National Aeronautics and Space Administration

Machine Learning for Autonomous Off-road Robotic Navigation

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BACKGROUND

Project goal

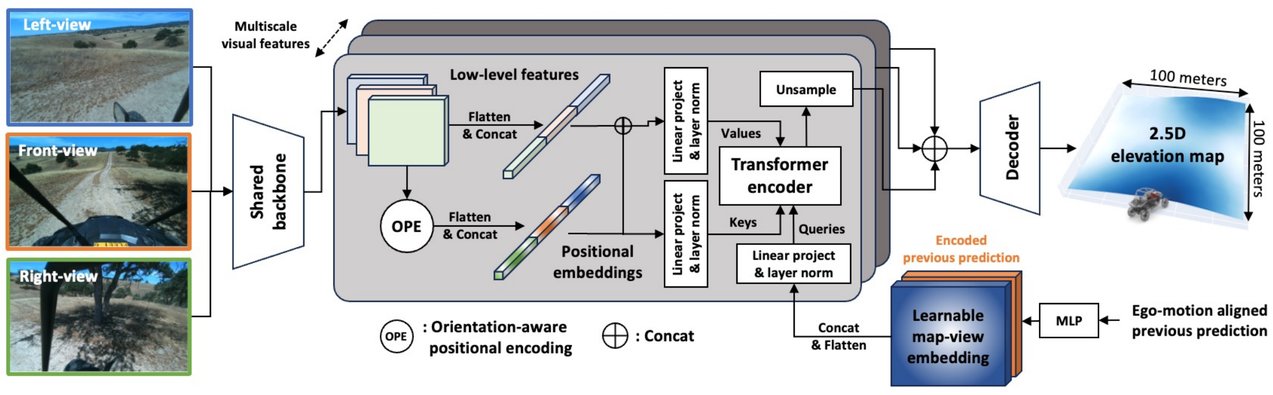
Demonstrate autonomous navigation capabilities for full-scale offroad vehicles in **complex, unstructured, and mission-relevant off-road environments** that are significantly more challenging than on-road conditions.

Approaches

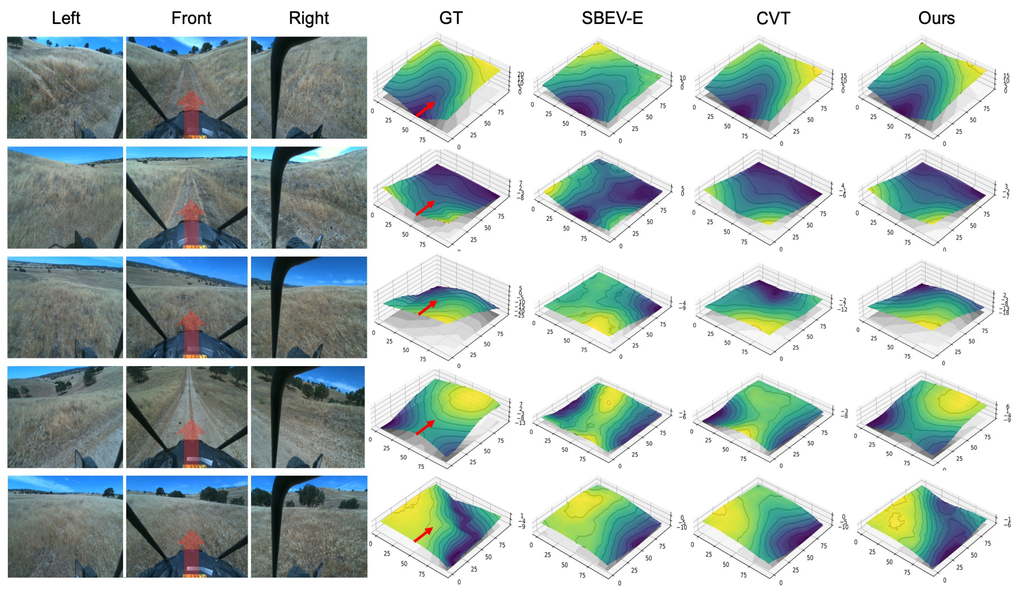
1. **Extending the perception range** using machine learning for off-road navigation tasks
2. **Improving the perception quality** using machine learning without manual labeling efforts.

[WORK 1] VISION-BASED LONG-RANGE ELEVATION MAP PREDICTION

Overall architecture



Comparison studies

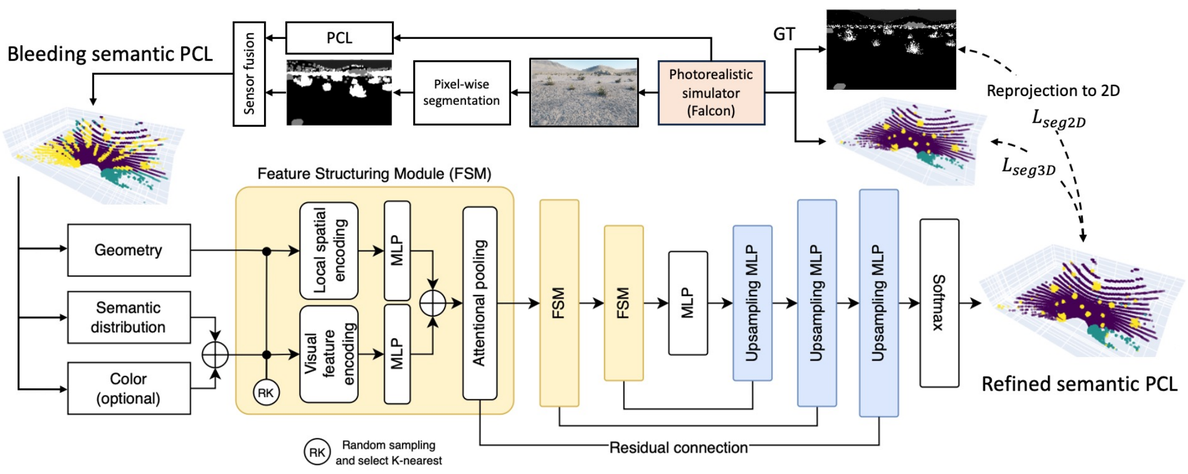


Key features of our approach

- **History-augmented learnable map-view embedding** that provides cues for achieving spatial and temporal consistency.
- **Cross-view transformer** that associates multiple perspective views with the 2.5D elevation map-views.
- **Orientation-aware positional encoding** that injects 3D pose information into the 2D space.

[WORK 2] LEARNING ROBUST LIDAR-CAMERA PROJECTION

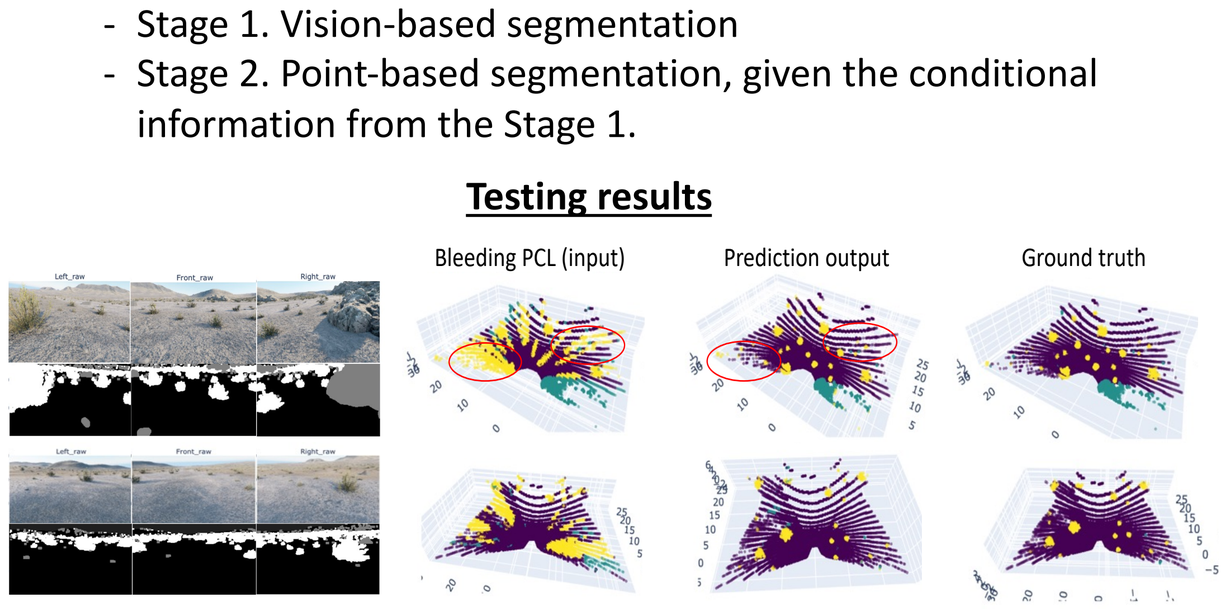
Overall architecture



Approach: Two stage segmentation for semantic Lidar projection

- Stage 1. Vision-based segmentation
- Stage 2. Point-based segmentation, given the conditional information from the Stage 1.

Testing results



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Publications:

From Pixel to Elevation; Long Range Elevation Prediction using Cross-View Transformer for Offroad Navigation (Prep for the IEEE RA-L 2023)

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