Technologies for
Safe and Efficient
Transportation

National University Transportation Center on Safety

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The T-SET
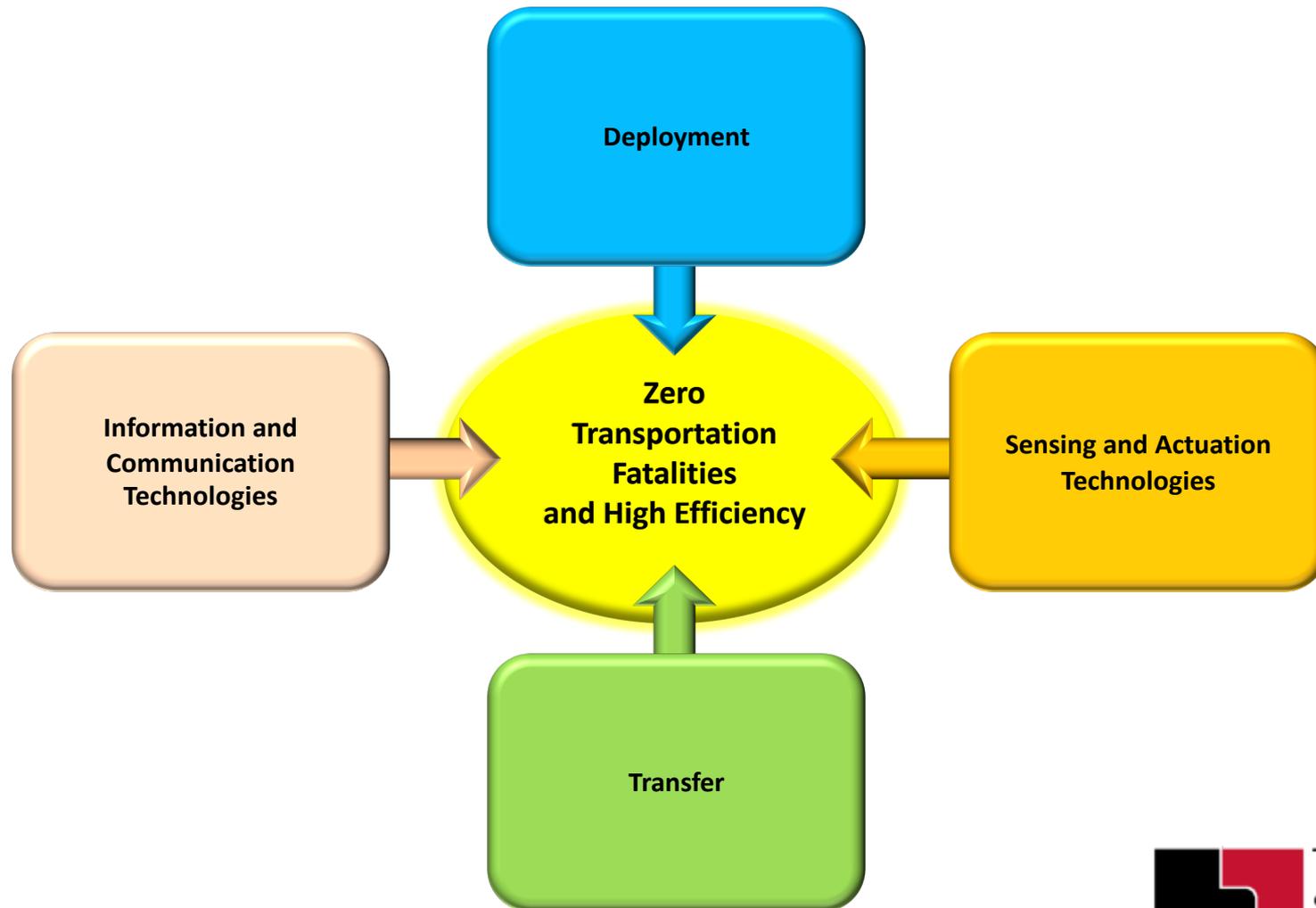# National University Transportation Center
on Safety

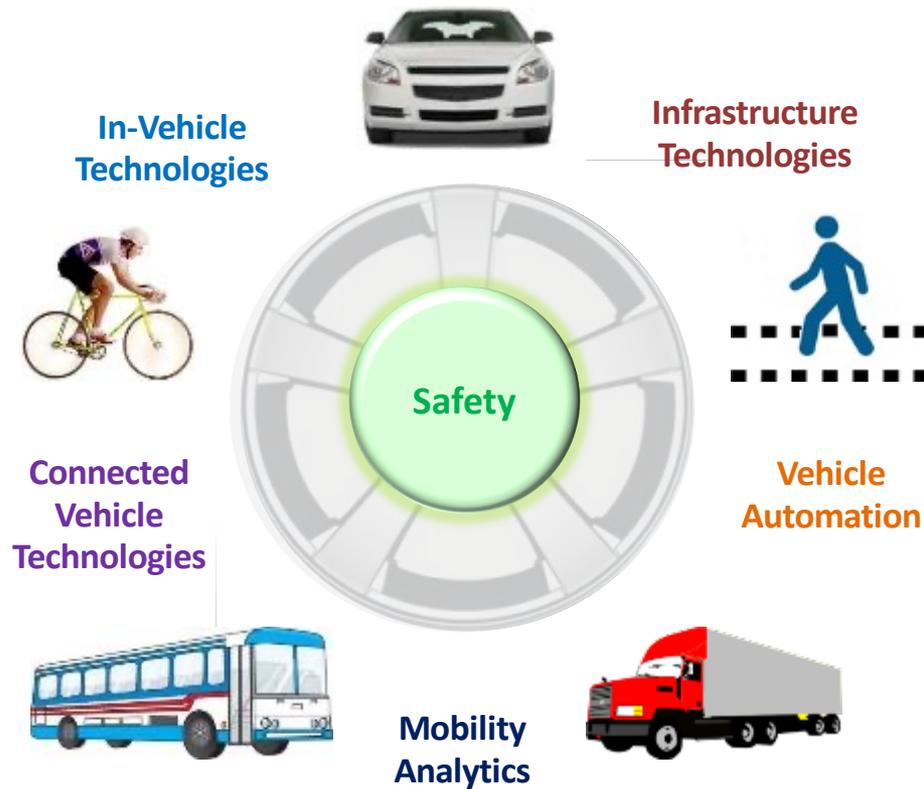Prof. Raj Rajkumar, T-SET UTC Director

The T-SET UTC

- **A consortium of Carnegie Mellon and Penn**

- **The T-SET University Transportation Center** aims to study, build and deploy an integrated suite of complementary technologies and policies to make **surface transportation safer and more efficient**.

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The Vision and High-Level Approach

Overall Thrusts

In-Vehicle Technologies

Infrastructure Technologies

Connected Vehicle Technologies

Vehicle Automation

Safety

Mobility Analytics

Societal and Economic Benefits

- Fewer accidents, fatalities and injuries

- Higher throughput (less traffic congestion)
    - Continually evolving technology to improve infrastructure
    - Lower maintenance costs
    - Support for multi-modal transit
    - Sound technical basis for policy-making

  - **Higher economic productivity**
  - **Better quality of life.**

Project Categories

- In-Vehicle Safety Technologies

- Infrastructure Technologies for Safety

- Connected Vehicle Safety Technologies

- Vehicle Automation

- Mobility Analytics

Key UTC Pieces

Faculty & Leadership

CMU Faculty Members

- Jacobo Bielak (CEE)
- Bernardine Dias (Robotics)
- John Dolan (Robotics)
- Jim Garrett (CEE)
- Martial Hebert (Robotics)
- Chris Hendrickson (CEE)
- H-J Kim (Robotics)
- Christoph Mertz (Robotics)
- Srinivas Narasimhan (Robotics)
- Hae Young Noh (CEE)
- Andre Platzer (CS)
- Sean Qian (Heinz College)
- Raj Rajkumar (ECE, Robotics, CyLab)
- Aaron Steinfeld (Robotics)

Penn Faculty Members

- Prof. Rahul Mangharam (ESE)
- Prof. Jianbo Shi (CIS)
- Kostas Danillidis (CIS)
- John Landis (Design)
- Prof. Insup Lee (CIS)
- Prof. C.J. Taylor (CIS)
- Prof. Vijay Kumar (MechE and CIS)

Executive Leadership

- Chris Hendrickson, Director, Traffic 21
- Al Biehler, Executive Director
- Stan Caldwell, Dep. Exec. Director
- Rick Stafford, Director, Traffic 21
- Courtney Ehrlichmann, Project Mgr
- Mark West@ Penn

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~20 graduate students (mostly Ph.D.)

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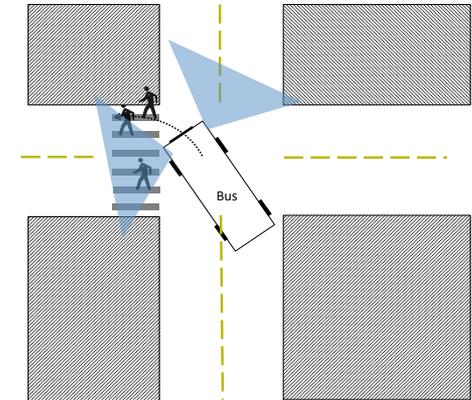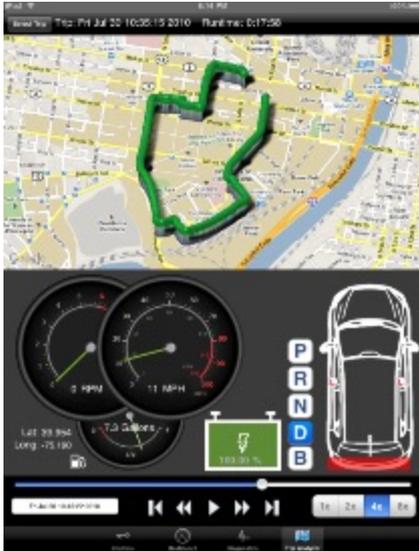
Penn Schools and Centers

GRASP LABORATORY — General Robotics, Automation, Sensing & Perception

PRECISE (Penn Research in Embedded Computing and Integrated Systems)

PennDesign

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UPenn Projects

Adaptive Traffic Signals

Lead:
Dr. Steve Smith, Robotics

Objective

– Demonstrate ability of adaptive signalization approach

Benefits

– to improve traffic flow and reduce air pollutants in urban road networks
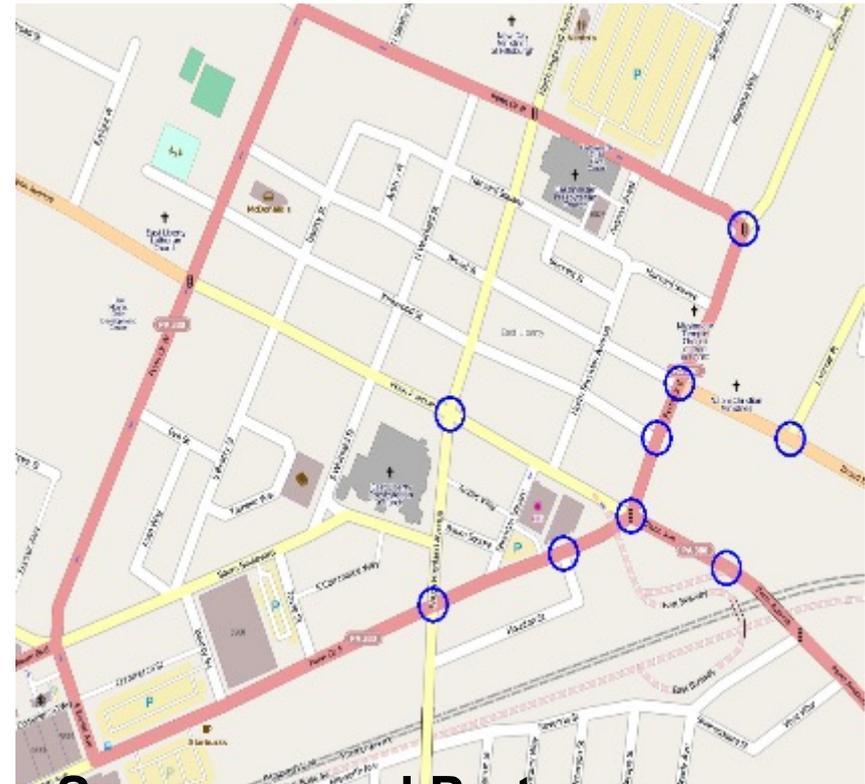
Test Site

– Developing area with changing traffic patterns and volumes

– 9 recently upgraded intersections (controllers and cameras)

Current Status

– CPUs and network that run the system are installed at each intersection and system test trials are ready to commence

– "Before" traffic flow analysis is complete

– Simulation results comparing system with current timing plans are promising:

Sponsors and Partners:

– Heinz Endowments (Breathe.org)
– City of Pittsburgh
– Traffic Control Products, Inc.
– Traficon Traffic Video Detection

% Reduction	Travel Time	Wait Time	Emissions
AM rush	37%	63%	32%
PM rush	23%	42%	20%

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V2I Infrastructure near Pittsburgh
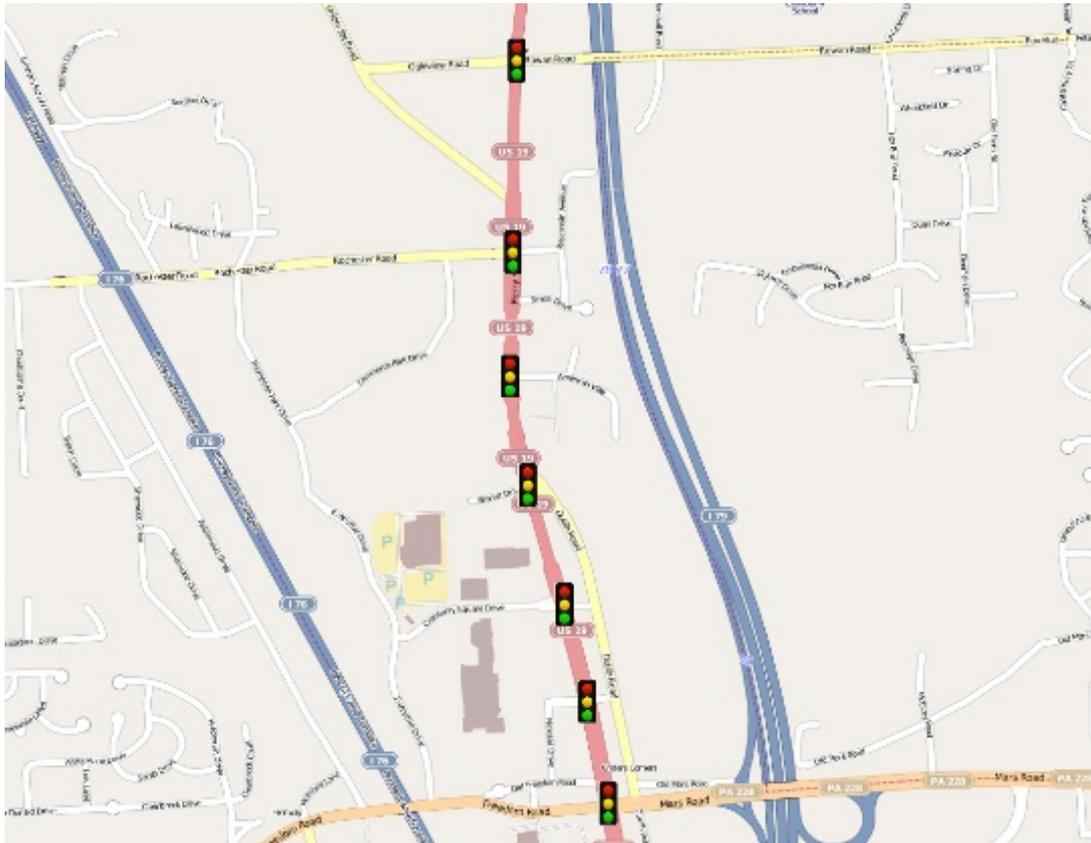
- **Cranberry Township**, PA
- Located 20 miles north of Pittsburgh, PA
- 1.8 mile stretch along Rt. 19 corridor
- 11 intersections are instrumented

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Planned Traffic Light V2I Testbed in Pittsburgh

- 23 traffic lights near UPMC Shadyside Hospital, Shadyside, Pittsburgh

- Part of **adaptive traffic signals** project
  - Extension from East Liberty/Bakery Square neighborhood
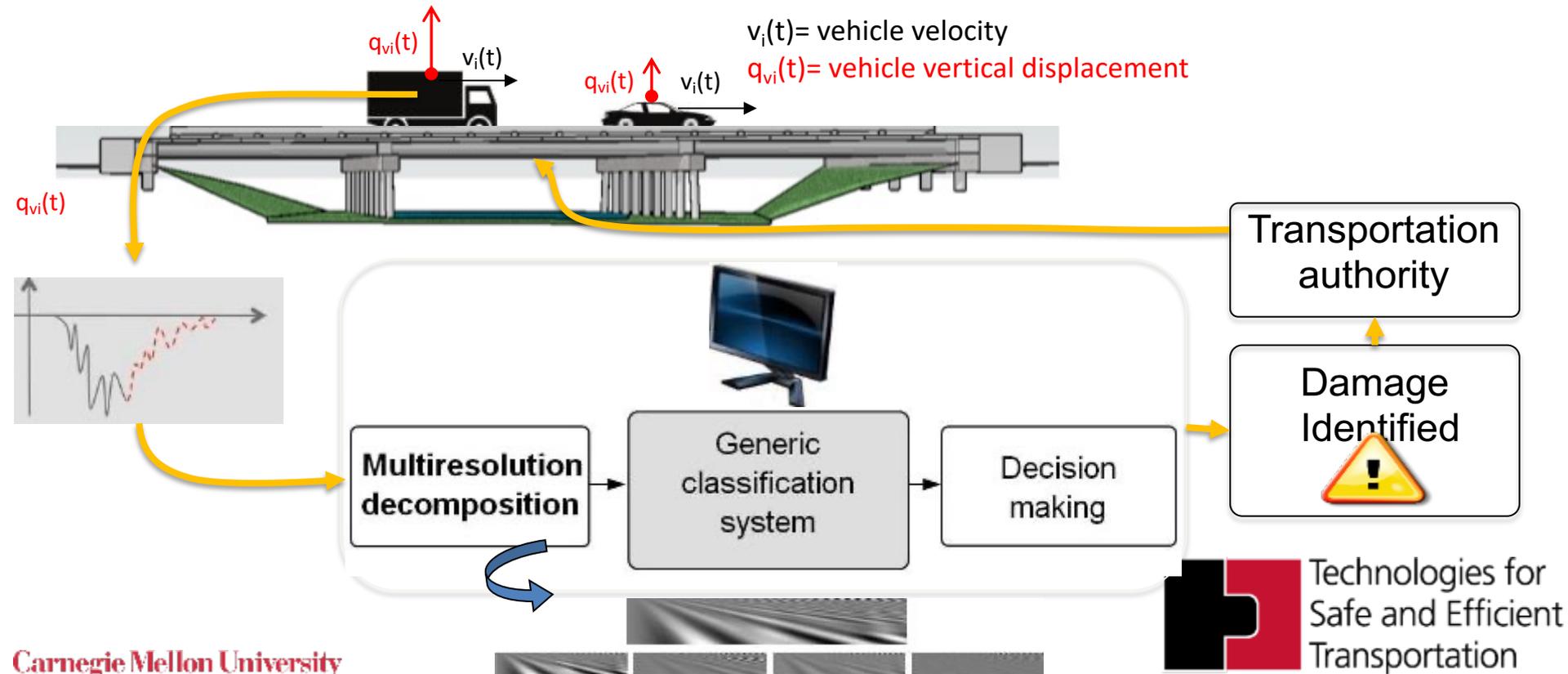
- **Summer 2014**

Bridge Monitoring

Leads:
Prof. Jim Garrett (CEE), Prof. J. Bielak (CEE), J. Kovacevic (BME)

Objective: Develop an approach that takes the acceleration data that comes from many vehicles passing over a bridge to determine if changes to bridge have occurred.


$q_{vi}(t)$

$v_i(t)$

$q_{vi}(t)$

$v_i(t)$

$v_i(t)$= vehicle velocity
$q_{vi}(t)$= vehicle vertical displacement

$q_{vi}(t)$

Multiresolution decomposition → Generic classification system → Decision making → Damage Identified → Transportation authority

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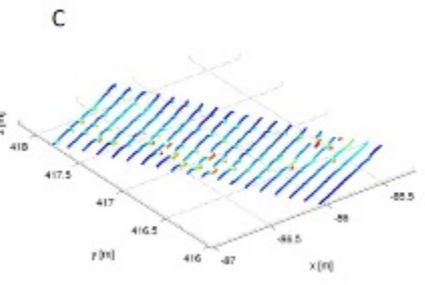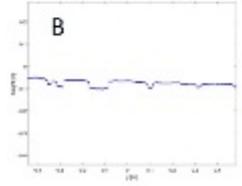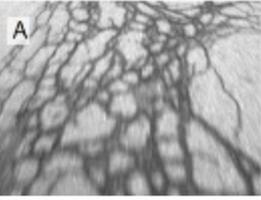**National University Transportation Center on Safety**

Continuous Road Surface Distress Detection

Lead:

Dr. Christoph Mertz, Robotics

Mount a structure light sensor (cost ~$1k, resolution ~1mm) on vehicles that regularly traverse the road network .
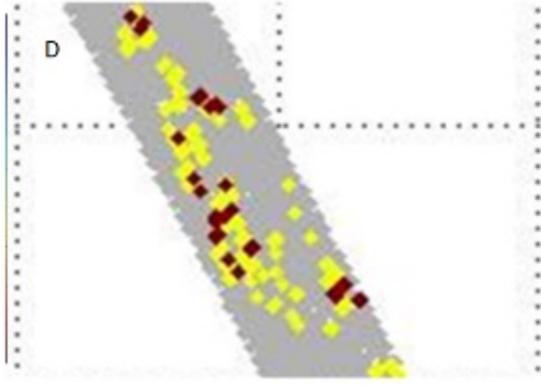
Analysis of the data gives an assessment of the current state of the road surface (potholes, cracks etc.)

(A) Image of the damaged road. (B) One road cross-section (C) Several cross sections combined to form a 3D map of the road. (D) Map with medium (yellow) and severe (red) road distress.

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Autonomous Rides in Pittsburgh and DC

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Consortium

Consortium Partners		
AASHTO	City of Philadelphia	PITT OHIO Express
Access Transportation Systems	City of Pittsburgh	Philadelphia Port Authority
Accessible Transportation & Workforce Interagency Cooperative	Community College of Allegheny County	Pittsburgh Technology Council
ALCO Parking	Conference of Minority Transportation Officials	Port Authority of Allegheny County
Allegheny Conference on Community Development	Delaware River Port Authority	Port of Pittsburgh Commission
Allegheny County	Delaware Valley Regional Planning Commission	Southeastern Pennsylvania Transportation Authority
APTA	General Motors Global Research & Development	Southwestern Pennsylvania Commission
Beth's Barricades	IBM	Sustainable Pittsburgh
Bike Pittsburgh	Innovation Works	Takata
Bombardier	ITS America	Three Rivers Workforce Investment Board
Booz Allen Hamilton	Open Roads	University of Pittsburgh
Bosch Research & Technology Center	PennDOT	Women's Transportation Seminar
Pennsylvania Motor Truck Association		

Education and Technology Transfer

- Faculty Seminar Series Webinars

- Consortium

- Partner with **Center for Innovation and Entrepreneurship** at CMU

- Non-traditional, interdisciplinary approach to educating tomorrow's transportation professionals

Domains
- Civil & Environmental
- Electrical & Computer Engineering
- Robotics
- Computer Science
- Mechanical Engineering
- Public Policy

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Thank you.

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