



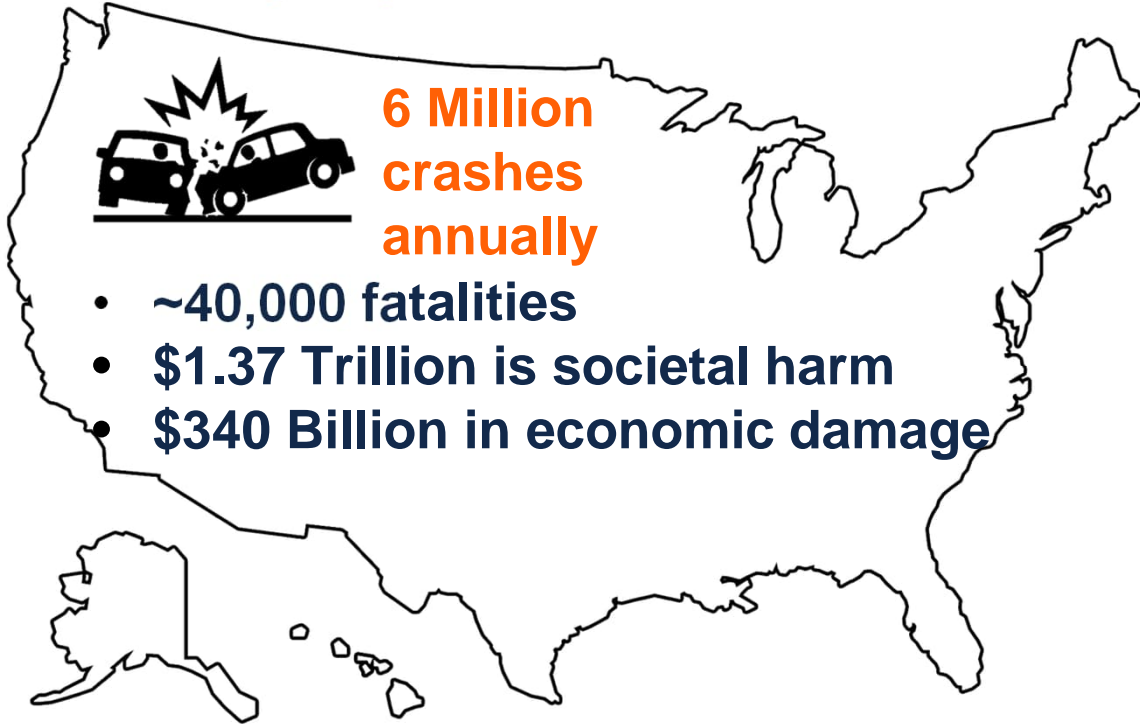
High-Speed Pavement Texture Measurement Prototype

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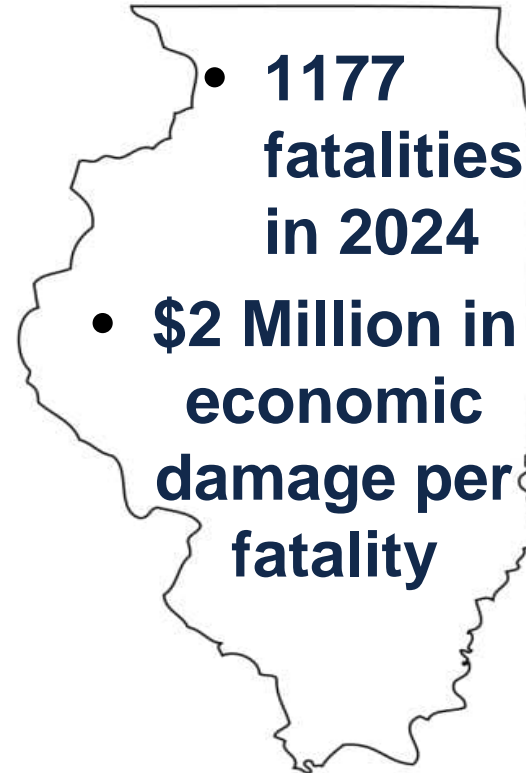


- **Principal Investigators: Professor Imad L. Al-Qadi and Professor Mani Golparvar-Fard**
- **Illinois Department of Transportation, Federal Highway Administration**
- **Hong Lang, Postdoctoral Scholar**
- **Technical review panel, special thanks to John Senger**
- **ICT research engineers**
- **ICT students and staff**

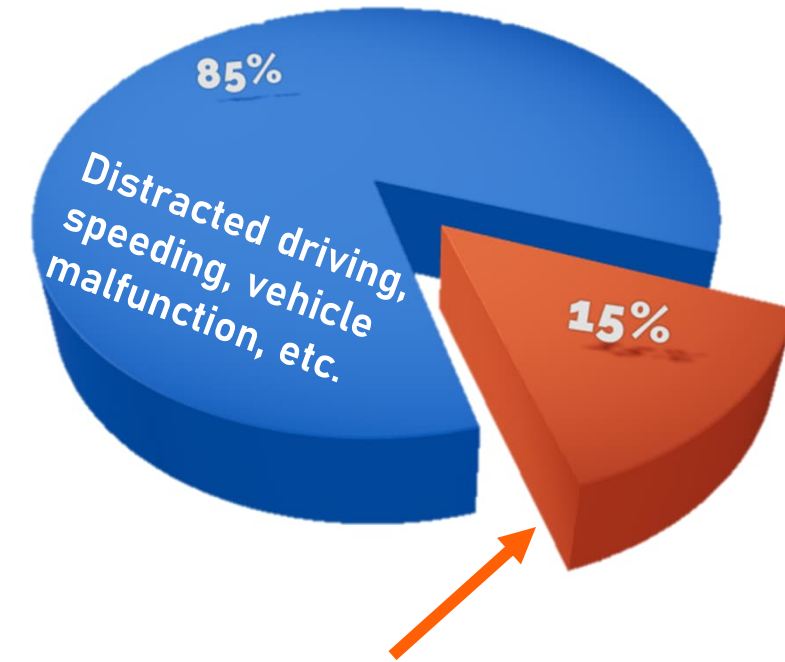
United States



Illinois



Crash Causes



Insufficient friction

Maintaining **adequate friction** on roads is critical for **traffic safety**.



Locked Wheel



Fixed slip



Side-Force

Limitations:

- Relatively expensive to own and operate
- Affected by test tire properties
- Require extensive training
- Spot/sporadic measurements

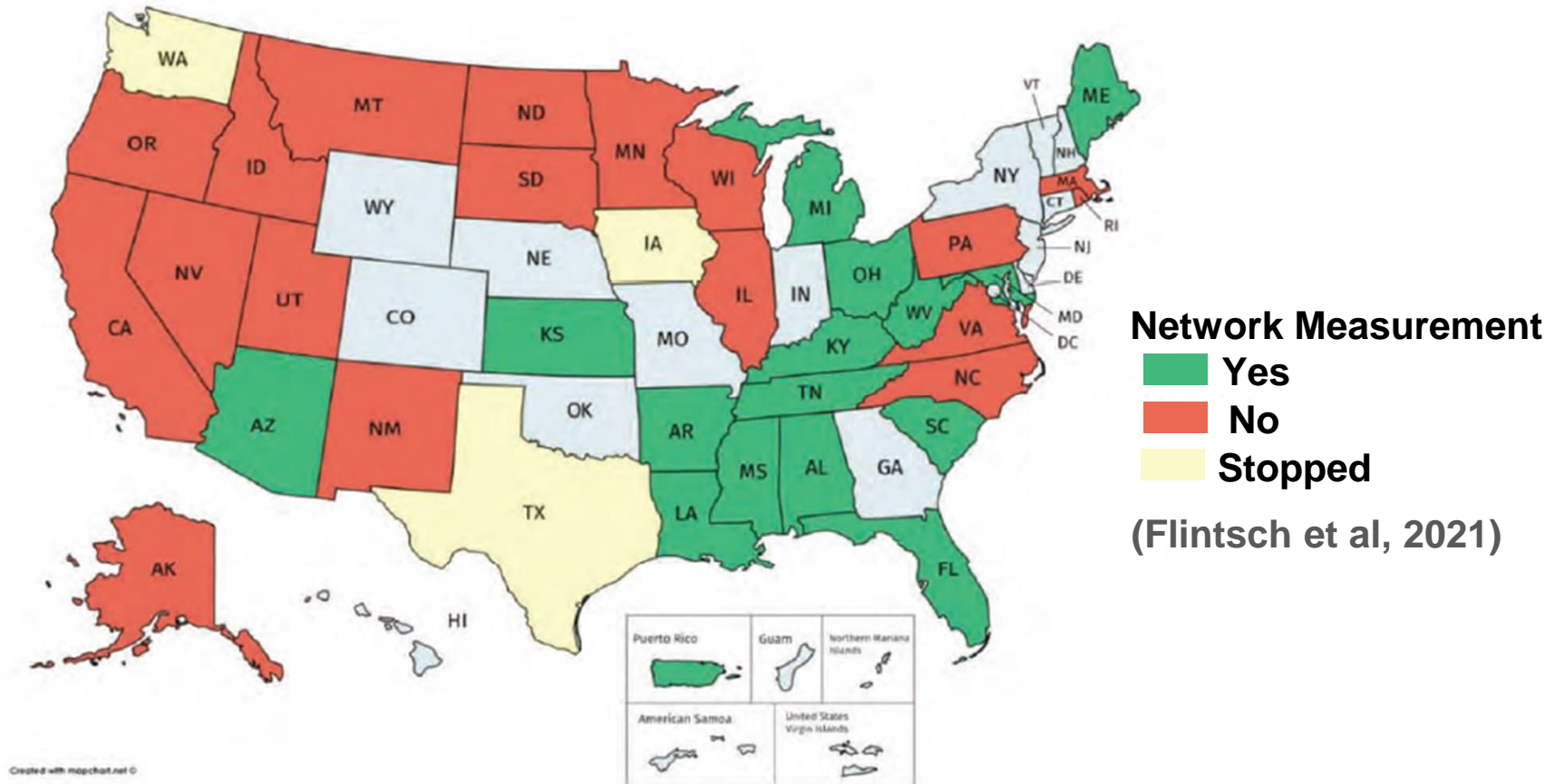


Alternative methods are needed.

Pavement Texture

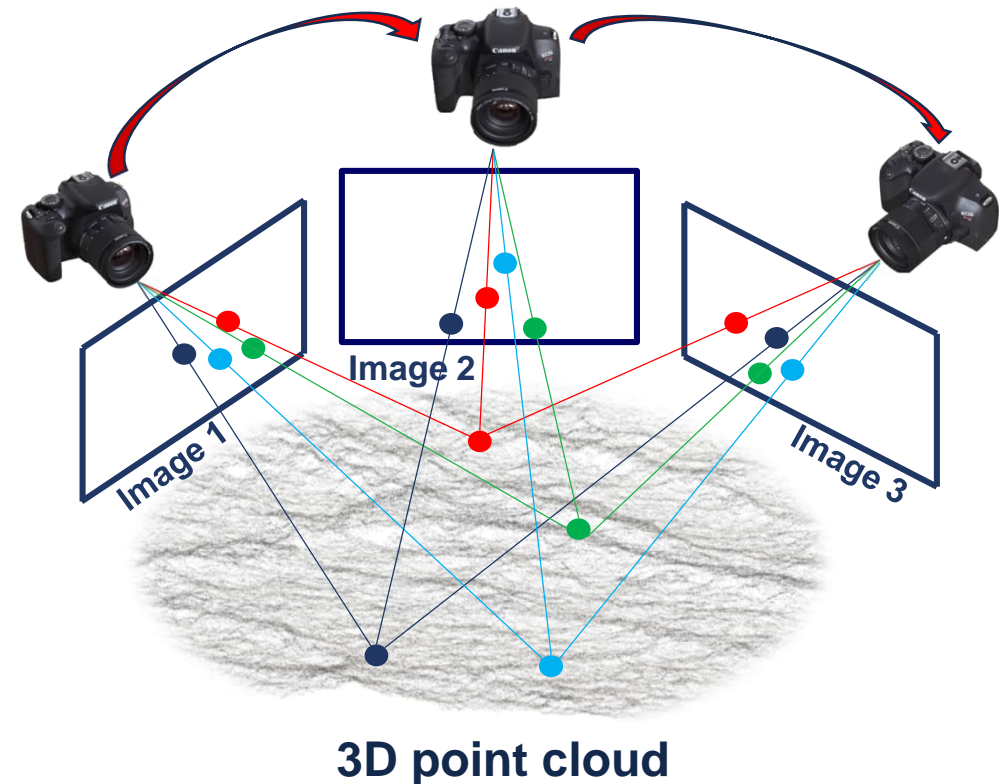


Pavement texture is a major driver of friction, yet only 15 states and Puerto Rico conduct network measurement of pavement texture due to the high cost of network-level laser scanning.



Computer vision techniques can be utilized to recover 3D information from 2D images.

Photogrammetry/Structure from Motion (SfM)



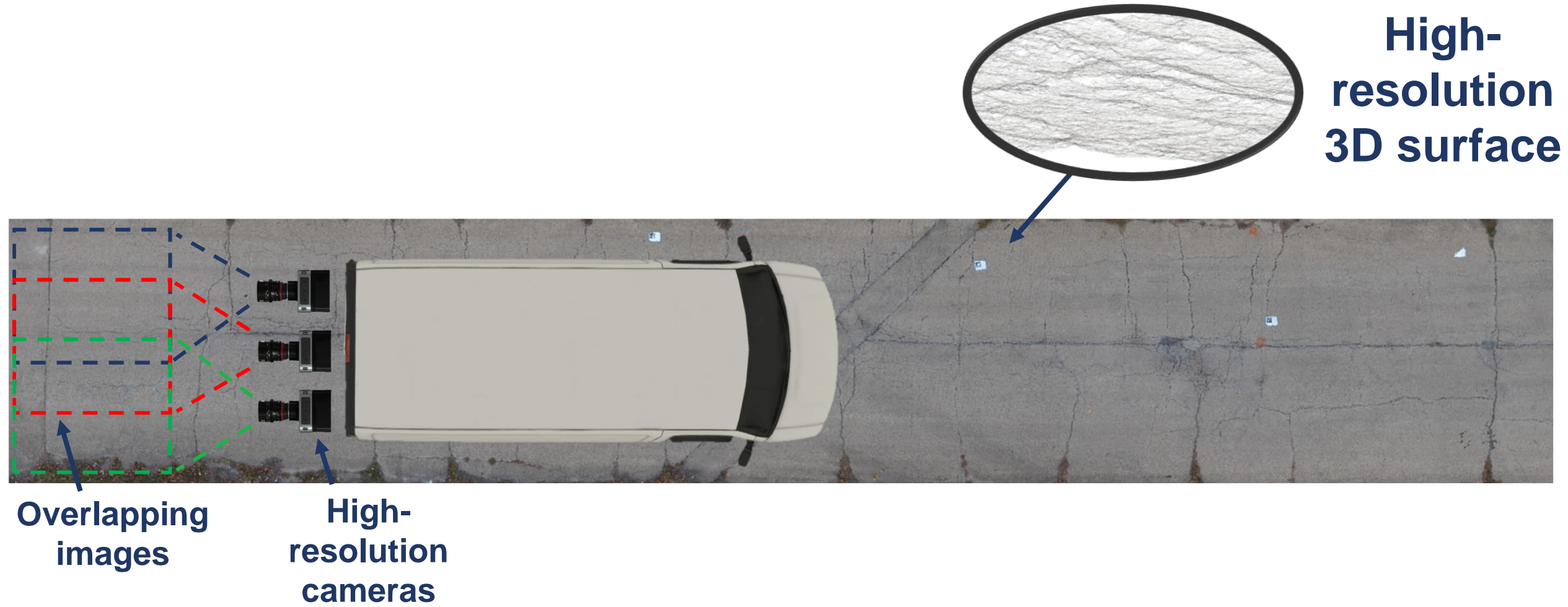
Advantages:

- Inexpensive equipment
- Comparable or higher quality data
- Less complex technology



No device exists for scalable measurement at speed.

SfM Vehicle-Mounted System

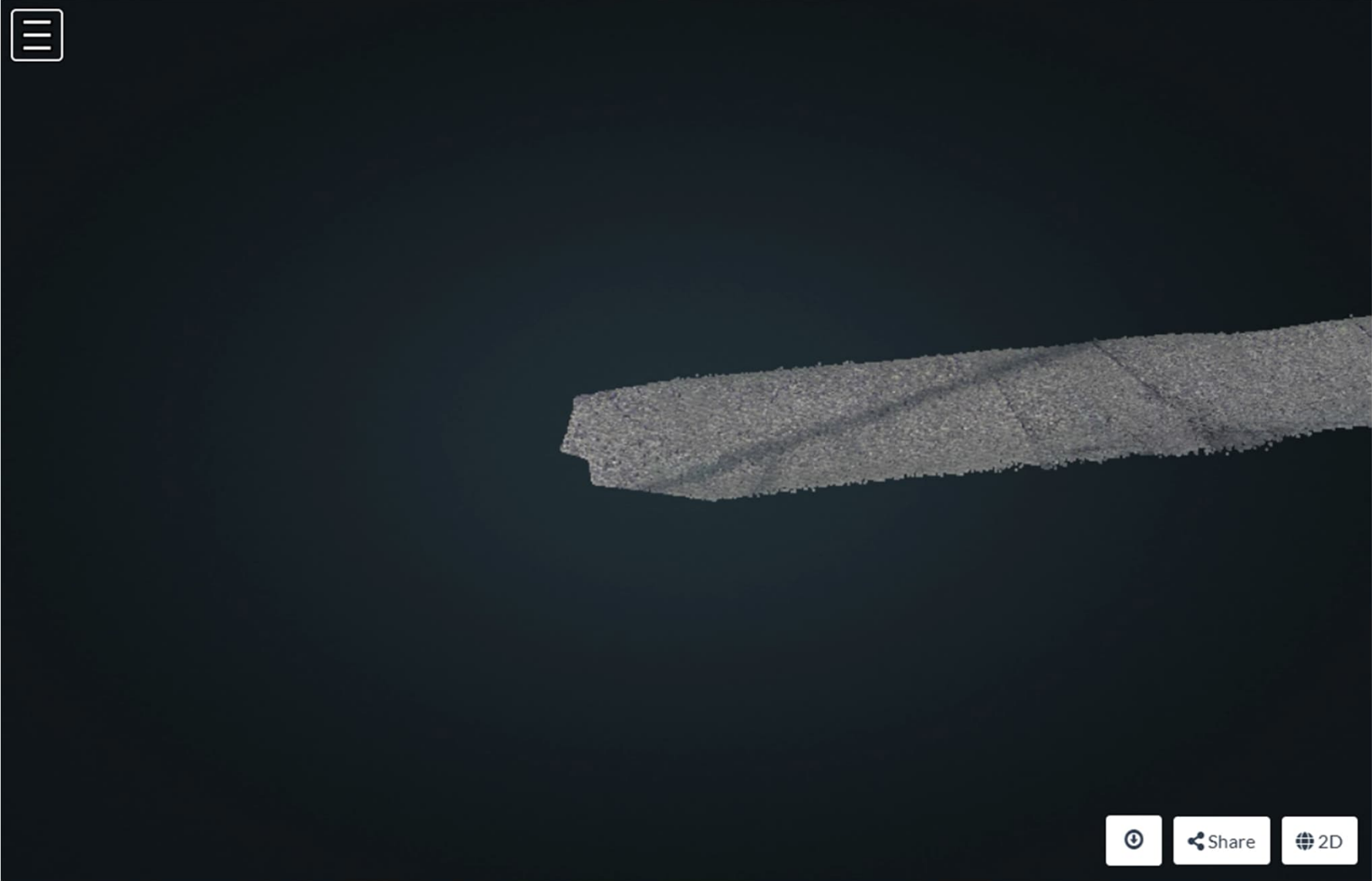


GPS antennas

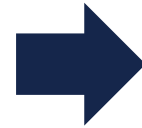
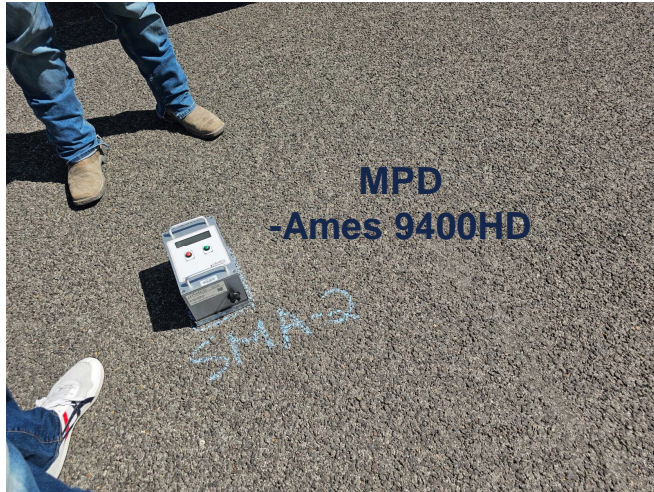


**Dual
cameras
shooting
high-
resolution
images at
high rates.**

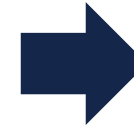
The prototype allows for inexpensive measurement of pavement surface characteristics, not just texture, and can also be used as a general mapping tool.



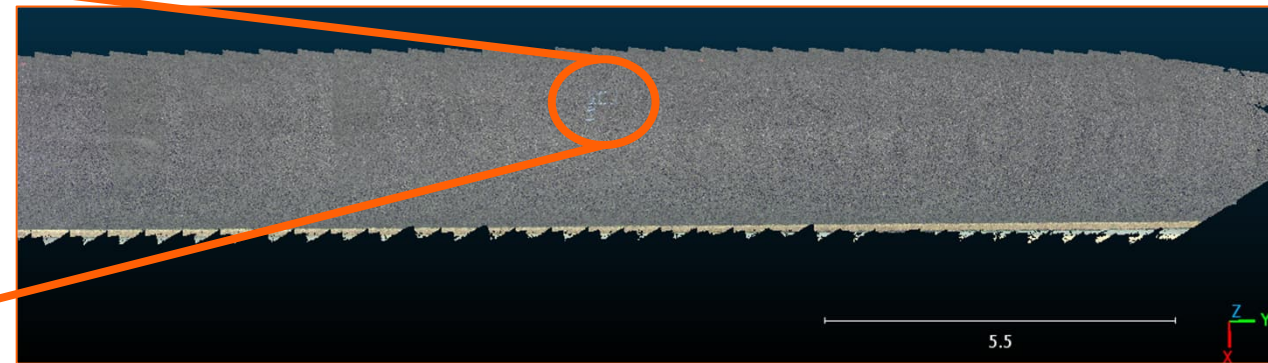
DATA COLLECTION - Laser



DATA COLLECTION - Prototype

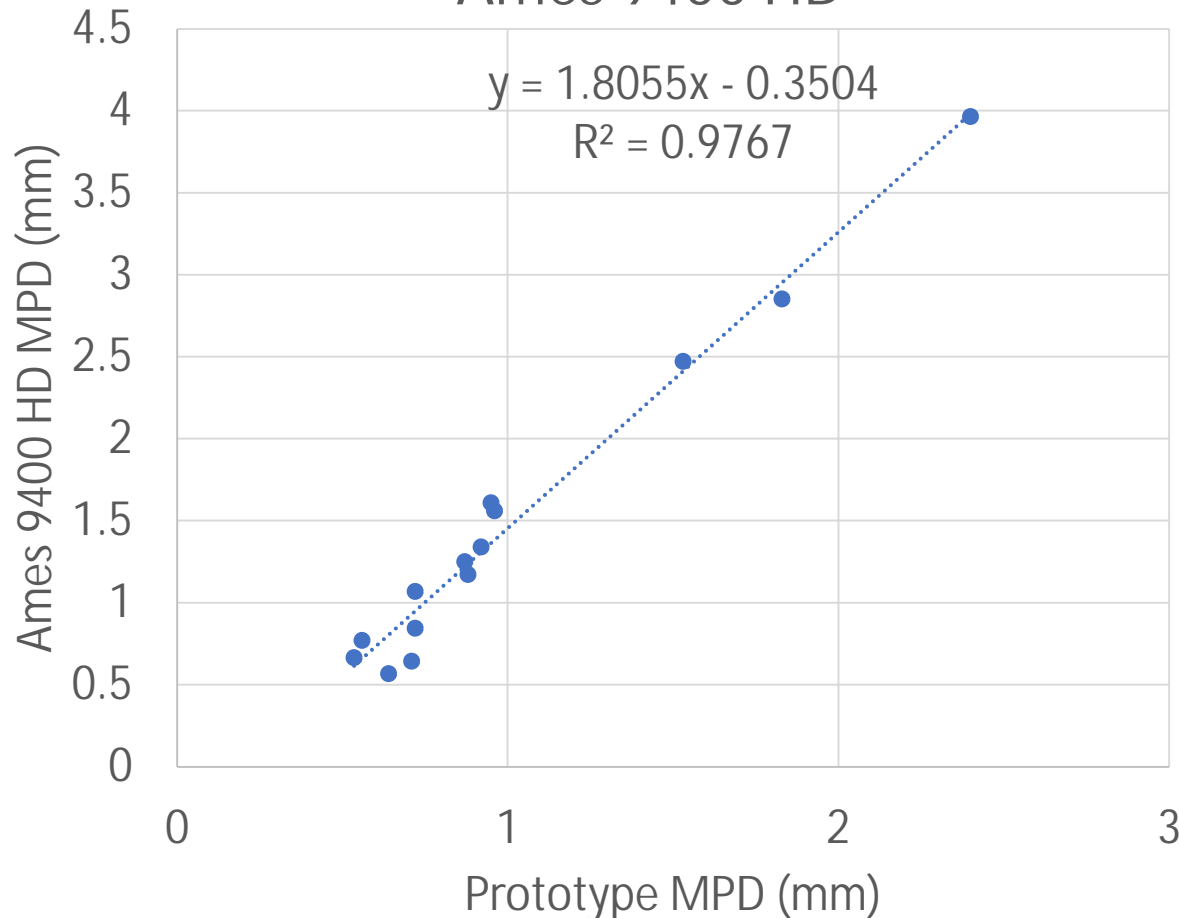


Measurement comparison



Surface 3D Reconstruction

Correlation Between Prototype and Ames 9400 HD

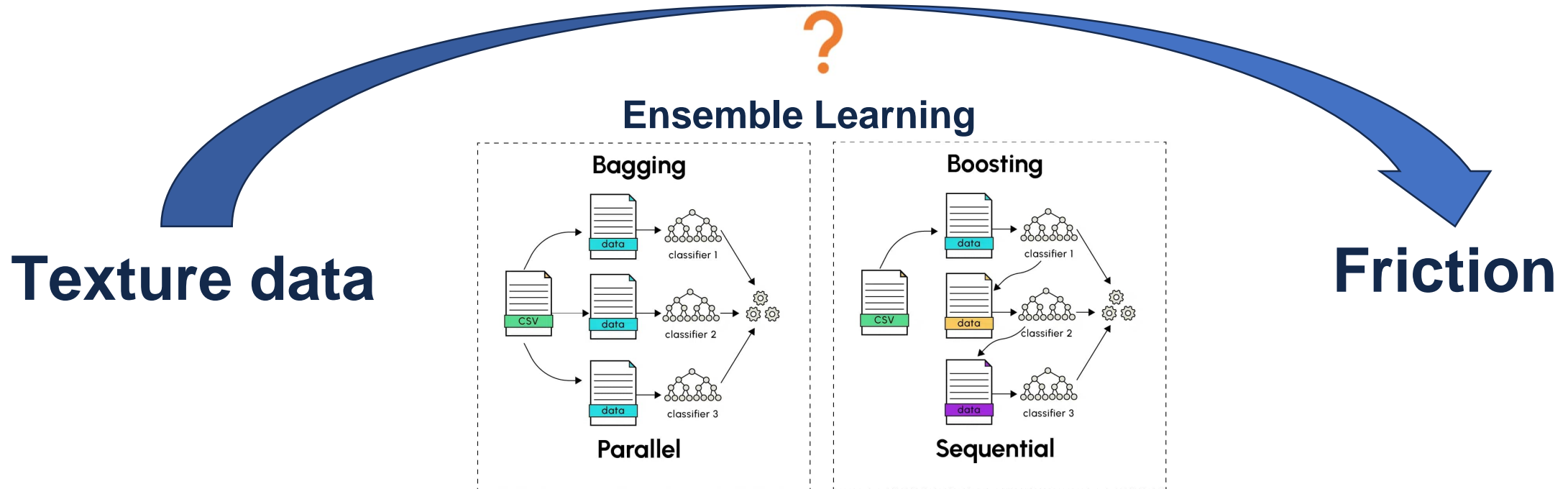


- **Correlation coefficient between AMES 9400 HD and prototype is 98%.**
- **An equivalent measurement to the laser device:**
$$MPD_L = 1.805MPD_P - 0.35$$

for $0.5mm < MPD_P < 2.5mm$
- **where MPD_L is measurement from AMES device and MPD_P is prototype measurement.**

- **~ 0.5 mm point cloud resolution**
- **Processing scales horizontally with multiple compute nodes**
- **Measurements correlate well with laser system**
- **Currently operates up to 35 mi/hr, and up to 45 mi/hr with software refinements**

To predict friction, a model that uses the measured texture as an input was developed.



- Random Forest
- Gradient Boosting
- Extra Trees
- XGBoost



Illinois (2023)



- Legend**
- Friction Data
 - Illinois Road Network
 - Illinois State Boundary

0 21 42 84 126 168 Miles

Illinois (2025)



- Legend**
- Friction Data
 - Illinois Road Network
 - Illinois State Boundary

0 21 42 84 126 168 Miles

Florida (2024)

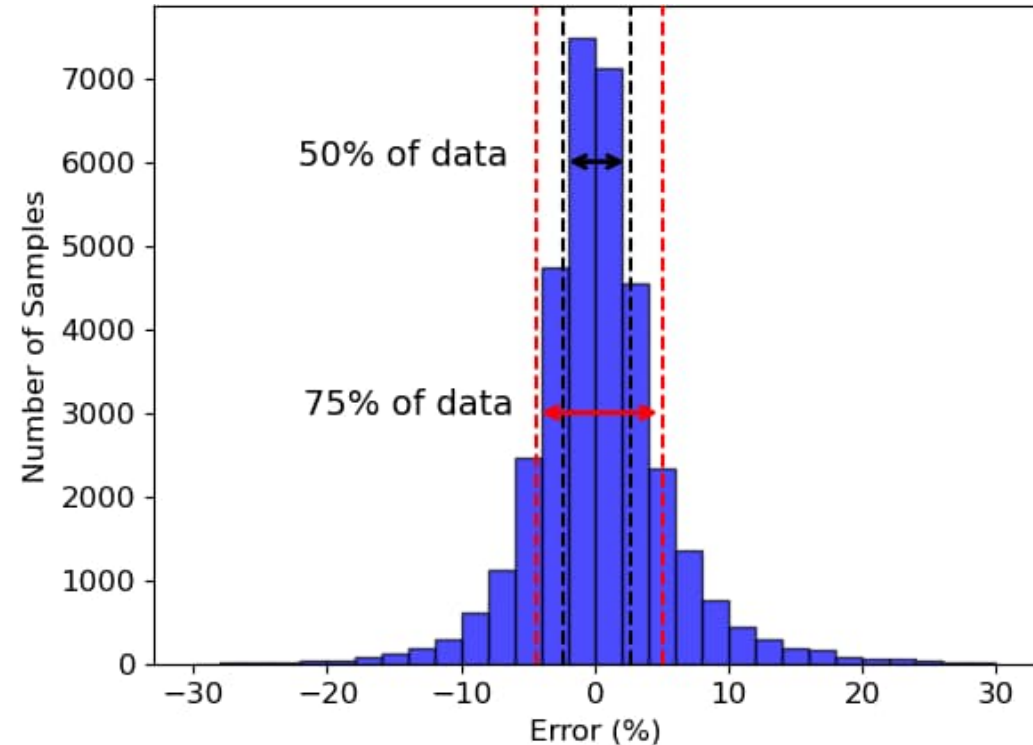


- Legend**
- Friction Data
 - District 7 Road Network

0 7 14 28 42 56 Miles

Extra Trees achieved the best performance and was also the fastest to train.

MODEL	R ²	MAE	RMSE
RANDOM FOREST	82%	1.96	2.96
EXTRA TREES	83.16%	1.89	2.85
GRADIENT BOOSTING	81.66%	1.99	2.99
XGBOOST	82%	2.02	2.95



The results show that with sufficient training data in diverse scenarios, data-driven models can predict surface friction with high accuracy.

- **New option for pavement surface data collection.**
- **Lower cost compared to current state of practice.**
- **Expanded testing in rural areas.**
- **Technology is transferable to normal vehicles (including autonomous vehicles), which can provide wide coverage of road networks.**



CELEBRATING ★ ★ ★ ★ ★ ★ ★ ★

250

 RPUG
Road Profile Users' Group

★ ★ ★ ★ ★ ★ ★ ★

★ ★ ★ ★ ★ ★ ★ ★ YEARS OF PROGRESS

HONORING THE PAST. PAVING THE FUTURE.

Thank you! Any Questions?

