MSU Campus Mobility

Technology and Optimization Committee

- Subir Biswas (ECE)
- Kalyan Deb (ECE/BEACON)
- Tim Gates (CEE)
- Mehrnaz Ghamami (CEE)
- Nizar Lajnef (CEE)
- Graham Pierce (Univ. Outreach and Engagement)
- Xiaoming Liu (CSE)
- Sharlissa Moore (James Madison College/CEE)
- Tim Potter (MSU Bikes)
- John Prush (MSU PD Management Services)
- Hayder Radha (ECE)
- Arnold Weinfeld (Public Policy Initiatives)
- Mark Wilson (School of Planning Design and Construction)
- Ali Zockaie (CEE)
- John Verboncoeur (ECE/CMSE)
CANVAS Autonomous Vehicle Platform
MSU MOBILITY STUDIO: AN INTEGRATED SYSTEM of COMMUNICATION & CONTROL for AUTONOMOUS VEHICLES and THEIR ENVIRONMENT

BENEFITS:
- Safety
- Security
- Improved fuel efficiency
- Emissions reduction
- Traffic throughput
- Event/emergency management
- Public health
- Pedestrian-vehicle arbitration

MOBILITY STUDIO paints the complete picture for managed urban transportation systems.
Campus Mobility Technologies

Technologies
- Multispectral cameras
- Pavement sensors
- Mobile ped/cyclist app synced with signals
- Parking app
- Lightweight CAV shuttles
- EV charging stations

Processes
- Mapping optimization
- Ped, cyclist, vehicle throughput optimization
- Bus routes and stops
- Emergency vehicle prioritization
- Classroom optimization
- Park once, buses and CAVs, ride-sharing
- Distributed services (e.g. food trucks)
Autonomous Bus Routes

- Park once model
- Remove personnel vehicles from central campus
- Connect major work centers to parking centers
- Provide additional services onboard, e.g. autonomous coffee vending
- Mid-day campus mobility supported by hailable lightweight vehicles
CANVAS Students’ Club: Autonomous Golf Cart

- Attracted ~ 50 undergraduate students
- Breakdown by class
  - Senior 52%
  - Junior 27%
  - Soph. 12%
- Breakdown by major
  - Elect. & Comp. Eng. 45%
  - Comp. Sci. & Eng. 36%
  - Mech. Eng. 9%
- Students developing state-of-the-art technologies enabling autonomous driving through hands-on engineering experience
- Autonomous Golf Cart
  - Golf cart has been acquired
  - Safer integration in pedestrian dense areas
  - Developed radar detection system
- International student competitions
  - NHTSA Enhanced Safety Vehicle (ESV) Competition
  - SAE/GM AutoDrive Challenge Competition
Hailable Self-Driving Vehicle

- Park once on periphery or south campus
  - Parking cost reduced
- High frequency bus lines to major centers
- Lightweight self-driving electric vehicles
  - Mobile app hailing
Heterogeneous V2X Network Design for MSU Campus

Objective: Heterogeneous network design with Roadside Units (RSUs) using

- Dedicated Short Range Communication (DSRC) Radio
- Cellular Links
- Television Broadcast Link using ATSC

What will it Enable: Campus mobility support use cases

- Networking traffic management sensors, camera, traffic light etc.
- Vehicle and pedestrian traffic management applications
- Construction and other event map dissemination
- Coordinated traffic signal optimization
- Supporting Autonomous vehicle control needs
- Data collection and funded research needs (Engineering, Com Arts ..)

Deliverables:

- Campus-specific design specification with phased deployment plan
- Planning/simulation tool for network design
- Deployment and test support from Engineering
Objective: Design and develop a phone App for pedestrian traffic:

- Monitoring and
- Control

What will it enable:

- Collect pedestrian traffic data through the App
- Route pedestrian traffic through notification
- Avoid pedestrian hot-spots, thus improving vehicle traffic flow
- Incentive-based compliance for student participation
- Data gathering for funded research in Engineering, Transportation, CommArts, and other colleges

Deliverables:

- A fully functional App
- Backend server with algorithms for congestion clearance etc.
- Deployment engineering support
Parking App

Assessment of available technologies
- Cost and benefits of each technology
- Installation requirements
- Accuracy
- Barriers in implementing the technology

Counting methods
- Lot
  - Gate Counting
  - Induction Loop Vehicle Detectors
  - RFID Tags
  - Laser Line
  - Other (Infrared Cameras, Microwave Radar, and Infrared Strobe)
- Spot
  - Ultrasonic Detectors
  - Camera and Image Processing
  - Magnetometer and IR sensors
  - Other (Piezoelectric Cables)

Information Dissemination
- Variable Message Signs
- Smartphones
- LED Lamps

Recommendations
- Low traffic volume road: Gate counting
- Low traffic volume road: Induction Loop Detectors or RFID
- Indoor lots: Ultrasonic Detectors
- Outdoor lots: Magnetometer and IR sensors

Developed by Joseph Stafford (Freshman in Computer Science), under supervision of Dr. Mehrnaz Ghamami (CEE)
Multi-modal Traffic Simulation

Objective: Simulate traffic dynamics and assess implementation of different strategies to optimize campus mobility

- Consider impacts of connected vehicles in conjunction with the heterogeneous V2X network design
- Consider transit, walk, bike, autonomous, and conventional vehicles

What will it Enable: Campus mobility support use cases

- Networking traffic management
- Assessing the network performance for special events in the campus including construction and game days
- Traffic control optimization (signalized intersection, limited access areas, transit priority, …)
- Parking lot usage monitoring and real time pricing

Deliverables:

- Multi-modal traffic simulation model
- Proposing certain strategies to improve mobility campus-wide
Policy and Social Dimensions of Technology

- University test bed/ proof of concept for policymakers, results could be communicated via the Institute for Public Policy and Social Research
- Buy-in from stakeholders e.g., administration, students, police, raising awareness
- Privacy considerations
- Inclusion of environmental considerations (e.g., interface between electrification and autonomy)
- Incorporate policy and social dimensions into models
- Interface usability and accessibility
Questions? Comments?

- Contact johnv@egr.msu.edu
Backup Slides
Seamlessly integrating mobility, safety, and security in autonomous and connected vehicles.

**MSU KEY AREAS**

- Multi-modality sensing
- Radars and antenna design
- X2X networking

- Sensor and data fusion
- Deep learning
- Biometrics and cybersecurity
Other aspects of the Mobility Studio are research programs focused on **Smart Infrastructure** and **Traffic & Mobility Management**.

**SMART INFRASTRUCTURE**
- Communicating pavement, environmental, and vehicle-pedestrian traffic conditions in real time.

**MSU KEY AREAS**
- Sensors
- Urban cameras
- Pedestrian integration

**TRAFFIC/MOBILITY MANAGEMENT**
- Vehicle and pedestrian modeling and management for safety, efficiency, and predictive control.

**MSU KEY AREAS**
- System-level modeling, safety, optimization, and control
canvas RESEARCH GOALS

**external sensing**
- Pedestrian & Cyclist Activity
- Vehicular Activity
- Traffic Monitoring
- Road/Weather Conditions

**internal sensing**
- Emotive & Cognitive State
- Gesture/Posture Analysis
- Age Estimation
- Occupant Personalization
canvas RESEARCH FOCUS

- **sensor & data fusion**
  Intra- & inter-modality fusion of sensed signals
canvas RESEARCH FOCUS

- **(joint) deep learning**
  Object detection, recognition & motion forecast using deep learning