MSU Campus Mobility

Technology and Optimization Committee

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- Arnold Weinfeld (Public Policy Initiatives)
- Mark Wilson (School of Planning Design and Construction)
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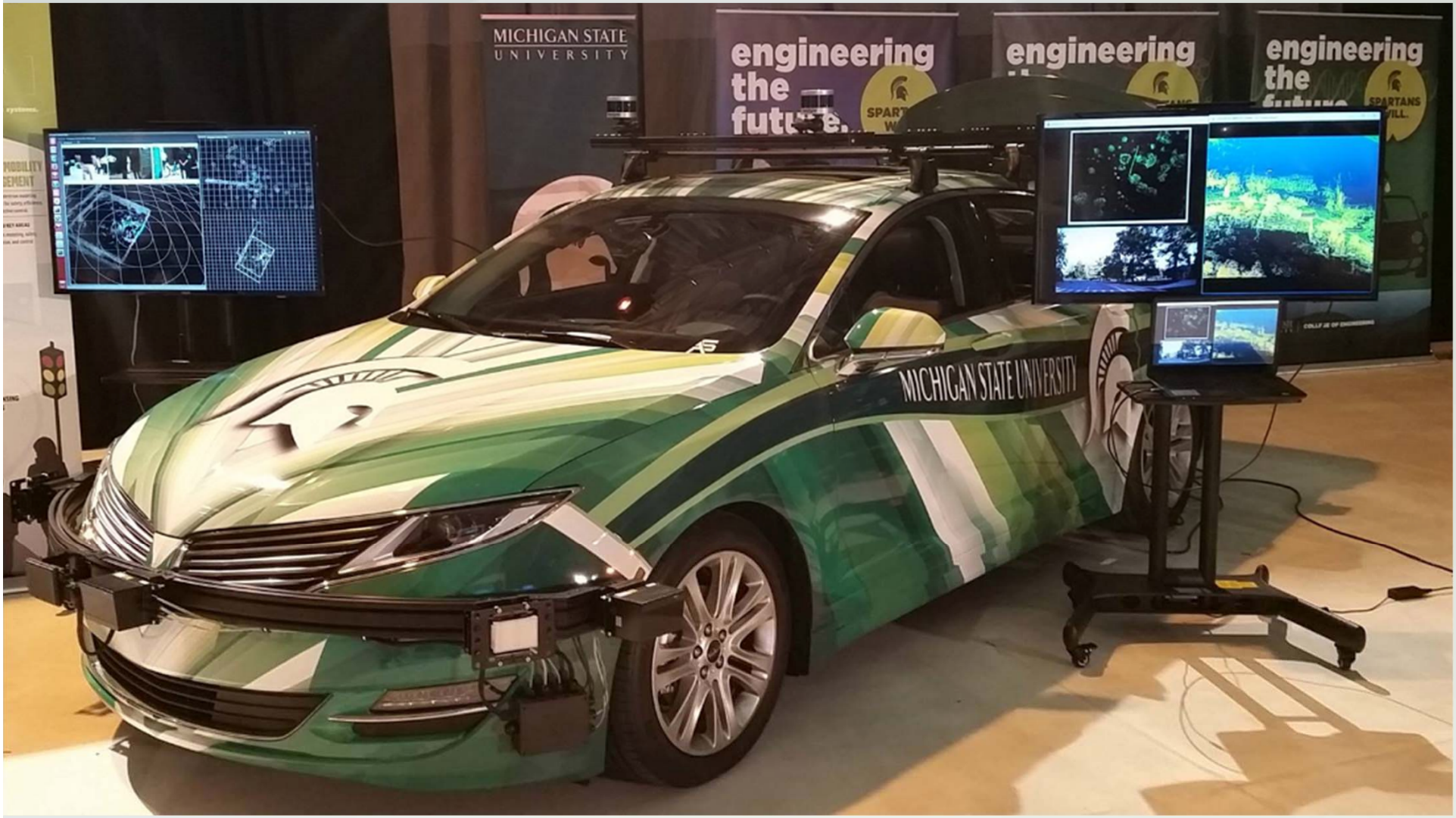
CANVAS Autonomous Vehicle Platform



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

App for Pedestrian Traffic Control and Data Collection

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:

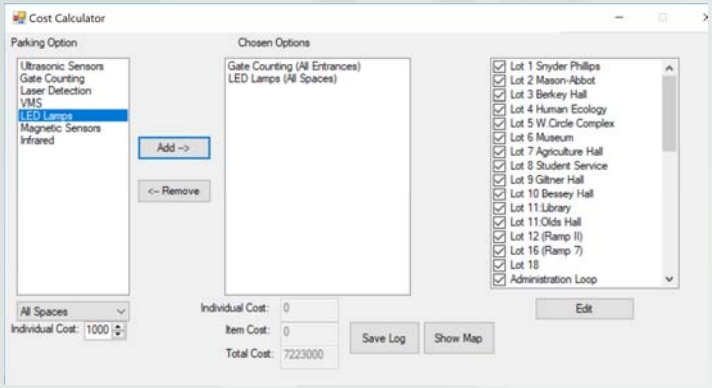
- ✓ A fully functional App
- ✓ Backend server with algorithms for congestion clearance etc.
- ✓ Deployment engineering support

Parking App

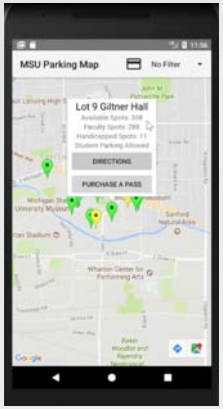
Assessment of available technologies

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

Cost analysis tool*



Parking App *



- **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

CANVAS

CONNECTED & AUTONOMOUS NETWORKD VEHICLES for ACTIVE SAFETY

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