategies.

Broader Impacts: This project will enhance synchronization between freight transportation modes and create synergies with vehicle and infrastructure automation. This will enhance intermodal freight network

Real-Time Classification of Vehicle Types and Modes Using Image Analysis and Data Fusion

Lead Principal Investigator – Dr. Robert Mullen, University of South Carolina
Co-Principal Investigator – Dr. Nathan Huynh, University of South Carolina

Description: This project will conduct a feasibility study on the development of software and selection of hardware that will measure multiple transportation modes and classify vehicles by their Federal Highway Administration (FHWA) classification. The research team will install several combined computer/camera systems to monitor the multi-modal traffic in proximity to the University of South Carolina campus. This area has multiple transportation users, including pedestrians, mopeds, bicycles, motorcycles, passenger cars, trucks, trains and buses. Along with the video data, additional traffic collection sources such as pneumatic tubes and Bluetooth will be used. Multiple cameras will allow three-dimensional representations of the environment to be constructed by the software. The video data will be combined with other data using a Bayesian statistical updating method to produce multi-modal traffic information. The research will also explore counting traffic in non-typical locations, such as the number of pedestrians in/outside of crosswalks. Three techniques will be used to analyze the data. 1) Image subtractions from successive images will be used to identify objects in the area of interest. 2) A discriminate function based on the object geometry and image texture will be used to classify objects. 3) Digital image correlation or other video object motion determination approaches will explored.

Intellectual Merit: The research will advance our ability to collect and analyze data to classify and count vehicles and pedestrians.

Broader Impacts: The collection and analysis of integrated multimodal movement of people and goods will provide transportation planners with better quantitative information about use of the existing system. Beyond providing raw counts, an integrated video based system could provide information about unsafe practices of pedestrians and bicyclists or moped users that could be used to improve safety.

Railway Right-of-Way Monitoring and Early Warning System (RailMEWS) Based on Satellite and Aerial Imagery

Lead Principal Investigator – Dr. Dimitris Rizos, University of South Carolina
Co-Principal Investigator – Dr. Robert Mullen, University of South Carolina

Description: This project will conduct feasibility studies and provide recommendations for the development of a Railway Right-of-Way Monitoring and Early Warning System (RailMEWS). It will answer the following questions:

1. How can we use drones and satellites to monitor the railway infrastructure?
2. What infrastructure components can be monitored effectively and what are the potential limitations of a RailMEWS in each case?
3. What railway infrastructure monitoring systems (IMS) are available today for integration with satellite and drone data?
4. What are the desired functions and design parameters of an early warning system? (e.g., connectivity to the signaling system, real-time vs. centralized processing, etc.)
5. What is the incremental investment needed to develop the RailMEWS system?

To answer these questions, the project will process information obtained from commercially available satellite and aerial imagery and combine it with information obtained by conventional monitoring systems to develop maps that show the kinematic behavior of the railway infrastructure at the terrain, sub-structure, and track scales.

Intellectual Merit: The research will explore how new technologies might improve the functioning of the rail system.

Broader Impacts: The work will lay the foundations for the development and implementation of a RailMEWS for the railway network, and then its expansion to other transportation modes and the transportation network as a whole. This research will create a framework for larger research projects with diverse partners and will be extended in future studies to monitor the roadway network, ports, and inland ports.

Improved Resiliency of Transportation Networks through Connected Mobility

Lead Principal Investigator – Dr. Paul Ziel, University of South Carolina
Co-Principal Investigators – Dr. Robert Mullen, University of South Carolina; Dr. Weichiang Pang, Clemson University

Description: Recent events, such as Hurricane Sandy, have shown how cascading failures of infrastructure systems result due to catastrophic disaster events. Transportation networks are complex, interdependent, and critical for safety. Embedded intelligence within transportation networks, however, is extraordinarily rare. When an extreme event does occur, it is critical that sub-components (e.g., bridges) within the network be evaluated in near real-time for re-routing of traffic and post-disaster emergency response purposes. Existing knowledge about remote wireless systems for infrastructure assessment at the local (bridge and bridge component) level, developed at the University of South Carolina, will be leveraged to complement expertise in the assessment of resiliency in transportation networks developed at Clemson University. The greater Charleston, SC area will be studied due to its large and diverse population coupled with its vulnerability to hurricanes, earthquakes, and manmade disasters.

Intellectual Merit: The goal of this project is to lay the groundwork for the deployment of intelligent transportation infrastructure, with a focus on extreme events in complex transportation networks. The research will fuse remotely gathered damage information from critical components (bridges) with rapid and reliable assessment of the resiliency of transportation networks.

Broader Impacts: The outcome of the project will be a framework whereby remotely gathered structural health assessment data will be incorporated into transportation network reliability models. This will enable quantification of the benefits of intelligent systems within transportation networks and will serve as a tool to determine the most critical locations within the network for timely deployment of such systems.

ADVISORY BOARD MEETING

The first meeting of the Center for Connected Multimodal Mobility's Advisory Board took place at the Madren Center on Thursday, November 2nd. Our Board is made up of members with a variety of transportation-related backgrounds who were asked to serve due to their ongoing contributions to the advancement of transportation technology and infrastructure. These members bring a wealth of experience in fundraising, research, legislating, education, and business. They will play a large part in shaping the future of our Center.

Nine of the fifteen Board members traveled to Clemson to meet with our Associate Directors and the Director for dinner prior to the meeting, while those not able to travel to South Carolina at that time joined remotely via conference call. The purpose of this meeting was twofold: first, to give our board members a chance to meet each other and our Associate Directors in person, and, second, to define the role of the Advisory Board and its part in determining the direction of C^2M^2. Board members weighed in on funding sources, research direction, and the establishment of specialized steering committees within the Board. Our Board members also elected a chair from among their ranks. We are very excited to announce that the new Advisory Board Chair is Jennifer Johnson of Kimley-Horn. Jennifer will lead the Board as it helps guide the growth of our Center.

The following day our visiting Board members participated in our Fall Conference, giving them an opportunity to interact with our faculty, staff, and students and to see in person some of the work that C²M² is doing.

Our Board will hold quarterly meetings via conference call, and will meet in person at least once a year. In addition, various subcommittees will confer to work on special projects as needed. We are very excited to see where our advisory board will take us.

Center for Connected Multimodal Mobility Advisory Board Members


R. Todd Anderson, South Carolina Dept. of Transportation


Dr. Nadim M. Aziz, SC EPSCoR

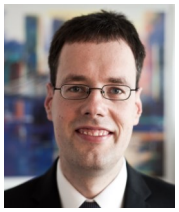

Carla Bailo, Ohio State Univ.


Dr. Imad L. Al-Qadi, Univ. of Illinois at Urbana-Champaigne


Dr. Kakan Dey, West Virginia Univ.


David Jared, Georgia Dept. of Transportation

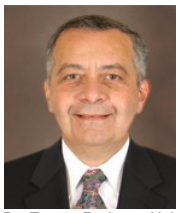

Jennifer Johnson, Kimley-Horn


Dr. Andre Luckow, BMW IT Research Center


Dr. Elise Miller-Hooks, George Mason Univ.


Dr. Patricia Mokhtarian, Georgia Institute of Technology


Fred Payne, Carolinas Alliance 4 Innovation


Dr. Essam Radwan, Univ. Of Central Florida


Dr. Anthony Saka, Morgan State Univ.


Art Shulman, Global Autonomous Vehicle Partnership


Terry Swygert, South Carolina Dept. of Transportation

C²M² FALL CONFERENCE HIGHLIGHTS


Dr. Mashrur "Ronnie" Chowdhury welcoming our guest.
Photo credit: Niloofar Asadi

On November 3rd, 2017, C²M² hosted our first annual Fall Conference. The theme was "New Frontiers in Connected Multimodal Mobility." The proceedings featured several exciting speakers and a live demonstration of the Center's connected vehicle technology. The conference opened with an overview of our partner institutions and the key components of our Center. Each of our Associate Directors — from Benedict College, the Citadel, South Carolina State University, and the University of South Carolina — spoke briefly about the work that their schools are contributing to C²M² and the research that they are engaged in. Their presentations were followed by our keynote speaker, Dr. Chris Hendrickson, who is the Director of the Traffic21 Institute and the Hamerschlag University Professor of Engineering Emeritus at Carnegie Mellon University. Dr. Hendrickson spoke about "Transformational Transportation Technologies," and more specifically about the work that the Traffic21 Institute is doing with autonomous- and connected-vehicle technology. After Dr. Hendrickson spoke, C²M² director Dr. Mashrur "Ronnie" Chowdhury took the stage to discuss his research on connected vehicles and connected infrastructure. Our last speaker of the morning was Fred Payne, Greenville County Councilor, who was instrumental in acquiring a four million dollar grant to launch autonomous taxis in Greenville County. Mr. Payne's talk was well received and followed by a lively question

and answer period. After lunch, our final speaker of the day was the South Carolina Department of Transportation (SCDOT) Deputy of Intermodal Planning, Jim Feda, who gave a talk on the SCDOT's ten-year plan to rebuild South Carolina's road system. Mr. Feda's talk was followed by a change in venue, as conference attendees were bused to another location where a live demonstration of C²M²'s connected vehicle technology was given. The demo was spread over two adjacent sites. At the first site, attendees could watch on two screens as connected vehicles sent notifications when the cars were stuck in a queue and when collisions were imminent. We also demonstrated our CVGuard, which is a V2I cybersecurity platform and real-time CV data-sharing toolkit, which will make the data from the Clemson testbed available to researchers in real time. The attendees were then able to inspect the technology within the vehicles and ask questions.

The second site demonstrated our CV devices and big data analytics for connected vehicles. Our conference concluded after the attendees were bused back to the Madren Center. Videos of our speakers' talks and our CV technology demonstrations will be posted on our new YouTube channel; keep checking our website and Twitter for updates.

Conference Highlights

Dr. Chris Hendrickson taking questions

Students from our partner schools presenting ongoing research

Councilman Payne outlining Greenville's new Autonomous Taxi Project

Dr. Mashrur "Ronnie" Chowdhury speaking at the offsite demo

Attendees inspecting the CV technology in our connected vehicles

Our connected vehicles lined up at the demo site

Dr. Amy Apon explaining our connected vehicle devices and big data analytics to attendees

Photo Credit: Katherine Brunk, Niloofar Asadi

UTC SOUTHEASTERN REGION CONFERENCE

On November 16th and 17th, five C²M² students from Clemson University and Dr. Gurcan Comert from Benedict College traveled to the 5th Annual University Transportation Centers Conference for the Southeastern Region. This year's conference was hosted by the Southeastern Transportation Research, Innovation, Development and Education Center (STRIDE) and was held on the campus of the University of Florida in Gainesville. This two-day conference featured over 50 presentations on a wide variety of transportation topics from infrastructure to freight movement, and had 65 poster presentations from graduate students and faculty. Our Center director Dr. Chowdhury was a part of the planning committee for this year's conference, and C²M² was proud to co-sponsor this event. We were also asked to give a live demonstration of the work our Center is doing with CV technology.

In addition to our live CV demonstration, two of our students presented posters on their research, on "Data Infrastructure-Enabled Connected-Autonomous Vehicle Operations in Mixed Traffic," and "Development of Connected Vehicle Applications through an Edge-Centric Cyber-Physical System (CPS) Platform." Both our demonstration and our poster presentations were well received. We are excited to announce that next year we will be hosting the 6th Annual UTC Conference for the Southeastern Region at Clemson University in Clemson South Carolina.

Students setting up for our connected vehicle technology demonstration

Our connected vehicle demo cars lined up and ready to go

Photo Credit: Dr. Gurcan Comert

OTHER NEWS & UPCOMING EVENTS

This November, one of our Associate Directors, Dr. Nathan Huynh from the University of South Carolina, worked with the Sultan Qaboos Cultural Center to organize a conference entitled "The Importance of Tourism and Ports in Economic Development: Best Practices in Oman and the USA." Dr. Huynh not only helped bring this conference to the University of South Carolina, but he also sat on a panel discussing "Global Supply Chain and Contemporary Ports" and gave a talk titled "Advances in Intermodal Freight Terminal Design and Operations."

Our research partners also attended, and presented research at, the Transportation Research Board's (TRB) annual meeting in Washington D.C. in January. C²M² students made 39 poster and podium presentations at the 2018 TRB meeting in January.

Keep checking our website for conference updates, as we have several events coming this spring. These range from a conference on models and simulations in Columbia to connected vehicle demonstrations in Clemson in March 2018. We will also be offering more webinars on a variety of transportation topics in the coming months, so stay tuned for those opportunities.

Special Thanks

We would like to offer a heartfelt thank you to all of our student volunteers who helped at all of our events this quarter, especially students from the Clemson chapters of ITE and IEEE. Without their help our events would not have been nearly as successful and we deeply appreciate their contributions to our Center!

See You Soon!

C²M² News will be back next quarter to bring you more news on our progress. In the meantime, for comments, questions, or further information about the USDOT C²M² and its activities, feel free to email us at c2m2@clemson.edu or check out our website at cecas.clemson.edu/c2m2.