

High Resolution Point Clouds from mmWave Radar

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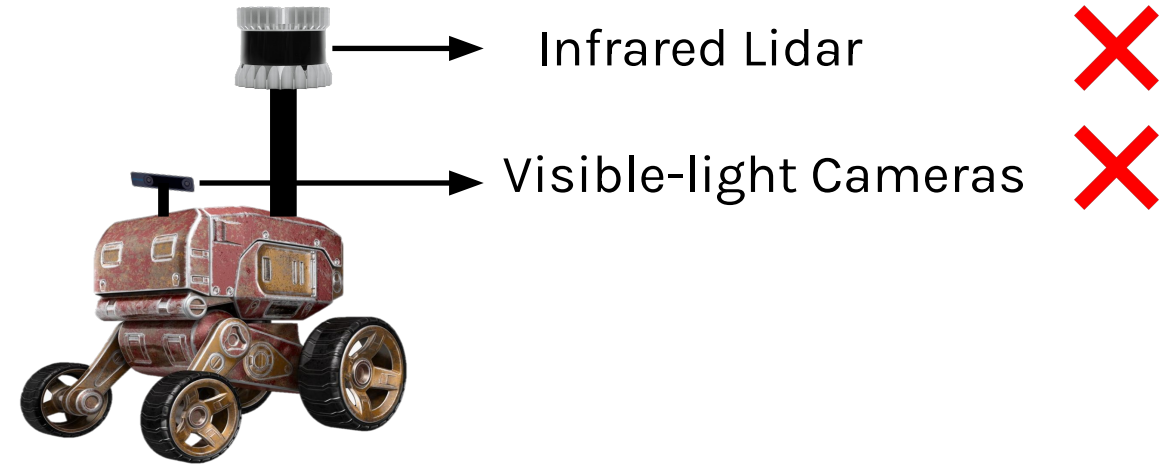
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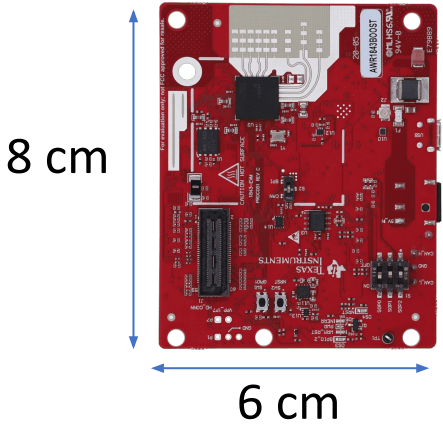
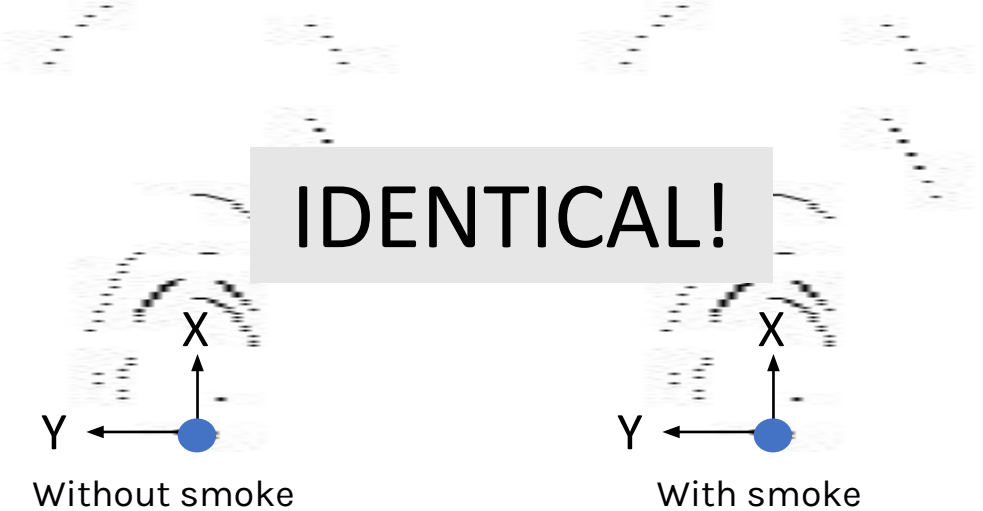
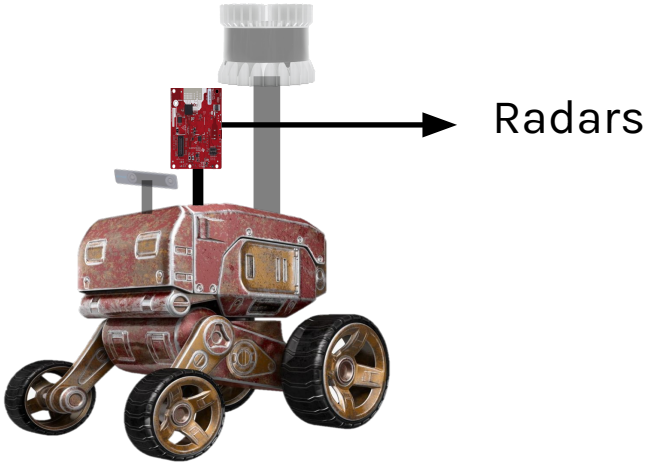


Firefighting robot navigating thick, dense smoke



Cameras and lidars suffer in smoky environments

Single-chip Millimeter-Wave Radars for through-smoke perception

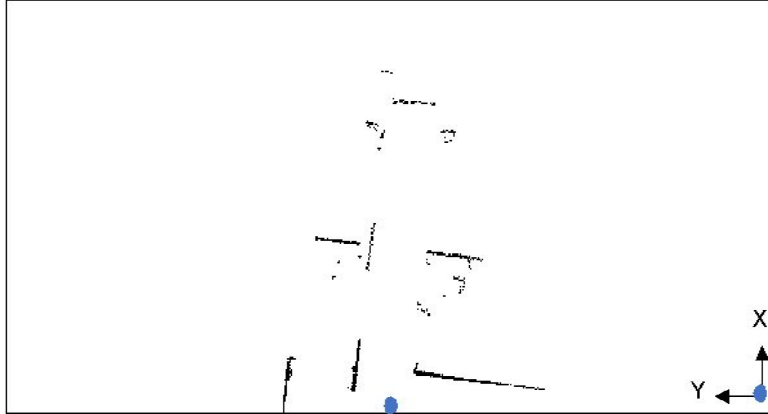


Through-smoke perception ✓

Size
Weight
Power
Cost

} SWaP-C ✓

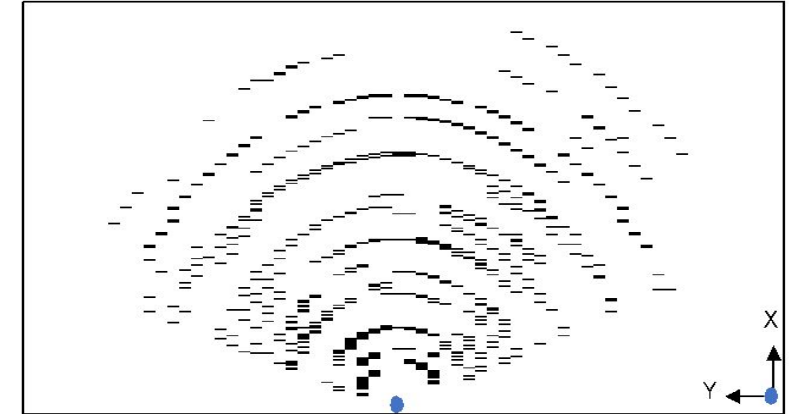
Problem with Single-chip Millimeter-Wave Radars



Lidar with 0.1° angular resolution

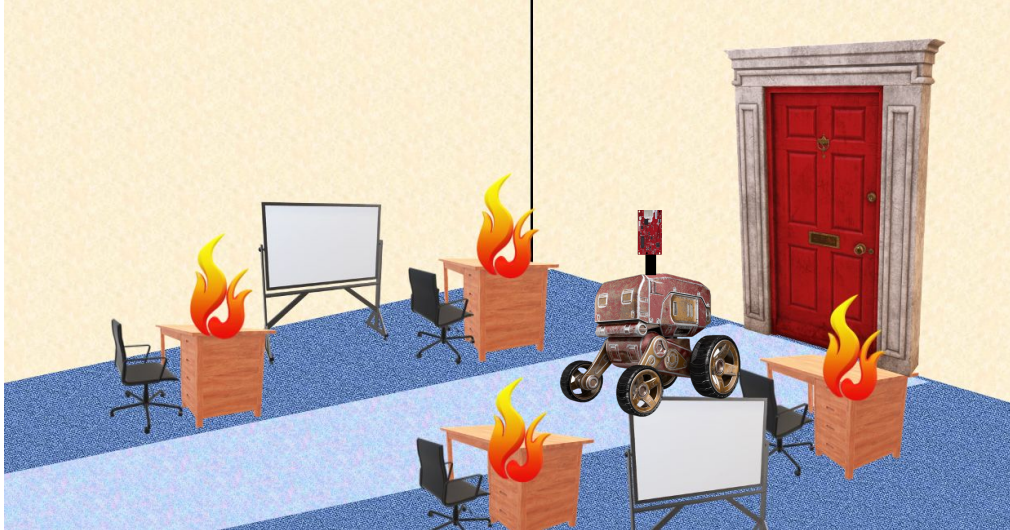


Camera with $\sim 0.01^\circ$ angular resolution



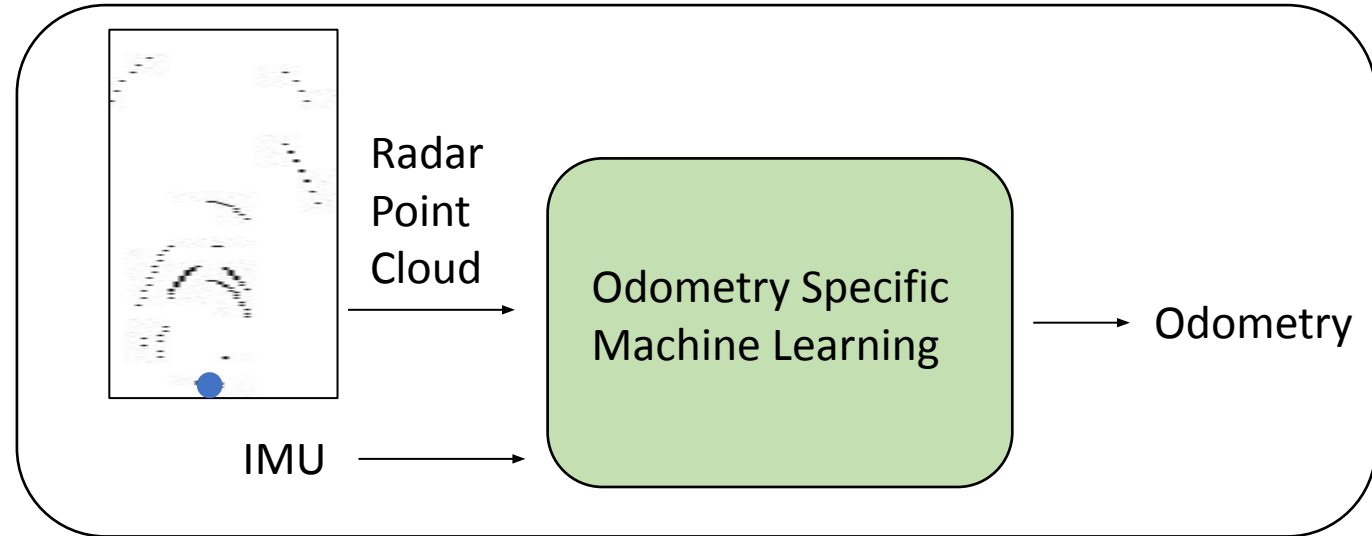
Single-chip mmWave radar with $\sim 15^\circ$ angular resolution

Past Approaches



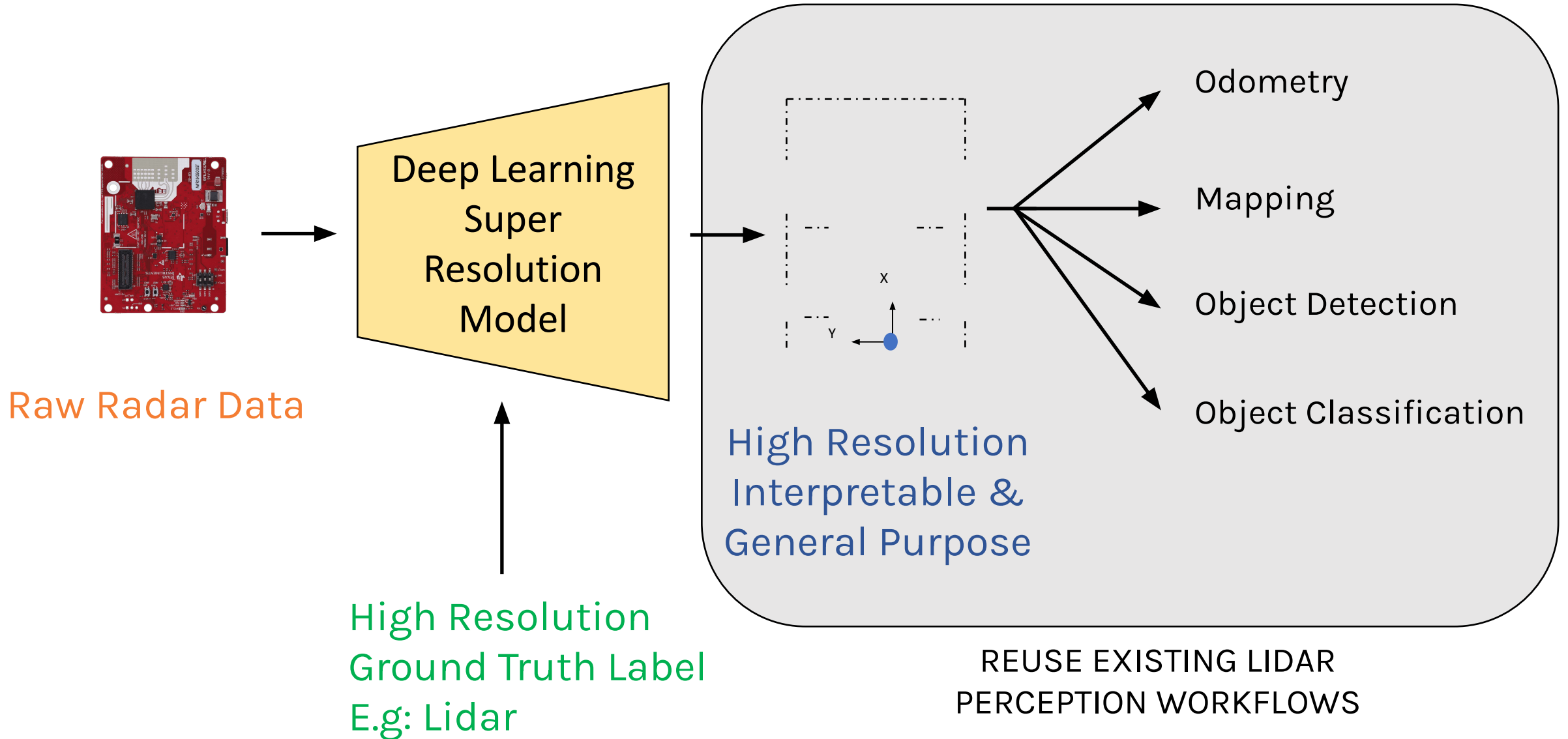
Synthetic Aperture Radar Imaging

- Robot can move arbitrarily
- Robot can move slowly
- Robot can choose to even remain static

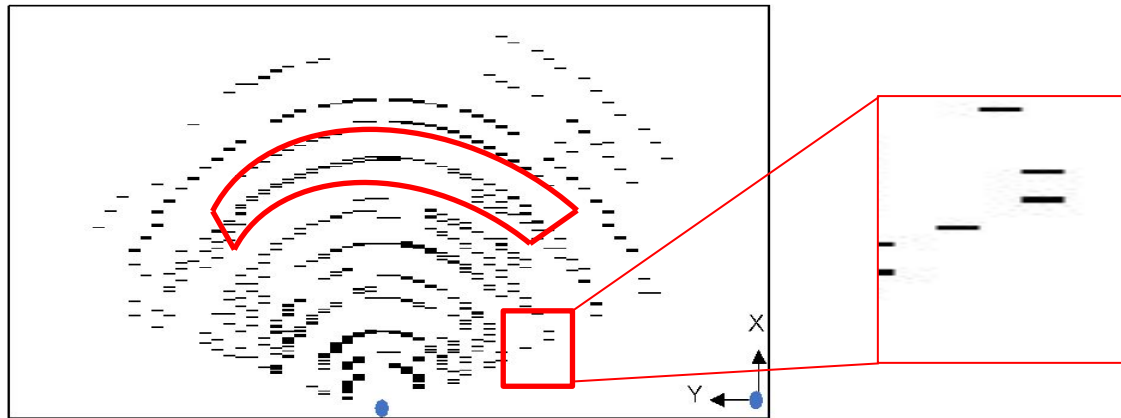


Higher-level Application Specific Machine Learning

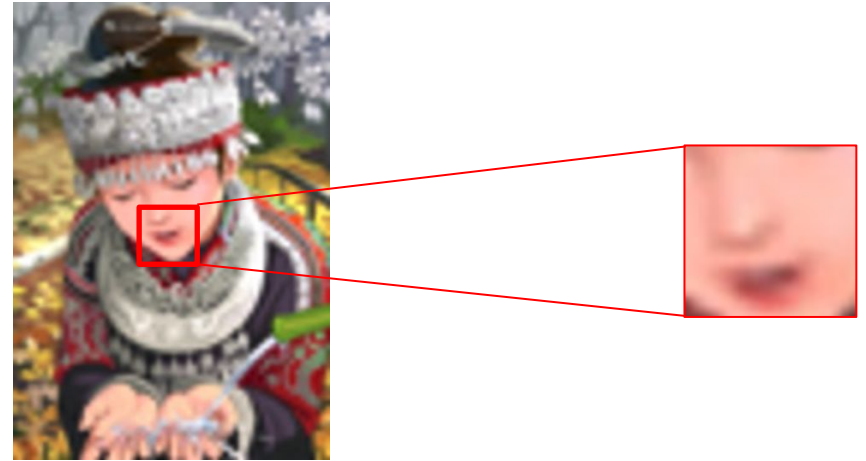
Our Approach



Why is this hard?



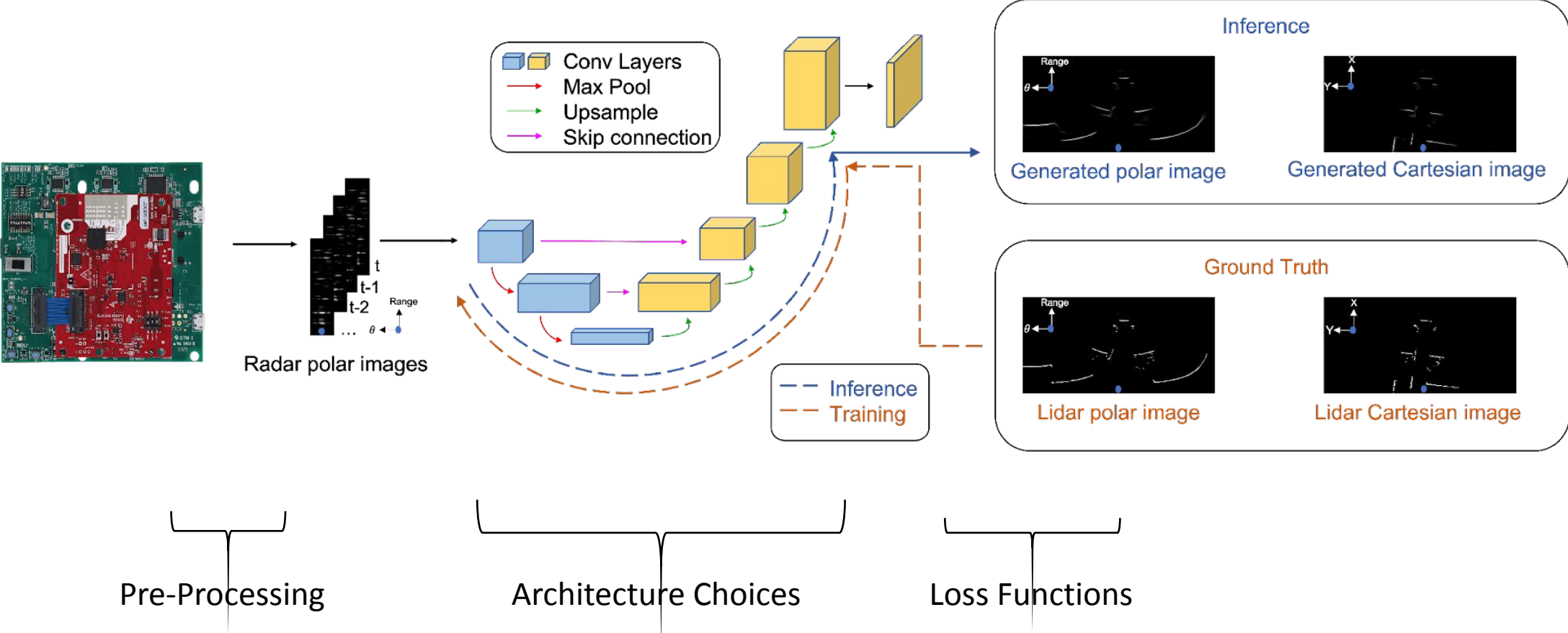
Single-chip mmWave radar



Low resolution camera image

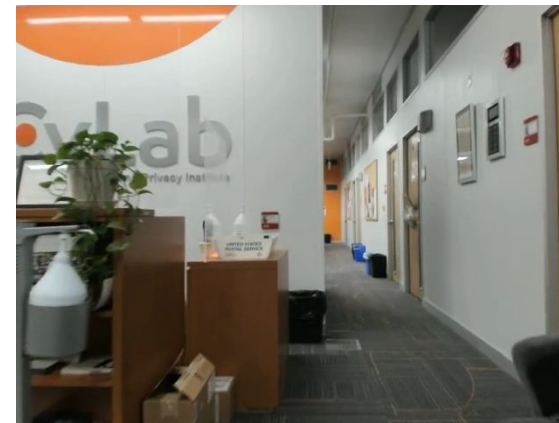
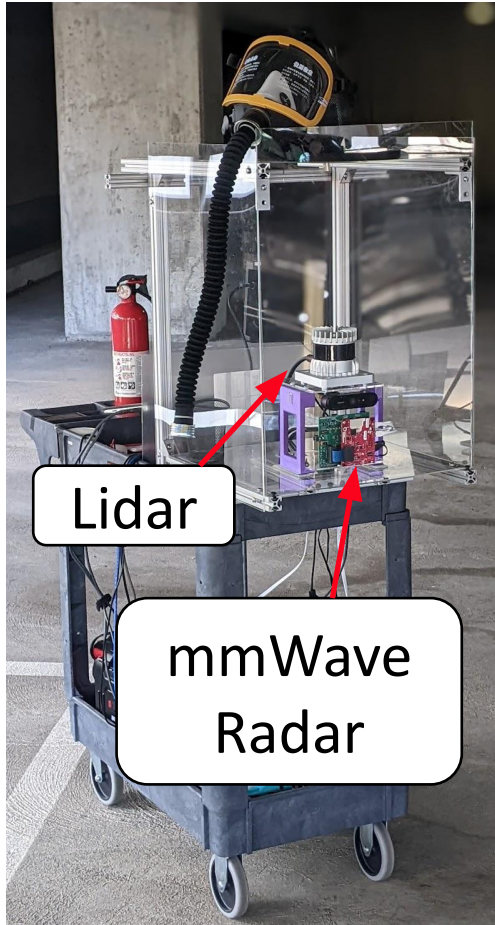
Radar Data very different from Camera Data
for Machine Learning

RadarHD: Our Overall Solution



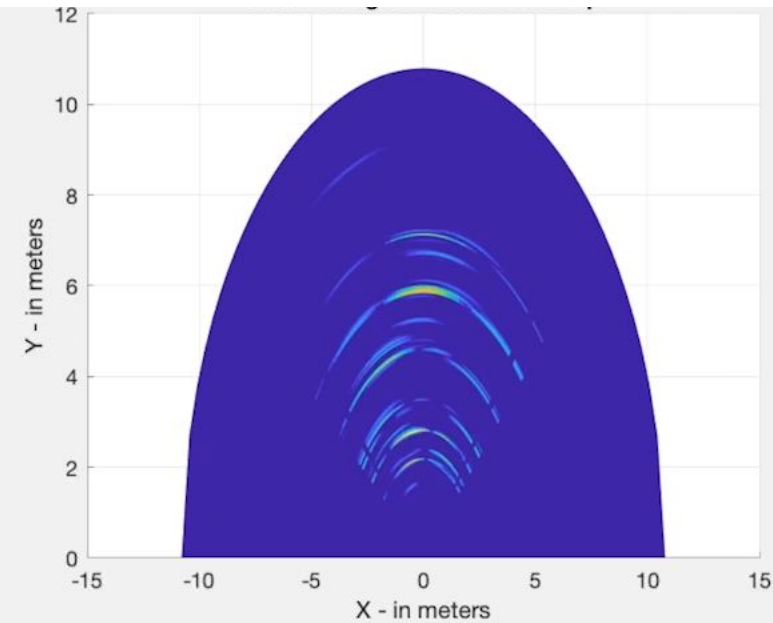
Check out the paper for detailed design decisions!

RadarHD Hardware, Data and Implementation

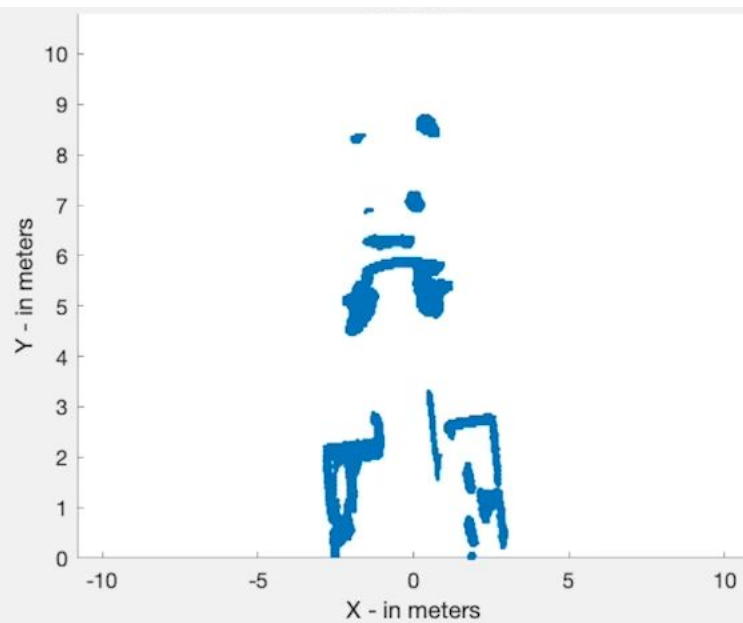


RadarHD Qualitative Result

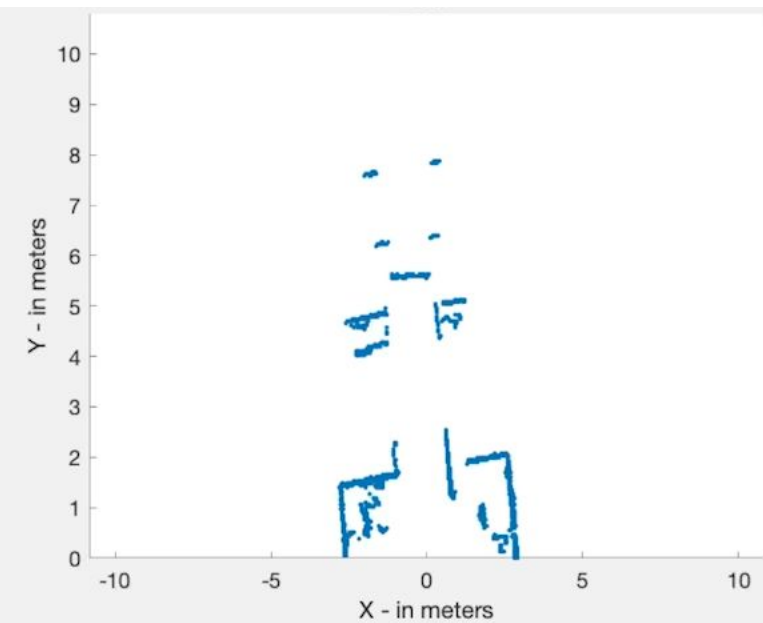
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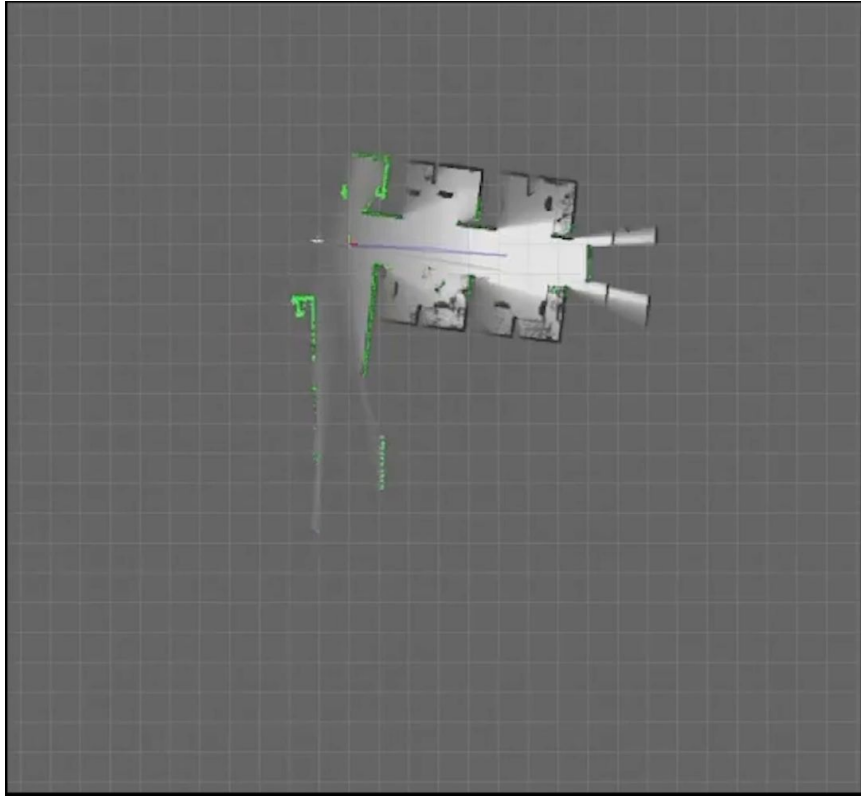
Raw Single-Chip Radar

RadarHD: Our Solution
(also only using a
single-chip radar)

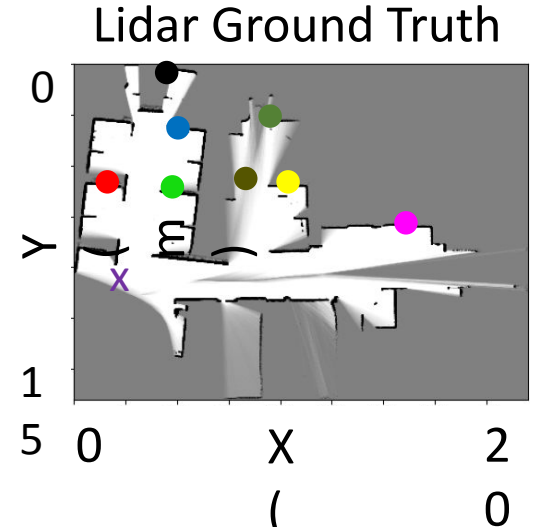
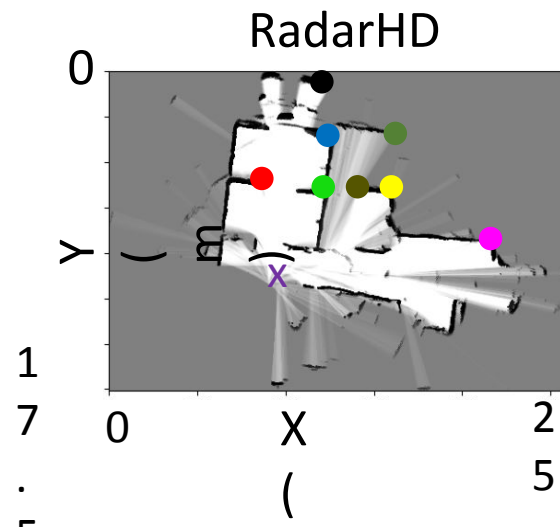
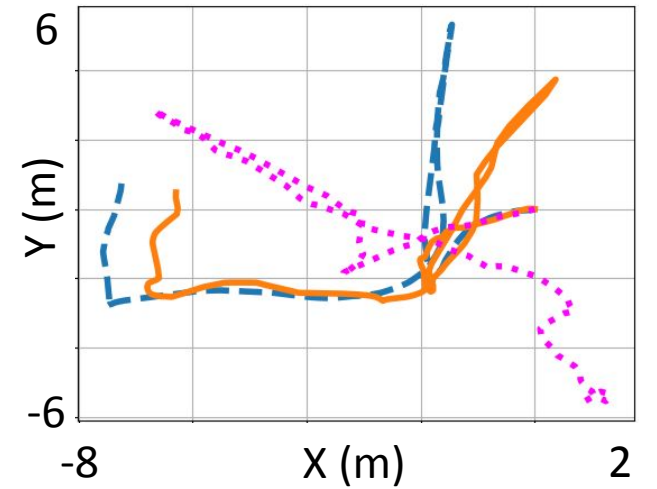
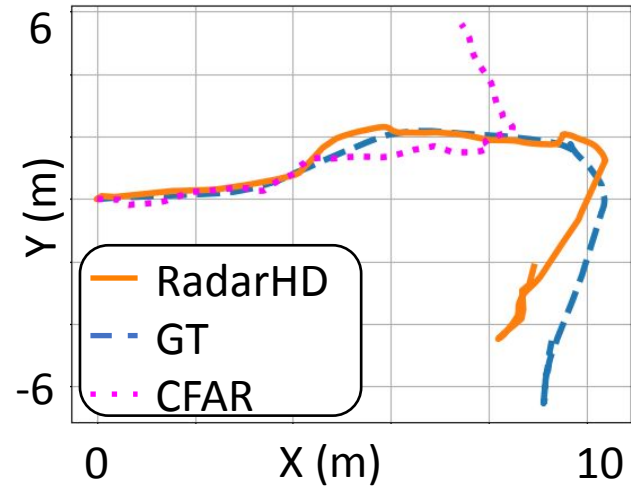
64 beam Mechanical Lidar

[Check the paper for quantitative results!](#)

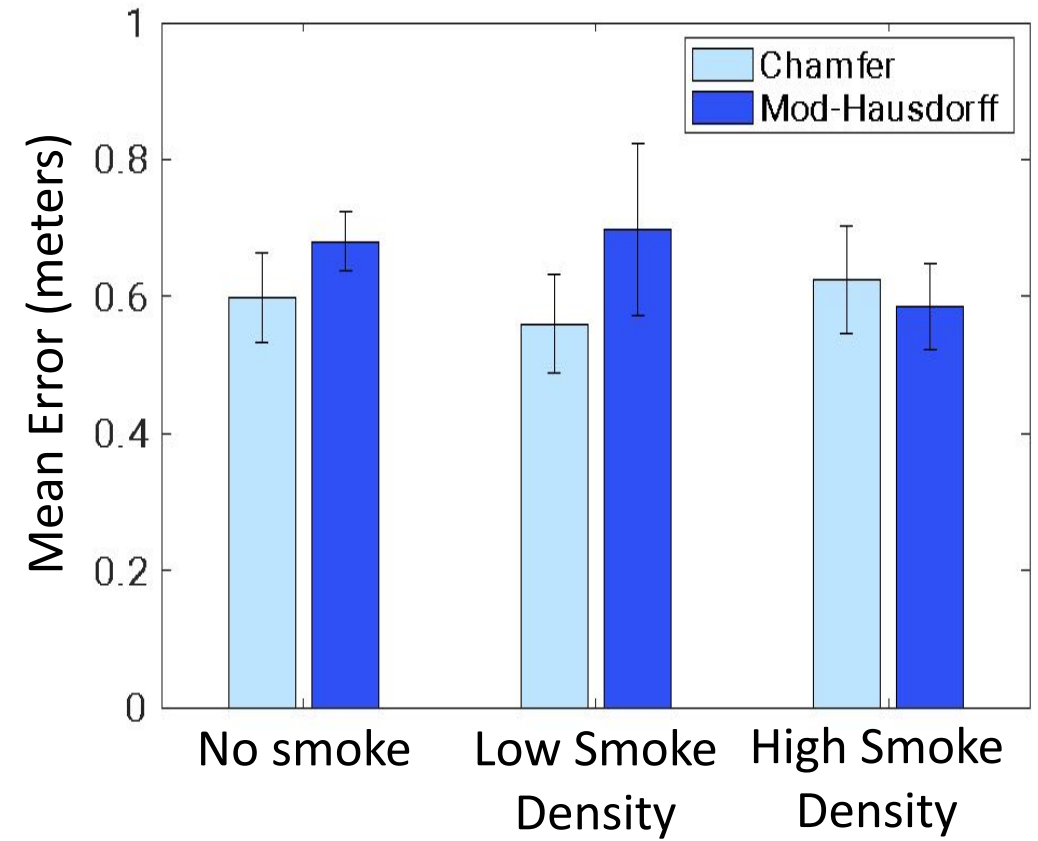
Perception on top of RadarHD



Running SLAM on Cartographer using RadarHD Output



RadarHD in smoky environments



High Resolution Point Clouds from mmWave Radar

- Enabling quality perception in occluded scenes
- Deep learning super resolution of single-chip radar to get lidar-like point clouds
- A large raw radar-lidar indoor dataset
- Use the generated high-res radar point clouds for perception tasks like odometry and mapping

