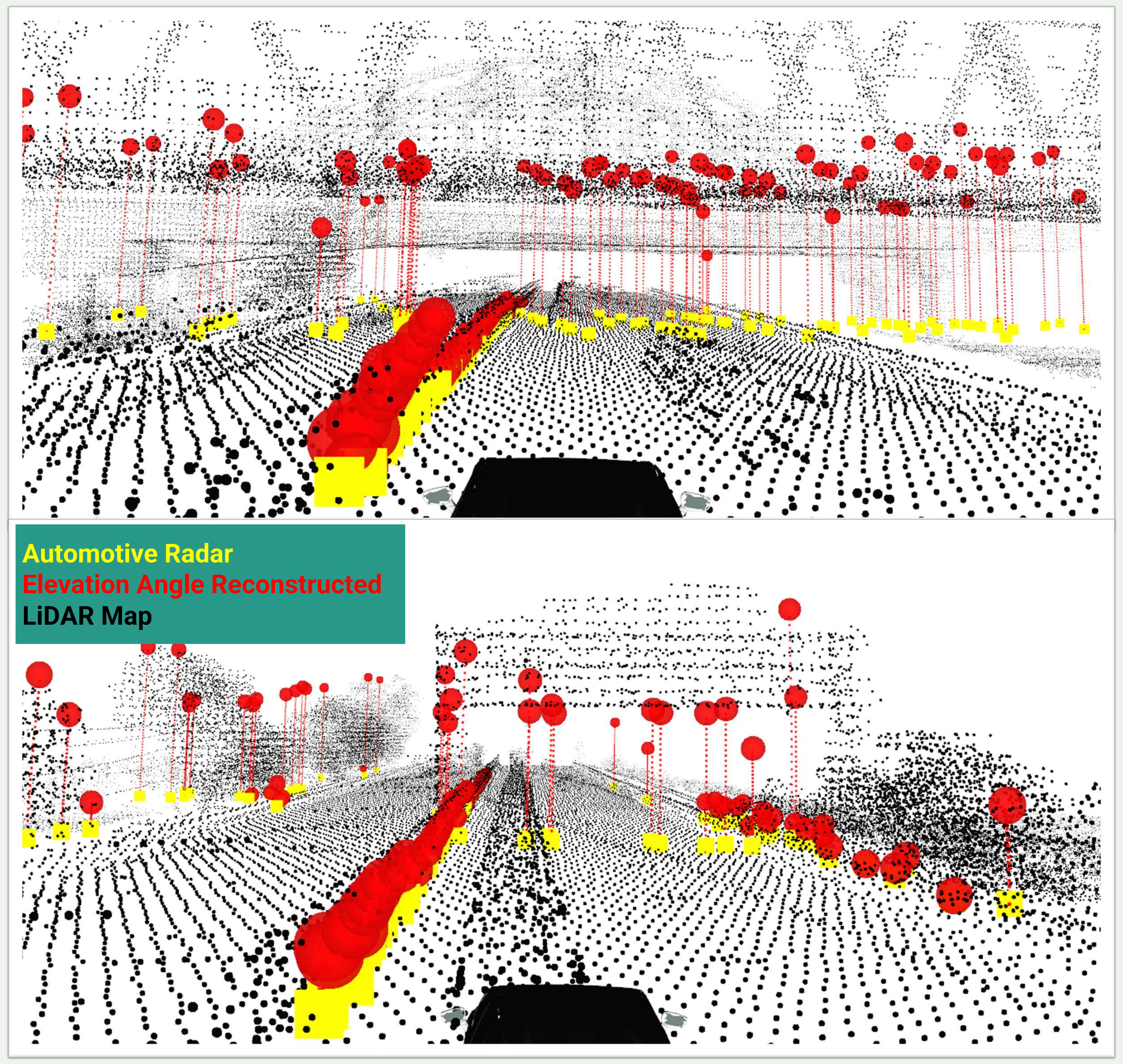
Automotive Radar Missing Dimension Reconstruction from Motion

OCTOBER 1 - 5, 2023
IEEE/RSJ International Conference on Intelligent Robots and Systems

Chun-Yu Hou, Chieh-Chih Wang, Wen-Chieh Lin

National Yang Ming Chiao Tung University (NYCU), Taiwan

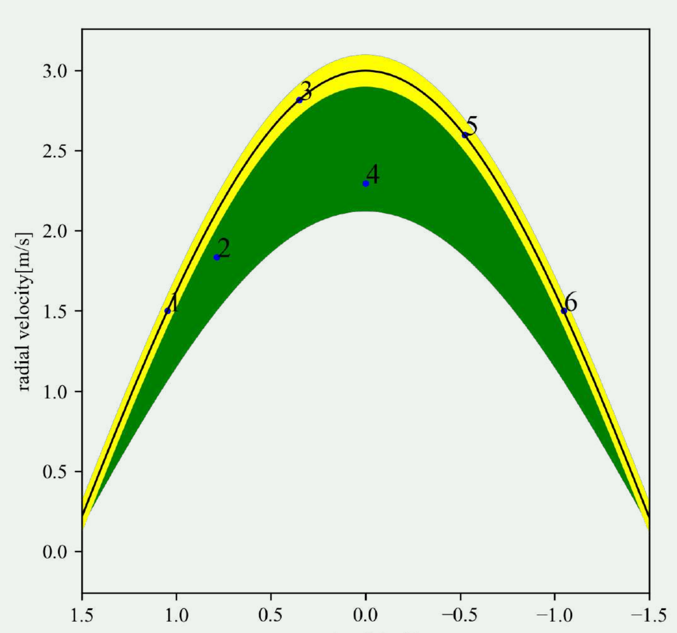
Abstract



- We propose a simple yet effective approach to estimate the elevation angle of stationary targets from an automotive radar.

Motion Segmentation

- Motion segmentation is performed based on radial velocity and azimuth.
- Instead of using a constant threshold, we consider the vertical FOV of radars.

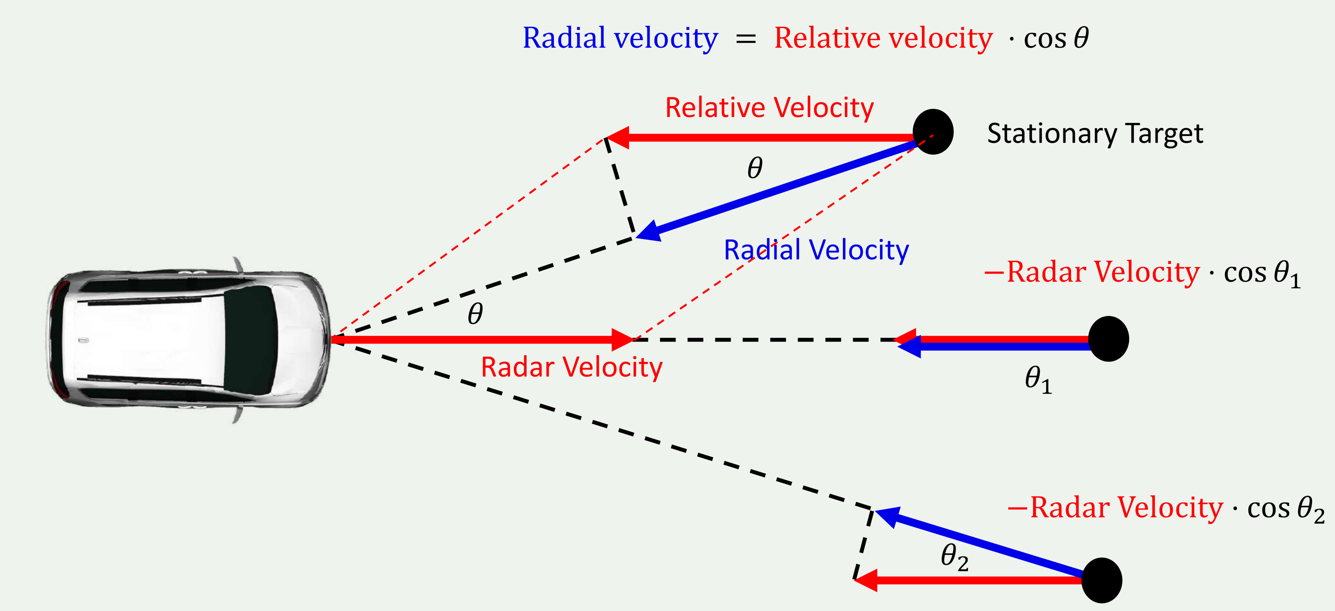


Elevation Angle Reconstruct

2D Radar Velocity Estimation

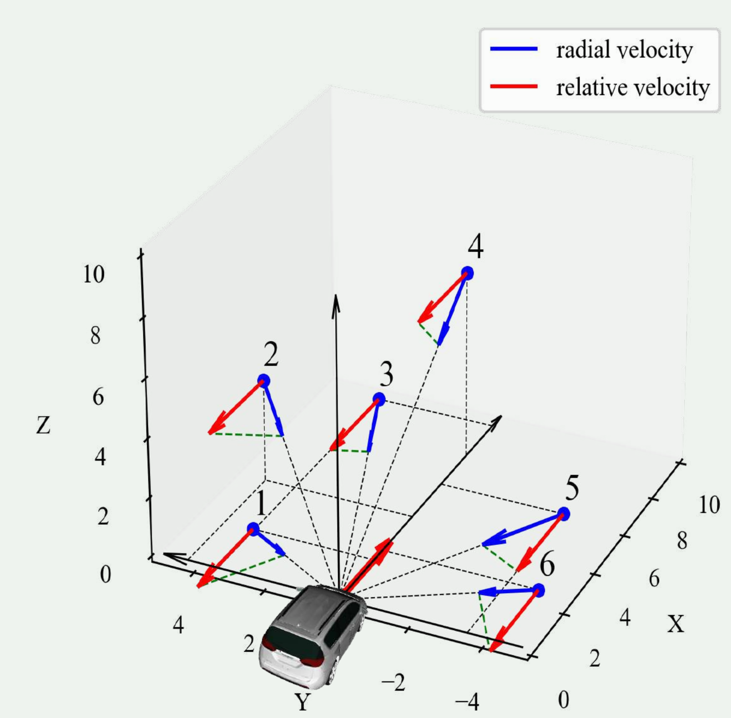
- Radial velocity is the relative velocity projection onto the line of sight.
- For stationary targets, the relative velocity equals the radar velocity in the opposite direction.

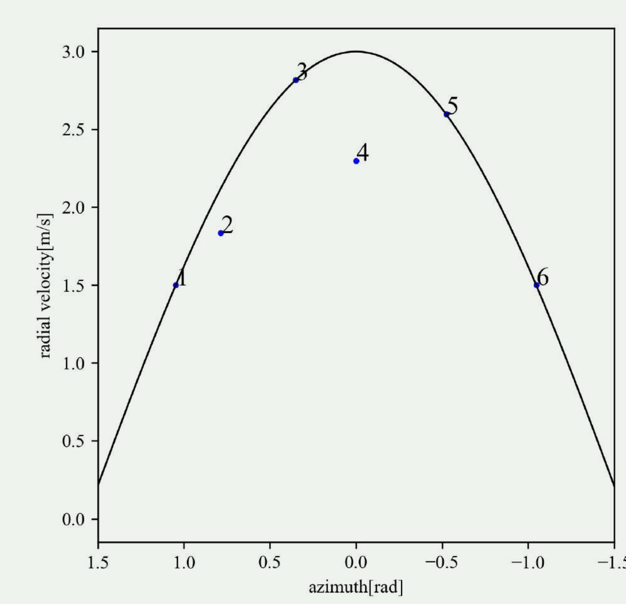
$$\text{Radial velocity} = \text{Relative velocity} \cdot \cos\theta$$



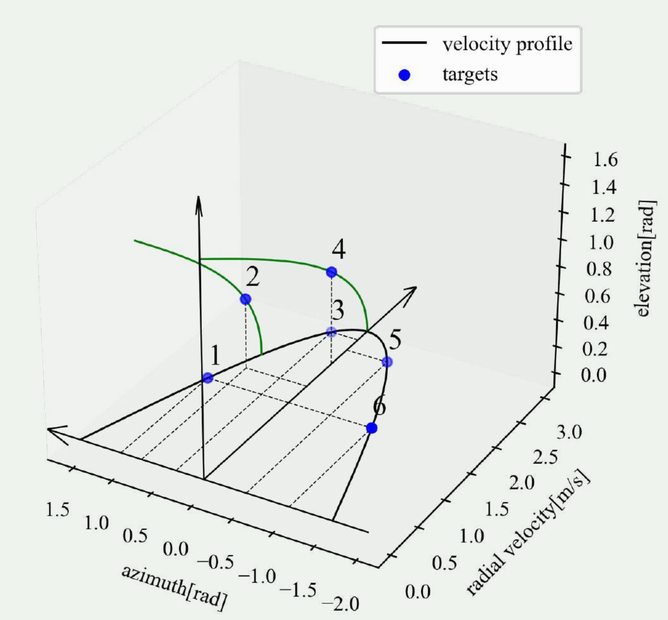
Extend to 3D

- Targets 2 and 4 have higher elevations. Resulting in smaller radial velocity measurements.

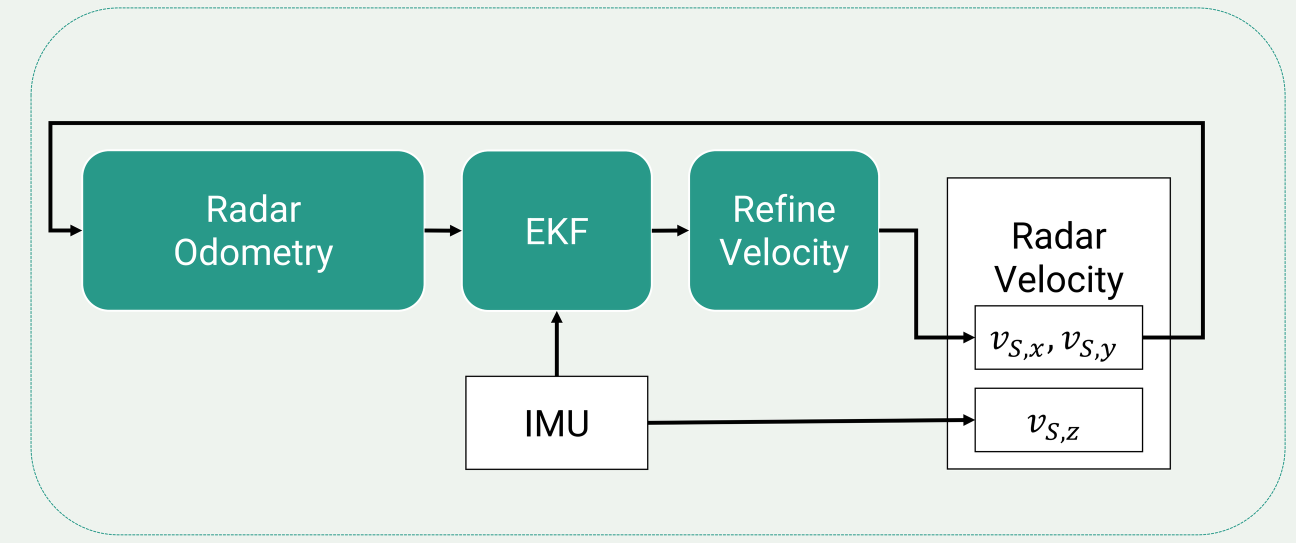




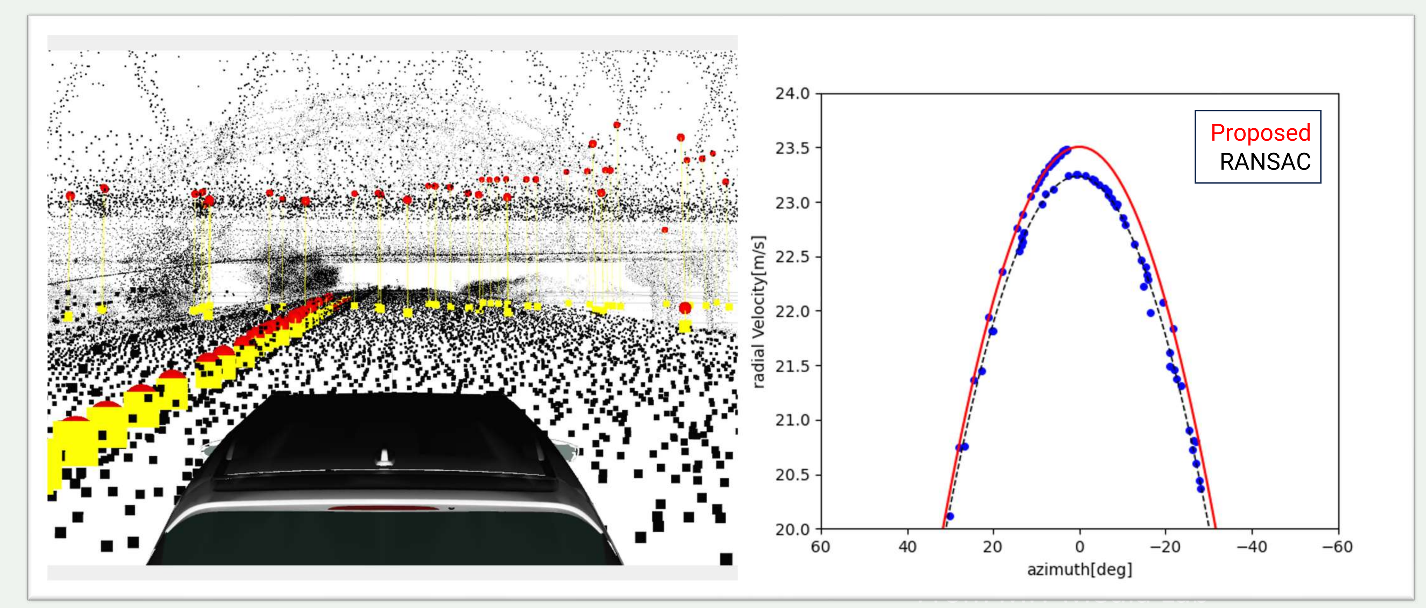
- The radial velocities of targets 2 and 4 decay with cosine curves.
- The distribution of the radial velocity in 3D space can be thought of as a multiplication of two cosines.



Velocity Estimation



- Radar odometry and EKF are used to provide more robust and accurate velocity estimation.
- Compared to RANSAC, the proposed method will not be influenced by stationary targets at high elevations.



Experiments

- Evaluate using a prebuilt LiDAR map and well localization pose.
- Achieve nearly half of the performance with a much older and missing dimension radar.

	Mean Angle Error [°]	Standard Deviation [°]
Elevation Angle Reconstruction Continental ARS 408-21 (2016)	1.41	0.6
4D Radar Continental ARS 548 (2023)	0.63	0.25