European Conference on EDGE AI Technologies and Applications - EEAI

Radar-based reactive planning for drones

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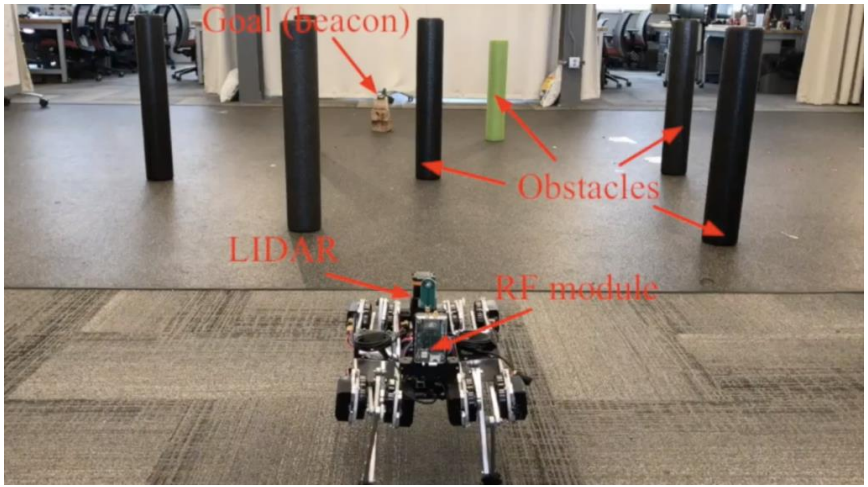
Reactive planning

- Mapping from the current state to action
- How to perceive the current state?
  - Use sensors!



https://kodlab.seas.upenn.edu/research/reactive-planning/reactivemotionplanningconvex/

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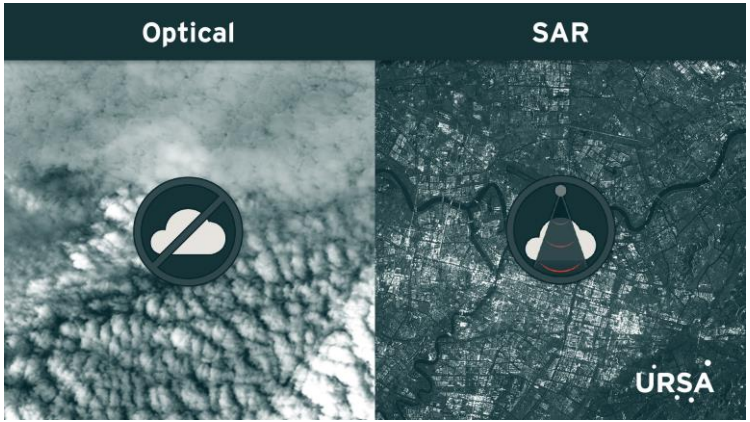
Reactive planning

Why radar?

- Robustness to weather and light difficulties
  - Complements (or replace!) camera
- Sees through occlusions
- Affordability



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Reactive planning

The plan!

- Effective pre-processing provides informative inputs to ML
- Simpler ML
  - Efficient structure
  - Less training data
  - More energy efficiency
- Our target: simple pre-processing + simple ML

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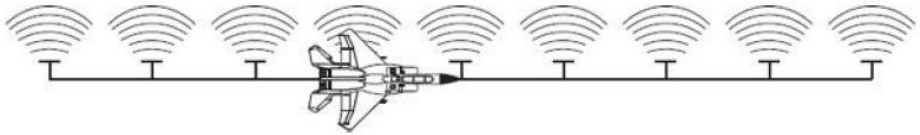
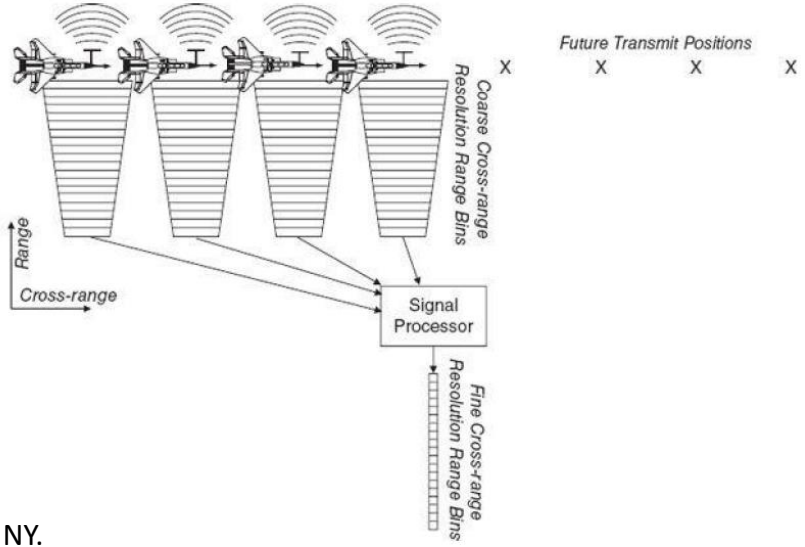
Synthetic Aperture Radar (SAR) Algorithm for Imaging

Introduction

- Radar resolution
  - Range resolution: $\rho_r = \frac{c}{2B}$
    - Please increase B!
  - Cross-range resolution: $\rho_\theta = \frac{\lambda R}{D_{az}}$
    - Not good!
    - Needs high freq., large antenna, limited range!



- SAR: utilizing radar motion to synthesize large large antenna aperture



[1] M.A. Richards, “Fundamentals of radar signal processing,”, Mc Graw Hill: NY.

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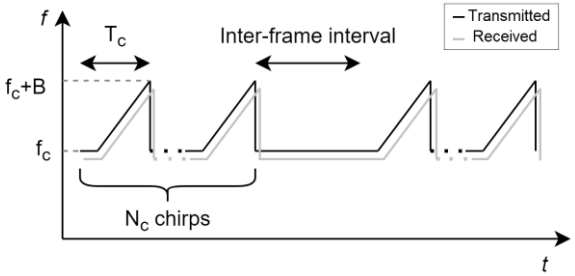
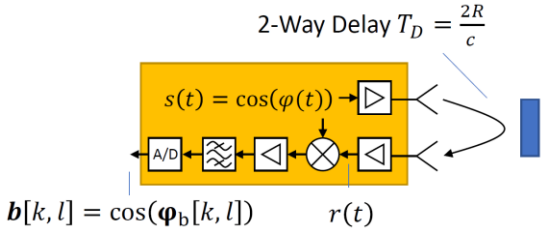
SAR for mmWave radars

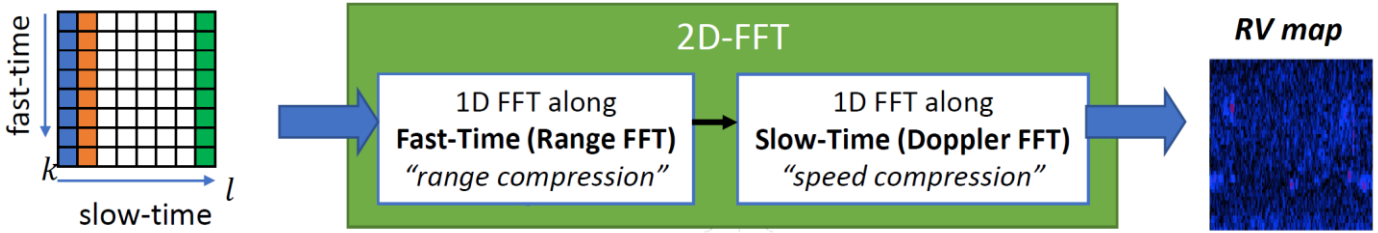
Frequency-modulated continuous-wave (FMCW) radar

- A sequence of chirps is transmitted





- Received chirps are shifted in time (due to range) and frequency (due to Doppler)
- In high-BW chirps, range and Doppler become separable



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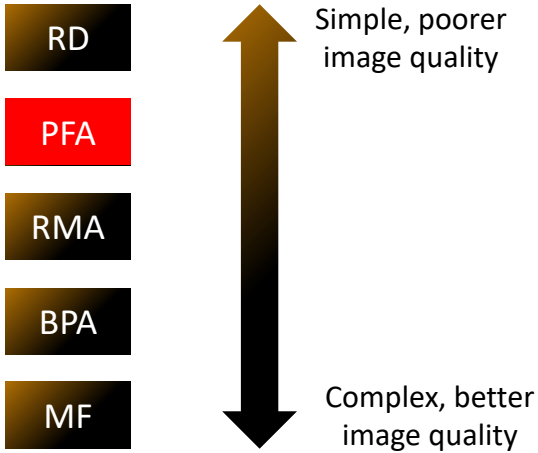
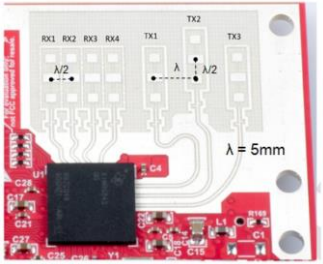
SAR for mmWave radars

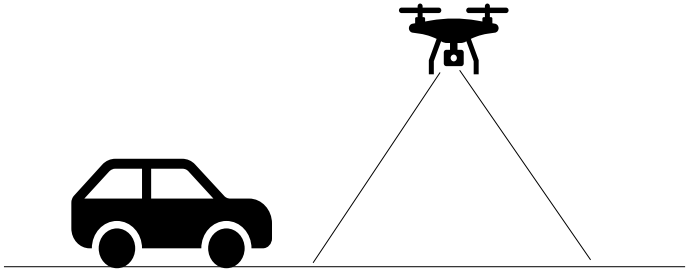
Which SAR algorithm for edge?

- Forest of SAR algorithms exist



- PFA in mmWave MIMO
- Radar: TI IWR6843 (60 GHz)





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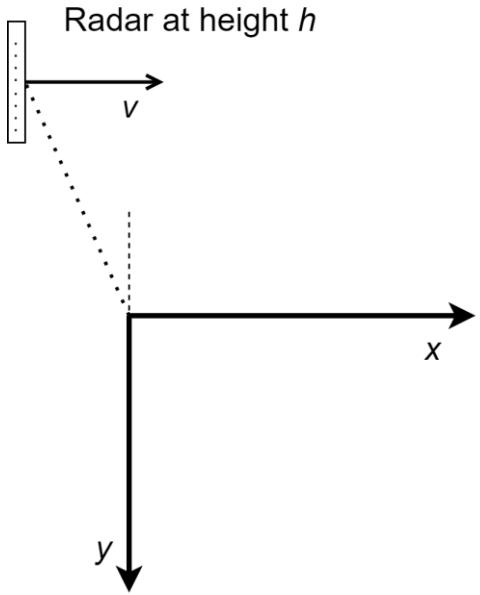
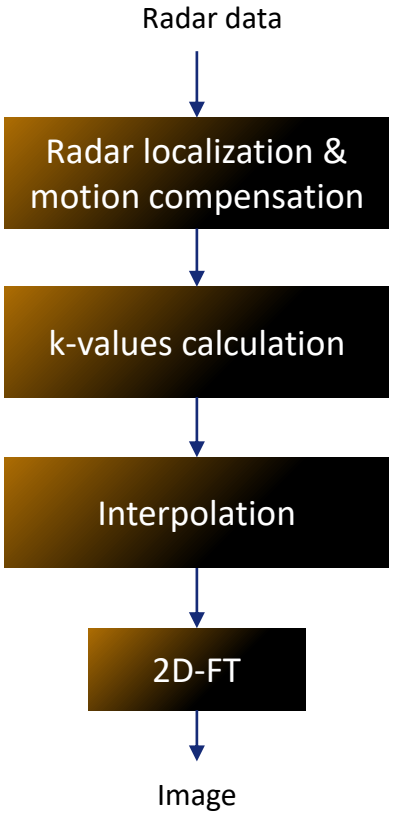
SAR for mmWave radars

Polar format algorithm (PFA)





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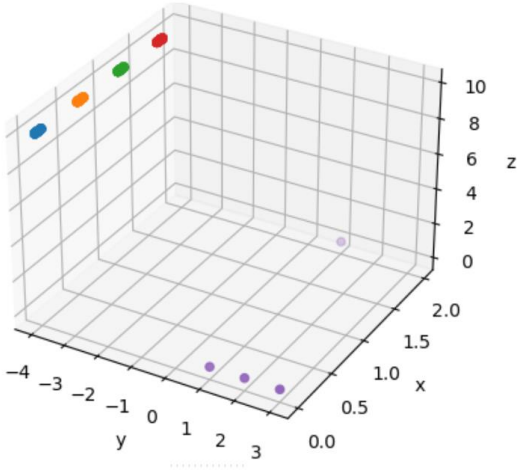
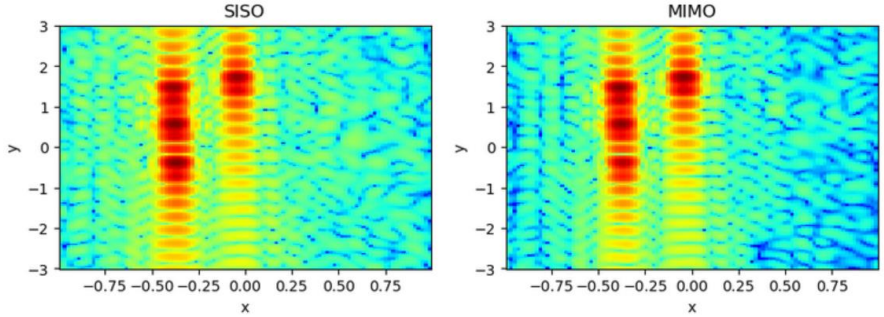
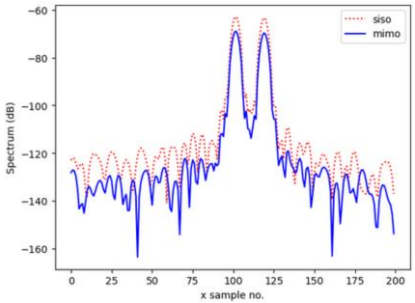
Results

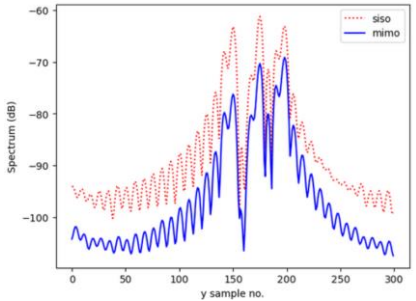
Simulation results

- Simulation scenario
  - FMCW radar with 2 Transmitters, 4 Receivers
  - Frequency band: 60GHz – 63GHz
  - CPI: 90 msec
  - Radar at height 10 m with speed 7m/s









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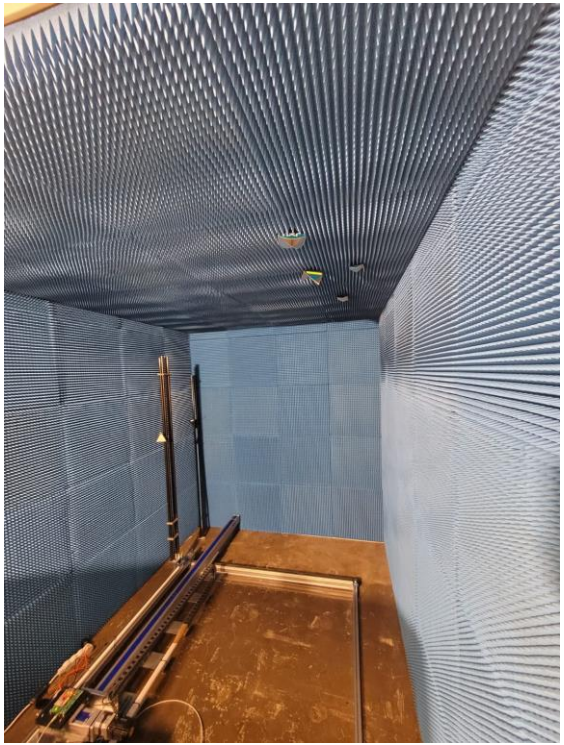
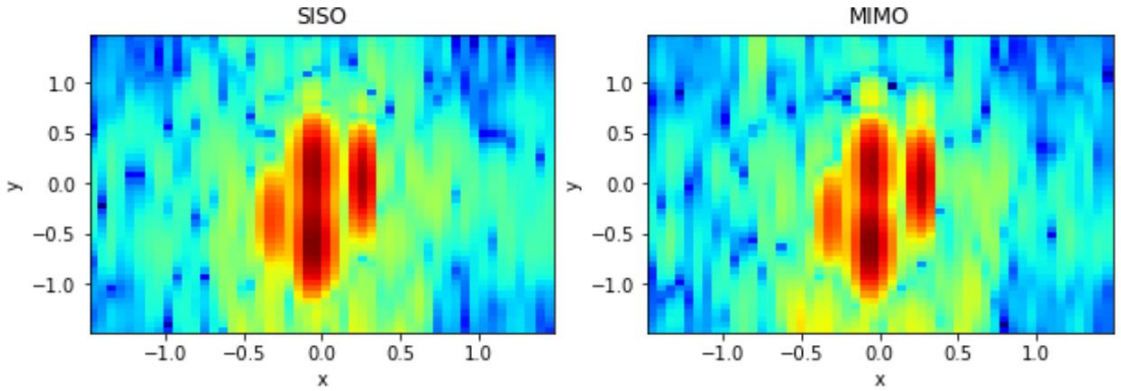
Results

Experimental results



- 3 Tx, 4 Rx
- Frequency band: 60GHz ~ 63.2GHz
- Radar speed: 1m/s
- CPI: 360ms



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Conclusions

- PFA less complex than BPA
- MIMO processing has potential to improve resolution
- Our developed MIMO PFA SAR doesn't limit the radar motion pattern
- Drawback
  - radar looks its side (not its below)
- We just started
  - Lots to explore
    - Radar localization
    - Autofocus
    - Segmentation
    - …

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Thank You

For your attention

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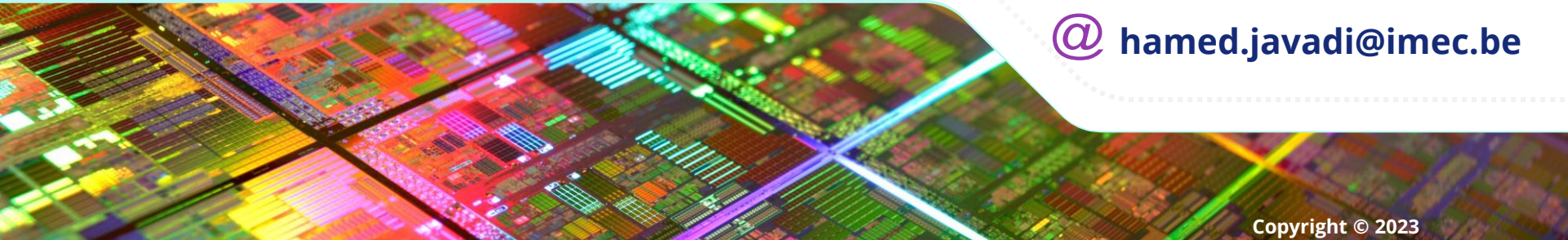

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