

# Enhanced Pavement Profiling Through INS Integration and Point-Cloud Fusion

Ryan Twilley, Dickie Martin & Morgan Reed



Fugro's ARAN® Elite platform unifies sub-millimeter pavement data capable of NCAT Class I profiling, 360° oblique LiDAR, and panoramic imaging under a single inertial reference frame. This produces spatially coherent, full-lane 3D surface data in one traffic-speed pass — capturing patch boundaries, material transitions, vertical discontinuities, and corridor-level influences that fixed wheel-path profiling do not reveal. Dense spatial sampling enables profile extraction at any location within the lane, while shared temporal and spatial registration support retrospective reprocessing as analytical methods evolve. These multimodal datasets open research pathways in machine learning-based condition inference, 2D/3D fusion analytics, and corridor-level performance modeling. Fugro will make representative datasets available to qualified researchers through collaborative, non-commercial arrangements.



## ARAN® Elite: Beyond the wheel path

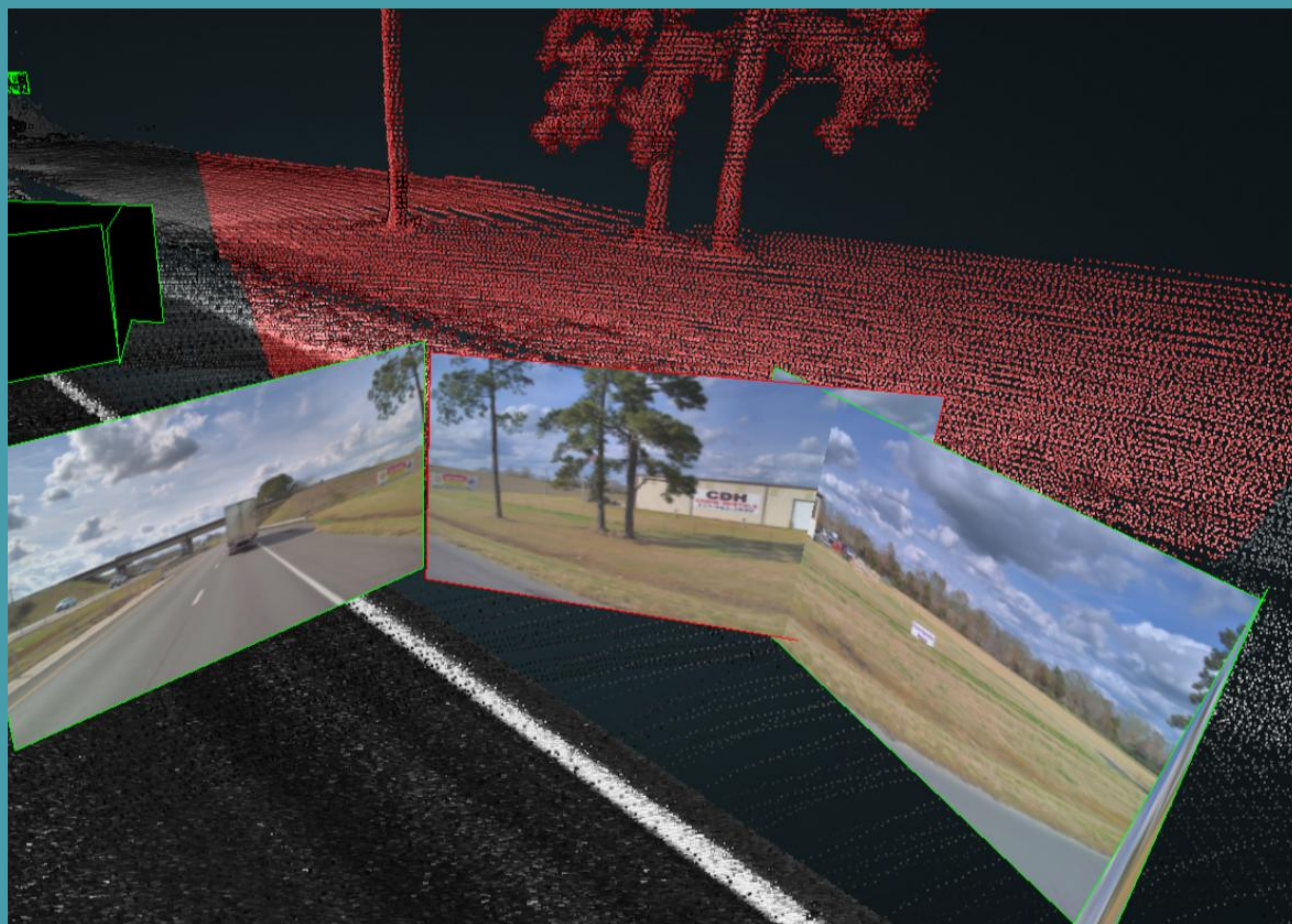
### System Design: INS-Integrated Multimodal Platform

Implemented within Fugro's ARAN® Elite platform, the system unifies three sensor streams under a single inertial reference frame:

Sensor Stream	Function
High-Rate Pavement Profiling	Longitudinal (NCAT Class I Profiler certified) and transverse surface measurements at traffic speed. Longitudinal profiles can be generated anywhere within the collected data.
360° Oblique LiDAR	Dense 3D point-cloud capture of the full roadway corridor
Panoramic Imaging	Visual context for surface features and roadside assets

#### Key Design Principles

- Unified inertial reference frame — All sensors share a common spatial and temporal basis, producing spatially coherent datasets
- Single-pass acquisition — Full lane, high-resolution 3D surface point clouds collected at traffic speed
- Dense sampling — Enables profile extraction at any location within the lane
- Retrospective analysis — Collected data supports future analysis as methods evolve



### Research & Development Roadmap

The richness of spatially coherent, multimodal datasets opens several research frontiers:

#### Machine Learning & AI

- Surface condition inference from fused profile and point-cloud data
- Automated feature extraction and classification
- Network-scale pattern recognition across diverse pavement types

#### Multimodal Fusion Analysis

- Correlating 2D profile metrics with 3D surface geometry
- Integrating imagery context with quantitative surface metrics
- Developing new condition indices that leverage multiple data streams

#### Advanced Condition Modeling

- Corridor-level influence modeling on profile shape and roughness
- Enhanced understanding of how local features propagate into network-level metrics



### Collaborative Data Initiative

To advance the state of practice, Fugro will make **representative, spatially coherent multimodal datasets** available to qualified researchers

- **Non-commercial use** through collaborative data agreements
- **Goal:** Enable exploration of insights these rich datasets may unlock
- **Applications:** Multimodal fusion analytics, advanced surface characterization, corridor-level performance studies