Turner-Fairbank Highway Research Center

"TFHRC provides the world highway community with advanced and applied research and development related to new and existing highway technologies."

- FHWA scientists and engineers providing expertise for over 100 transportation-related disciplines
- Over 20 onsite laboratories and data centers
- Functionally divided into infrastructure, operations, safety, and exploratory advanced research

Project Info

- Project began January 2015, and will end April 2017

- **Carnegie Mellon National Robotics Engineering Center (NREC)** is performing work under contract number **DTFH6115C00004**.

- Principal Investigators: **Dr. Herman Herman and Dr. Alonzo Kelly**

- Deliverable is an operational prototype guidance system that will be ready for further development

- Target commercialized unit cost <$15K

Problem: Safety

Low-Visibility Winter Plowing
Operations are Very Hazardous

Problem: Mobility

Closed Highways Inhibit Mobility and Prevent the Movement of Goods and Services

Constraint: No GPS

Snowplows often operate in areas where there is weak or no GPS Signal (GPS Denied conditions).

Constraint: Hidden Infrastructure

- Unmapped, snow-buried, highway and roadside features are easily damaged by plows (and likewise damage the plows themselves).

Photo Andrew Bossi

Constraint: Operator Acceptance

Operator must embrace, trust, and feel confident with the technology

Photo Oregon DOT

Solution: Real Time Navigation and Obstacle Detection

Using a <u>visual</u> sensor array that helps the plow "see" where is is...
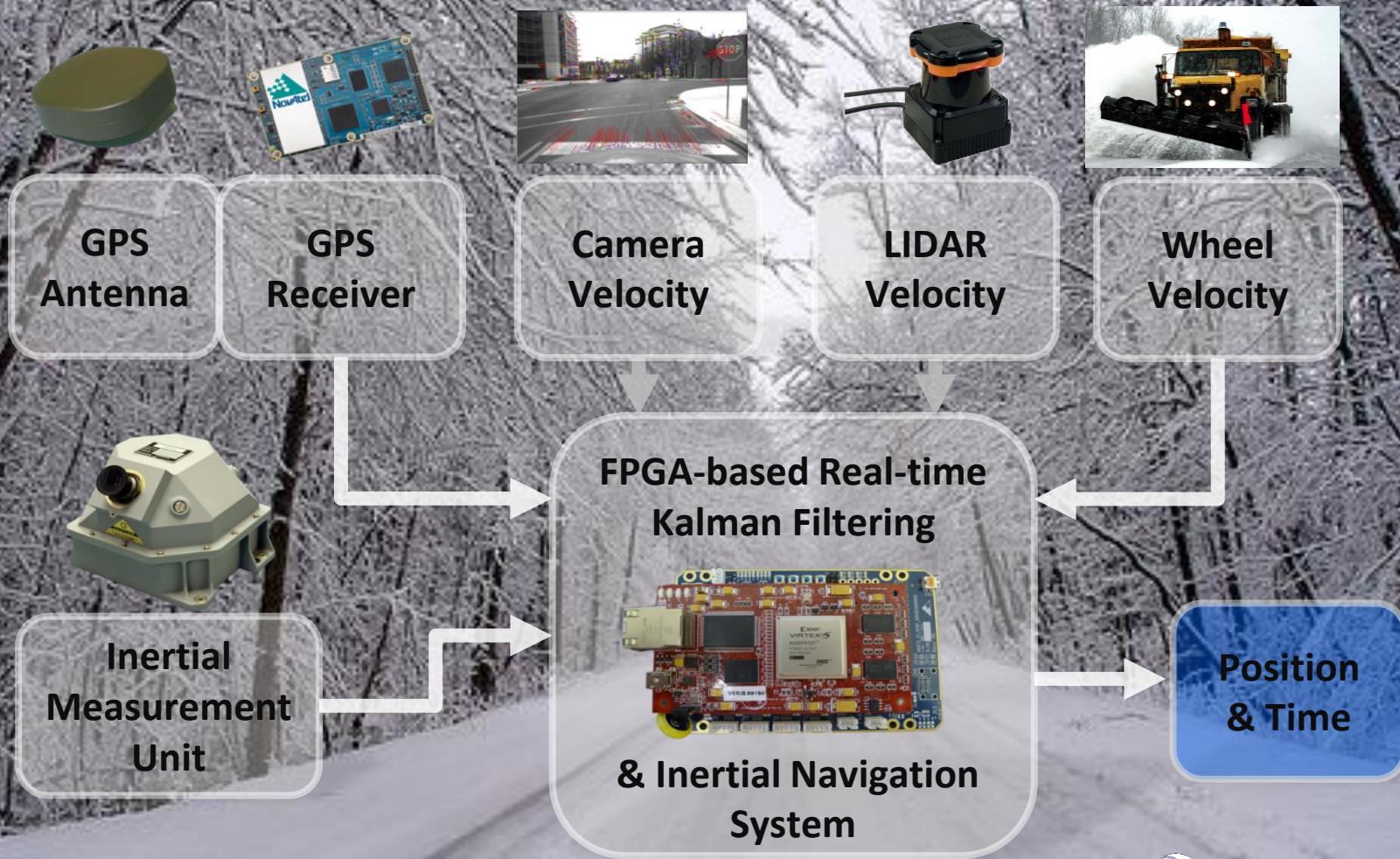
Lidar

Radar

Visual Camera

Thermal Camera

When GPS doesn't work:

Our approach uses an <u>array</u> of <u>guidance</u> sensor modalities:

GPS Antenna

GPS Receiver

Camera Velocity

LIDAR Velocity

Wheel Velocity

Inertial Measurement Unit

FPGA-based Real-time Kalman Filtering

& Inertial Navigation System

Position & Time

No GPS? Use Visual Cues.

Model 3-D visual features in the summer…

Tall Objects

WEST 3

Low, Metallic Objects

Buried Obstacles

Lanes

Shoulders

CALL 1-866-SEE-TRUX
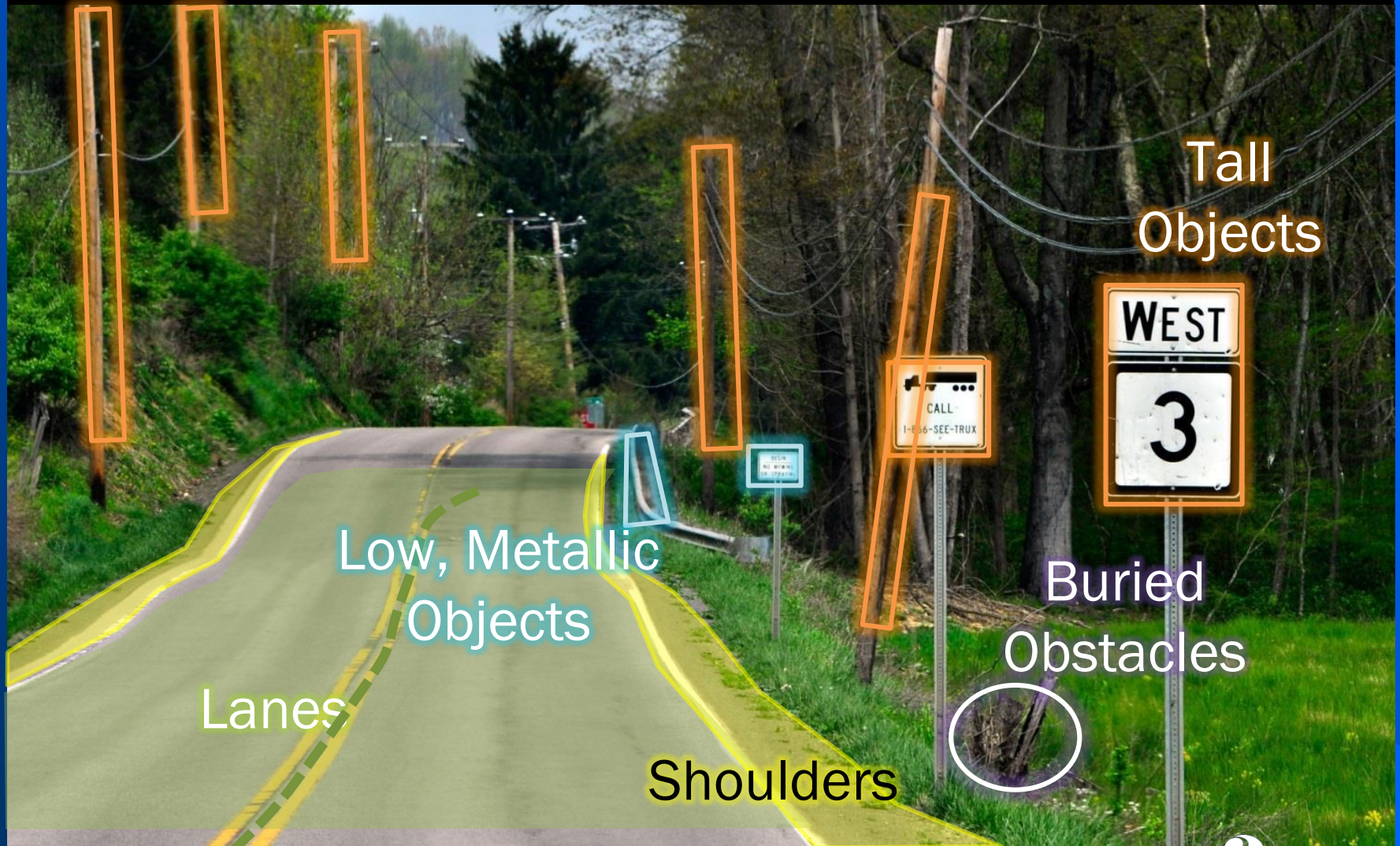
...to find your location and display the route and hidden highway features in Winter

Obstacle

Rail

Lanes

Shoulder

Audio Alerts

U.S. Department of Transportation
Federal Highway Administration

Key Challenge: Clearly displaying data that augments driver's view

Eye-Tracking Device

Location	Technology	Examples	Pros	Cons
Head-worn	Optical see-through	Osterhout ODG R-7	Fail-safe No eye-tracking required Can render depth Low-cost	User acceptance Limited FOV
	Video see-through	Oculus Rift	No eye-tracking required Can render depth Low-cost	User acceptance Not fail-safe
Windshield	Full windshield optical see-through	Sun Innovations DLP	Large display area Flexible	Expensive Eye-tracking required Large volume Requires windshield film Difficult to generate depth
	Combiner video see-through	Garmin HUD	Small volume No eye-tracking required	Small display area Difficult to generate depth Text or icon only display

Flexible Windshield Film

Facial feature recognition

U.S. Department of Transportation
Federal Highway Administration

Goals and Benefits

- Safer winter operations for the plow operator and public
- Reasonable cost
- Simple, intuitive controls and display
- Reduce the likelihood of damage to equipment and highway infrastructure
- Highways will open sooner after snow event

Status, and Moving Ahead

June 2016: Physical installation on test vehicle, software/hardware calibration

Summer/Fall 2016: Clear weather testing, preparation for winter testing

Winter 2017: testing and demonstration in both pre-established and "real" conditions.

Thank You

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