

Automated Pavement Cracking Analysis from 2D to 3D Challenges and Opportunities

Kelvin C.P. Wang

University of Arkansas & WayLink Systems

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The Team of 15-Year Effort

- Weiguo Gong
 - Terry Tracy
 - Dr. Jacqueline Zhiqiong Hou (now Arkansas highways)
 - Dr. Kevin D Hall
 - Dr. Vu Nguyen
 - Danny X. Xiao
 - Dr. Jiang Yangsheng
 - Ryan Reynolds, Daniel Byram, Jesus Martinez
 - Others
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Classics of Pavement Data Collection



Problems

- Pavement Surface Data
 - Critical in the entire pavement engineering spectrum
 - Partly Responsible for current standing of the discipline
 - Challenges
 - Automation not possible for a large portion of pavement surface characteristics in broad definition
 - Precision & Bias: not possible to establish
 - Result: wasted resources & frustration
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Opportunities

- Computing and Sensor Technology
 - Very advanced and low cost of entry
 - Similar sensor principles applied in other industries
 - Usefulness of Actual Representation of Pavement Surface: 3D
 - As good as actual pavements at the defined resolution
 - All current requirements for surface data: possible in the digital domain
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Surface Characteristics in Broad Definition

- Profiles: transverse and longitudinal
 - Texture: macro-texture and safety
 - Friction
 - Surface distresses: cracking, rutting (trans. profile), patching, faulting, various other surface defects (LTPP Distress Manual, AASHTO Interim/Provisional Standards)
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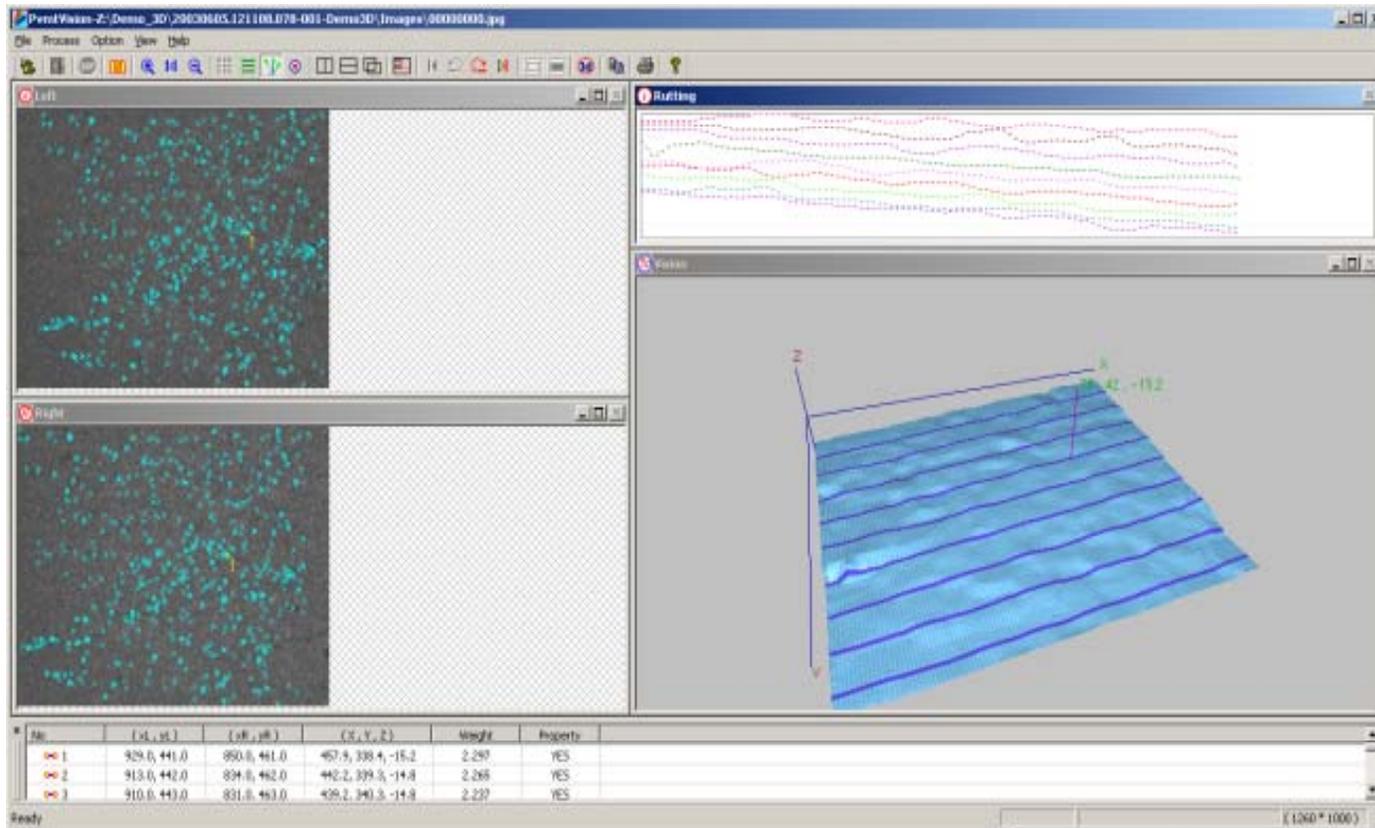
A Big If

- What happens if an actual pavement as far as eye can see can be virtually stored in a computer at 1-mm resolution with necessary/required spatial resolution & positioning accuracy?
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Methodologies for 3D Surface Data Acquisition

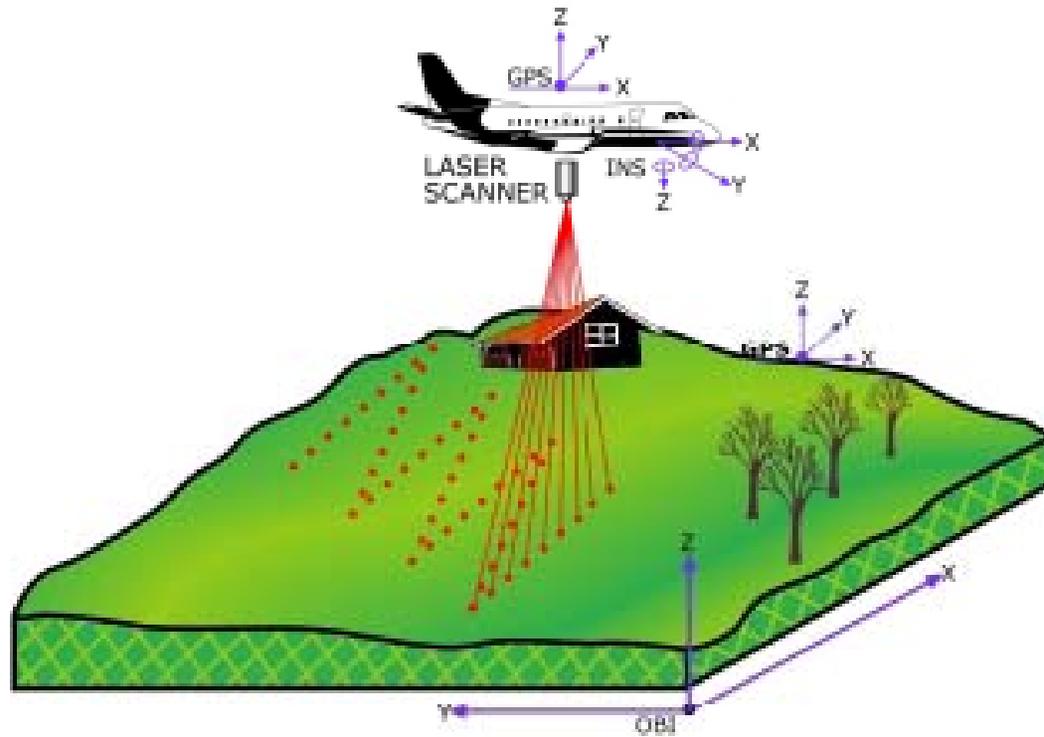
- Stereovision based on photogrammetric principle: tested, powerful, & accurate
 - LIDAR: powerful, long-range
 - Line laser imaging: high-resolution & speed
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Photogrammetric Stereovision

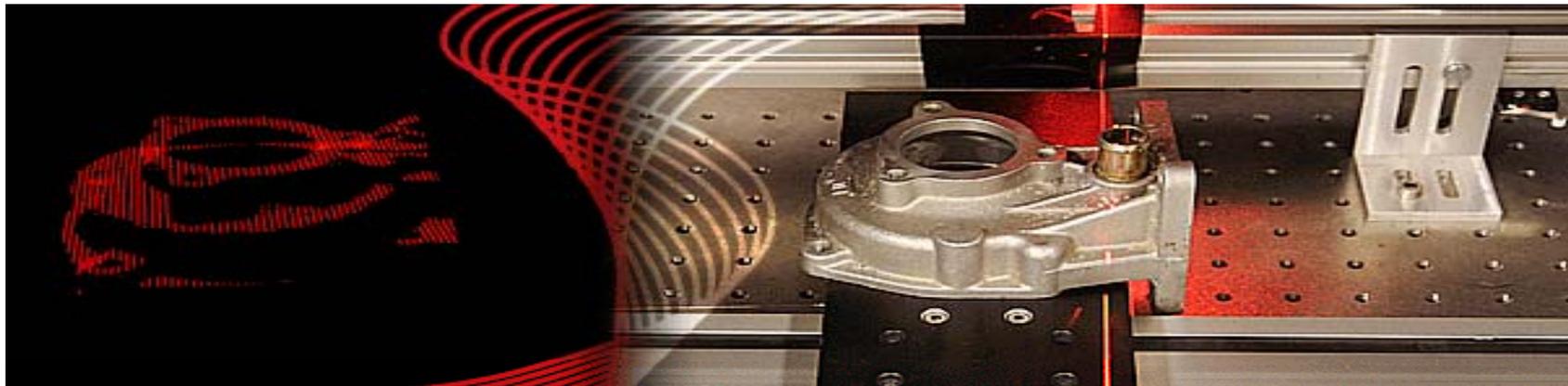
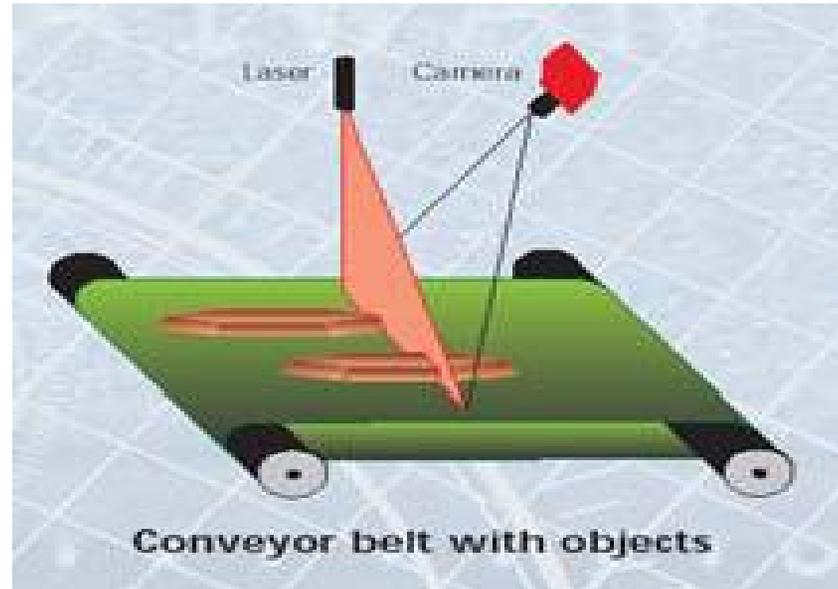


LIDAR

LASER SCANNING



Line Laser Imaging



Obvious Choice of Using Line Laser for 3D Surface Data

- Widely used in manufacturing, and food industry on conveyer belts
 - Easy on energy consumption
 - Mature laser and filtering technologies
 - Stable
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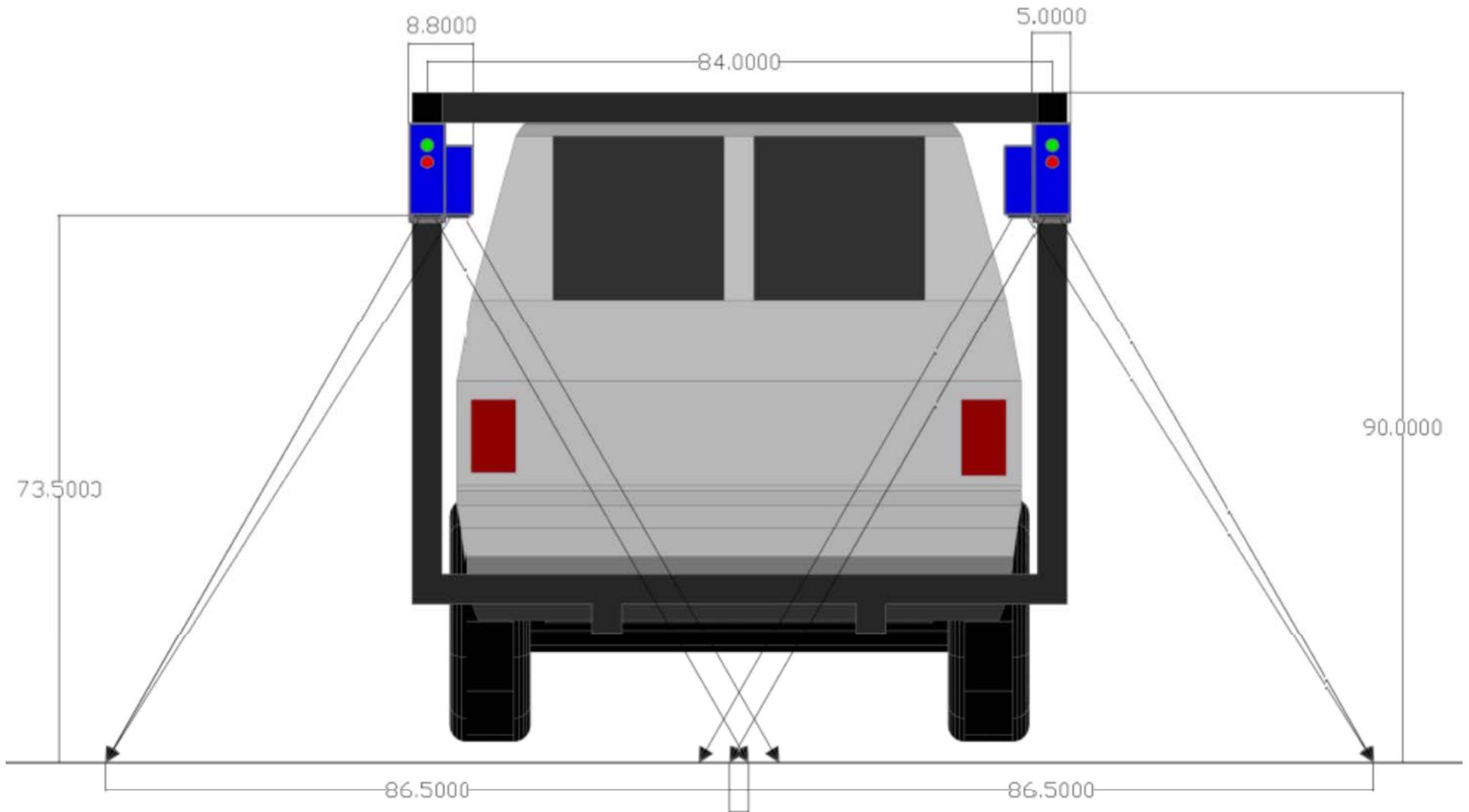
Latest Developments

- 3D Line Laser Solution: PaveVision3D
 - Capture x, y, & z dimensions of pavement surface
 - Resolution: 1-mm for x, y, and z
 - Two Data Streams
 - 2D 8-bit Gray Images at 1mm
 - 3D Height Points at 1mm
 - Power Consumption: <1000 watts for all computing, sensor, lasers, & electronics
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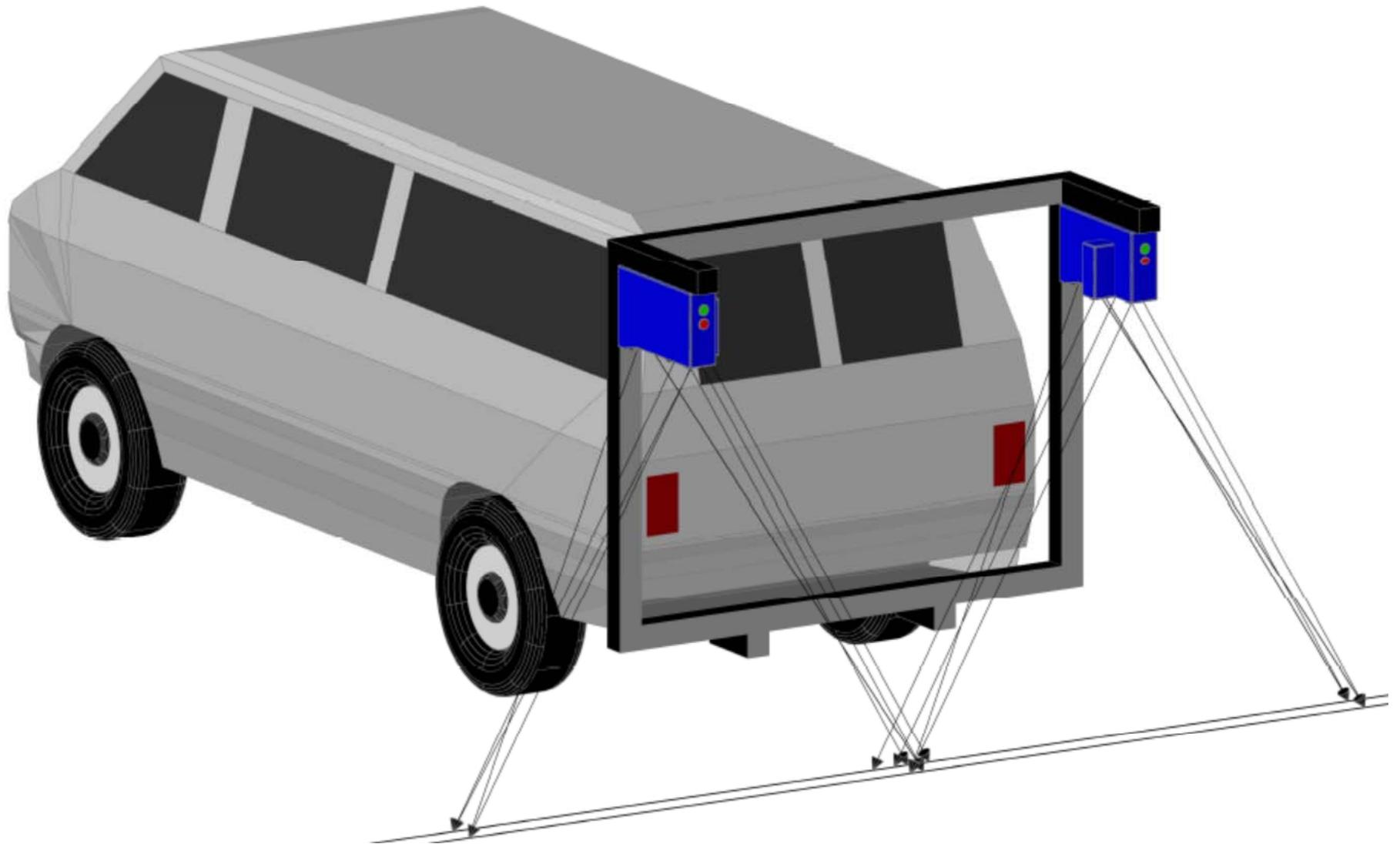
3D Profile Rate

- Fixed 1-mm Resolution: transverse and height directions
 - Resolution in the longitudinal direction: proportional to driving speed
 - 6,000 profiles per second
 - True 1-mm resolution at 15MPH
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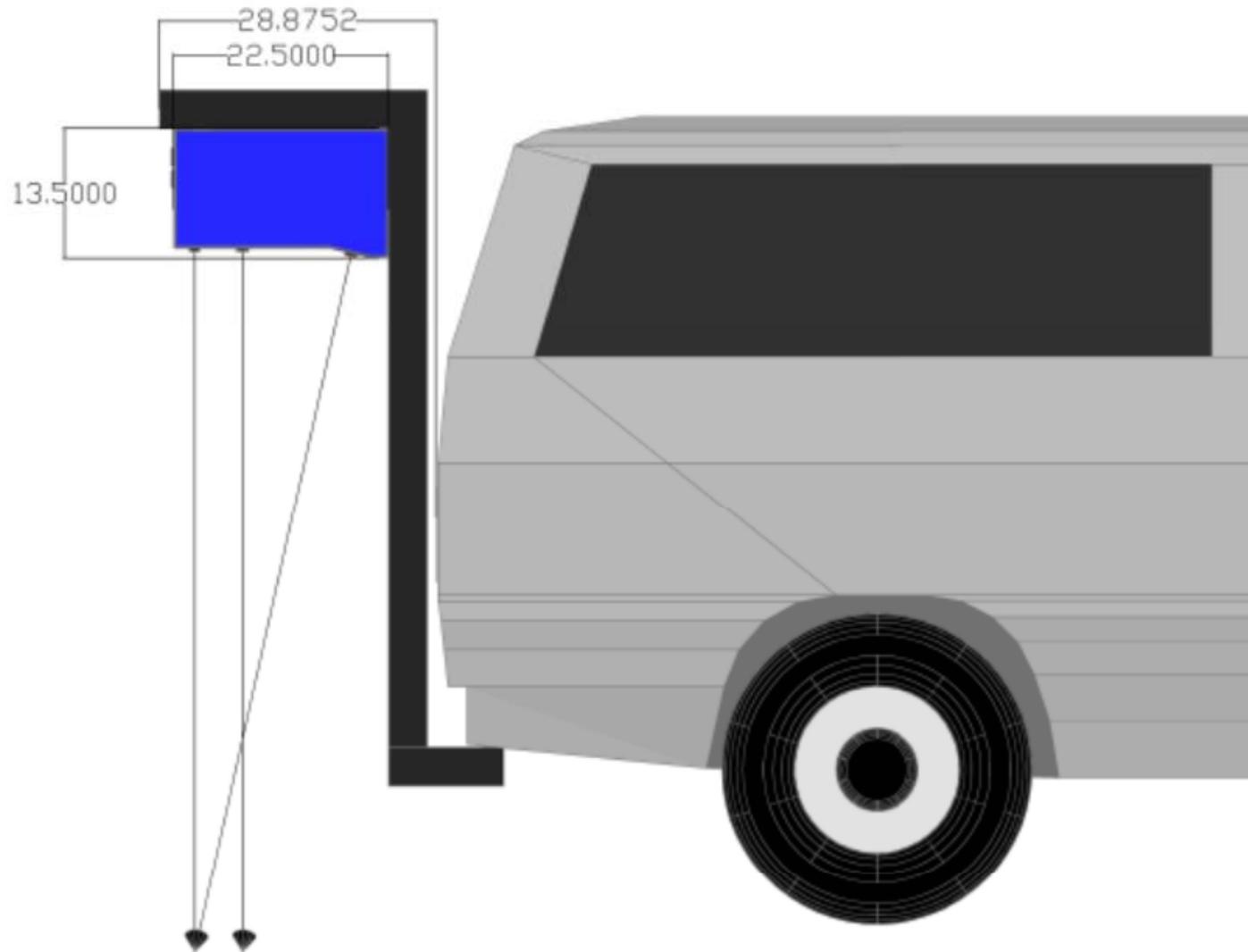
Sensor Positions



Sensor Positions



Sensor Positions



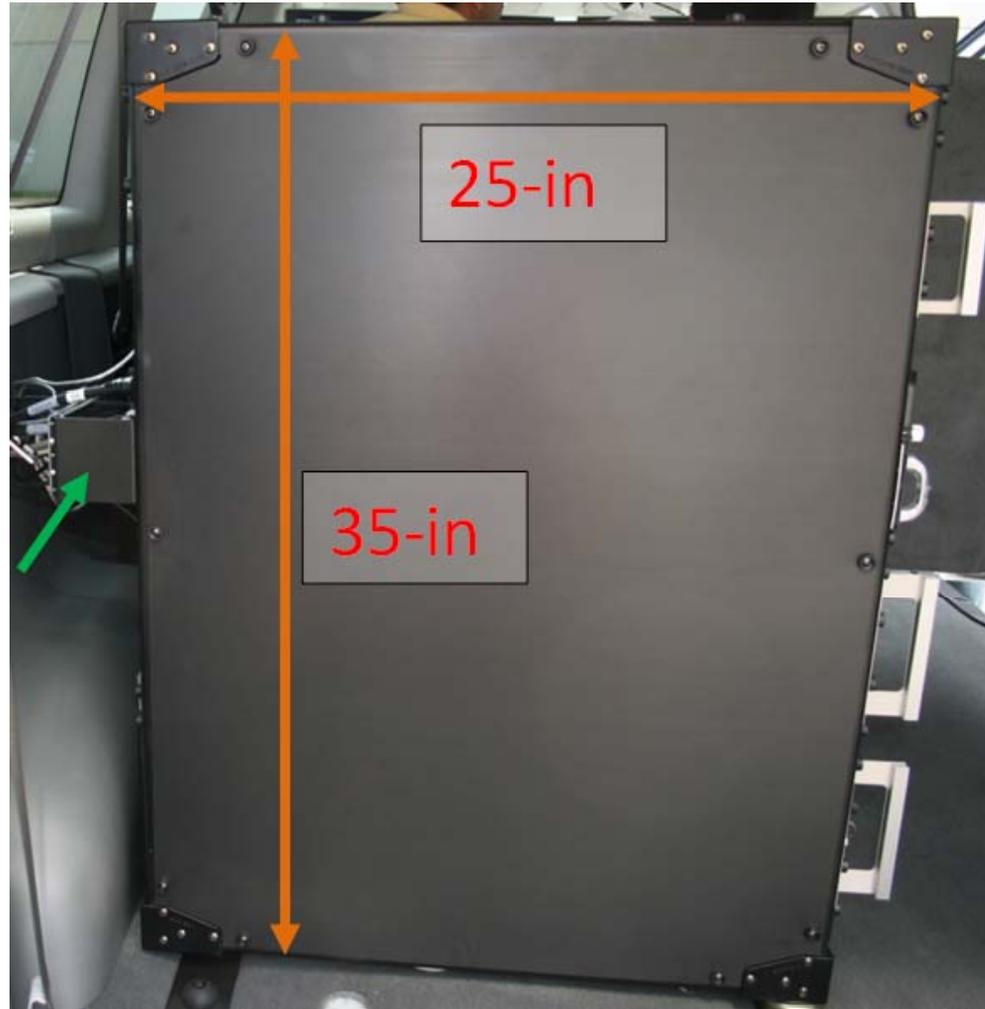
DHDV with PaveVision3D



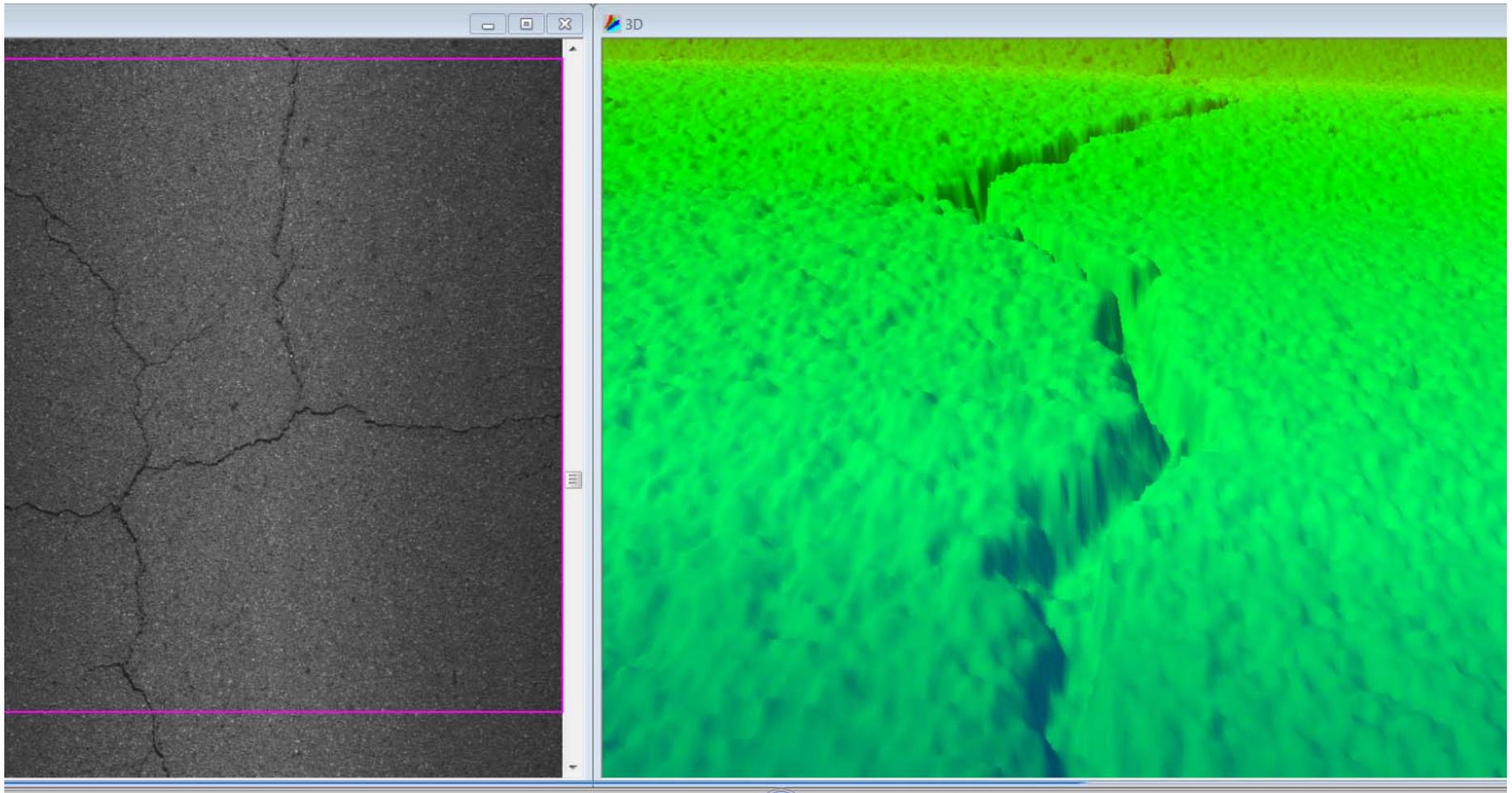
DHDV with PaveVision3D



Rack Dimensions



Demos



Software Solutions & Precision/Bias

- Near Term

- Rutting, Cracking, Macro-texture

- Mid-Term

- True 1-mm resolution in all 3 directions at 60MPH

- Ultimate Goals

- Most Surface Characteristics as Broadly Defined: Fully Automated and in Real-Time at Needed Precision & Bias Levels
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Thank You !