Bringing AR/VR to Everyday Life- A Wireless Localization Perspective

Nakul Garg, Irtaza Shahid, Karthik Sankar, Mallesham Dasari‡, Ramanujan K Sheshadri‡, Karthikeyan Sundaresan§, Nirupam Roy

NEC Labs America‡, Georgia Institute of Technology§, University of Maryland College Park

Concept overview

Prototype headset
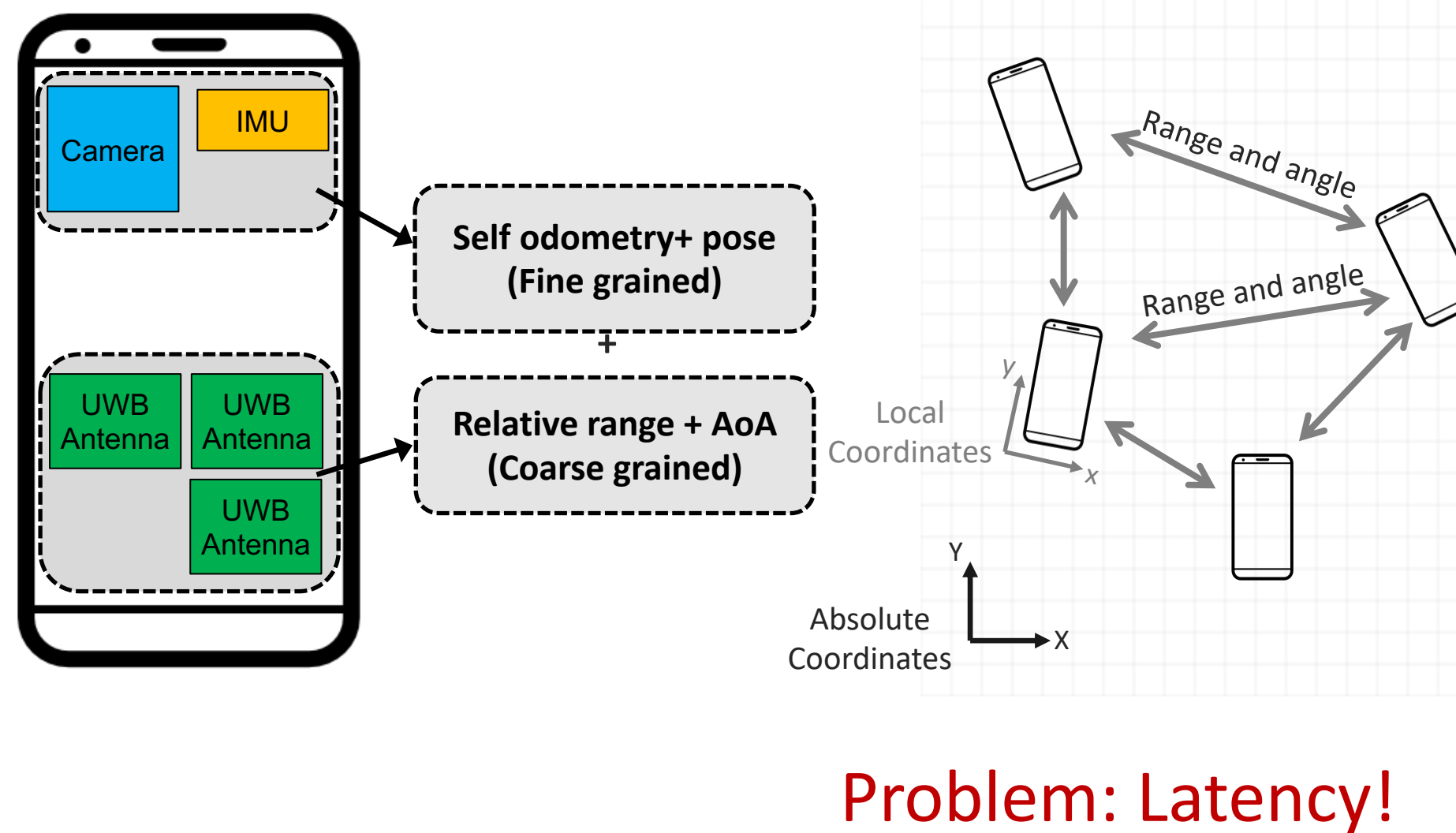
Topology optimization

Problem: Latency!

6 Degrees of freedom

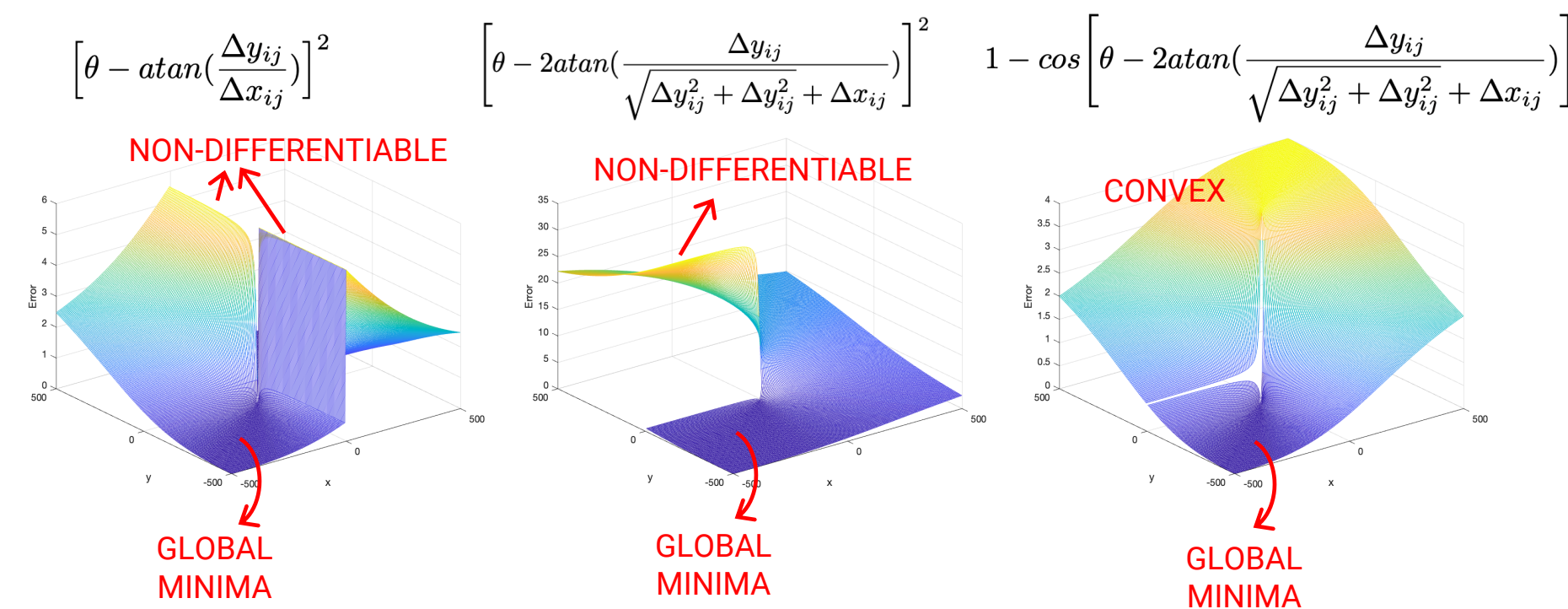(a) Spherical coordinates   (b) Euler angles
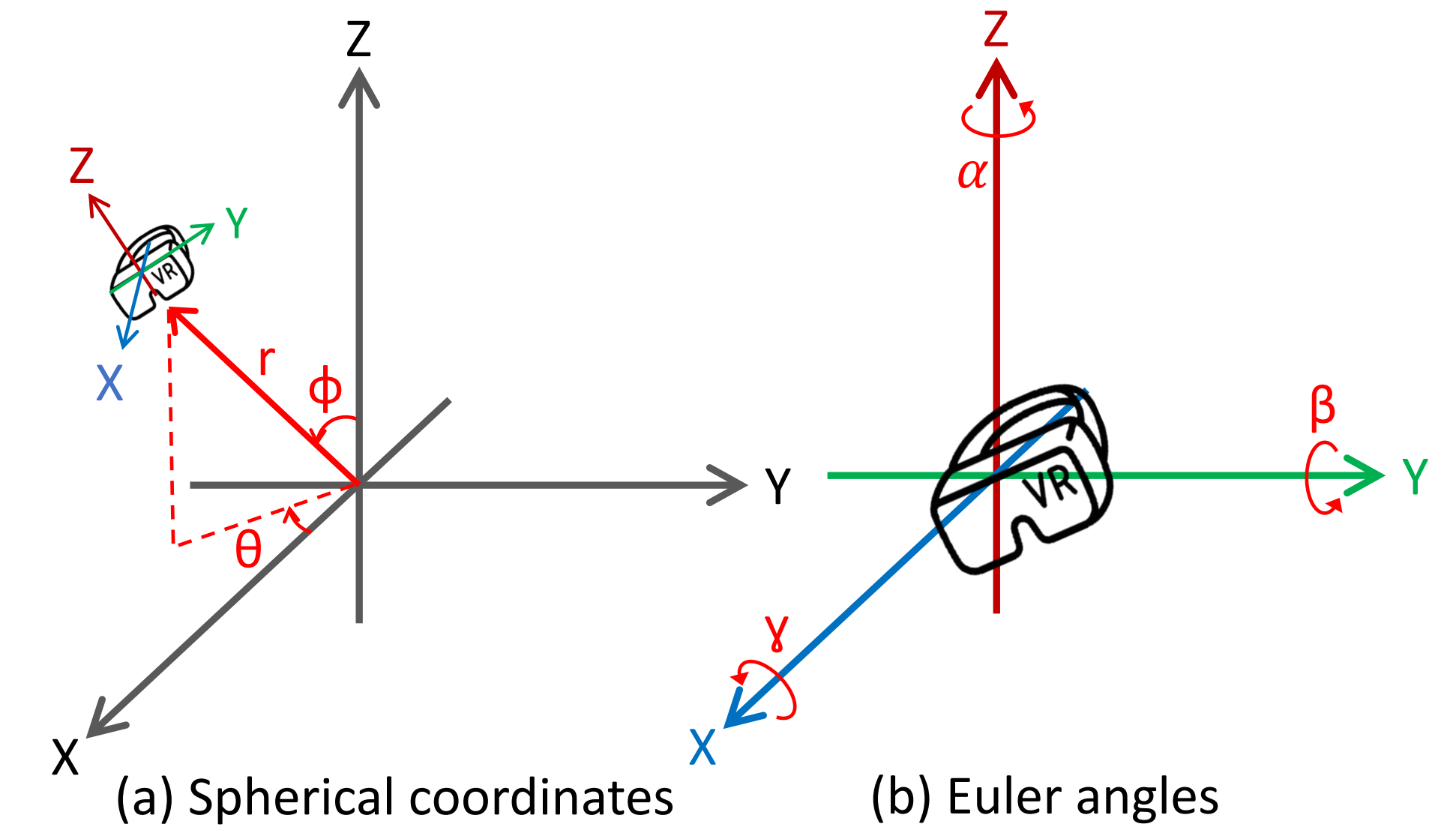
Incorporating angles

Including angles is non-trivial because the loss function becomes highly non-convex.

$$\left[\theta - atan\left(\frac{\Delta y_{ij}}{\Delta x_{ij}}\right)\right]^2$$
NON-DIFFERENTIABLE
GLOBAL MINIMA

$$\left[\theta - 2atan\left(\frac{\Delta y_{ij}}{\sqrt{\Delta y_{ij}^2 + \Delta y_{ij}^2} + \Delta x_{ij}}\right)\right]^2$$
NON-DIFFERENTIABLE
GLOBAL MINIMA

$$1 - cos\left[\theta - 2atan\left(\frac{\Delta y_{ij}}{\sqrt{\Delta y_{ij}^2 + \Delta y_{ij}^2} + \Delta x_{ij}}\right)\right]$$
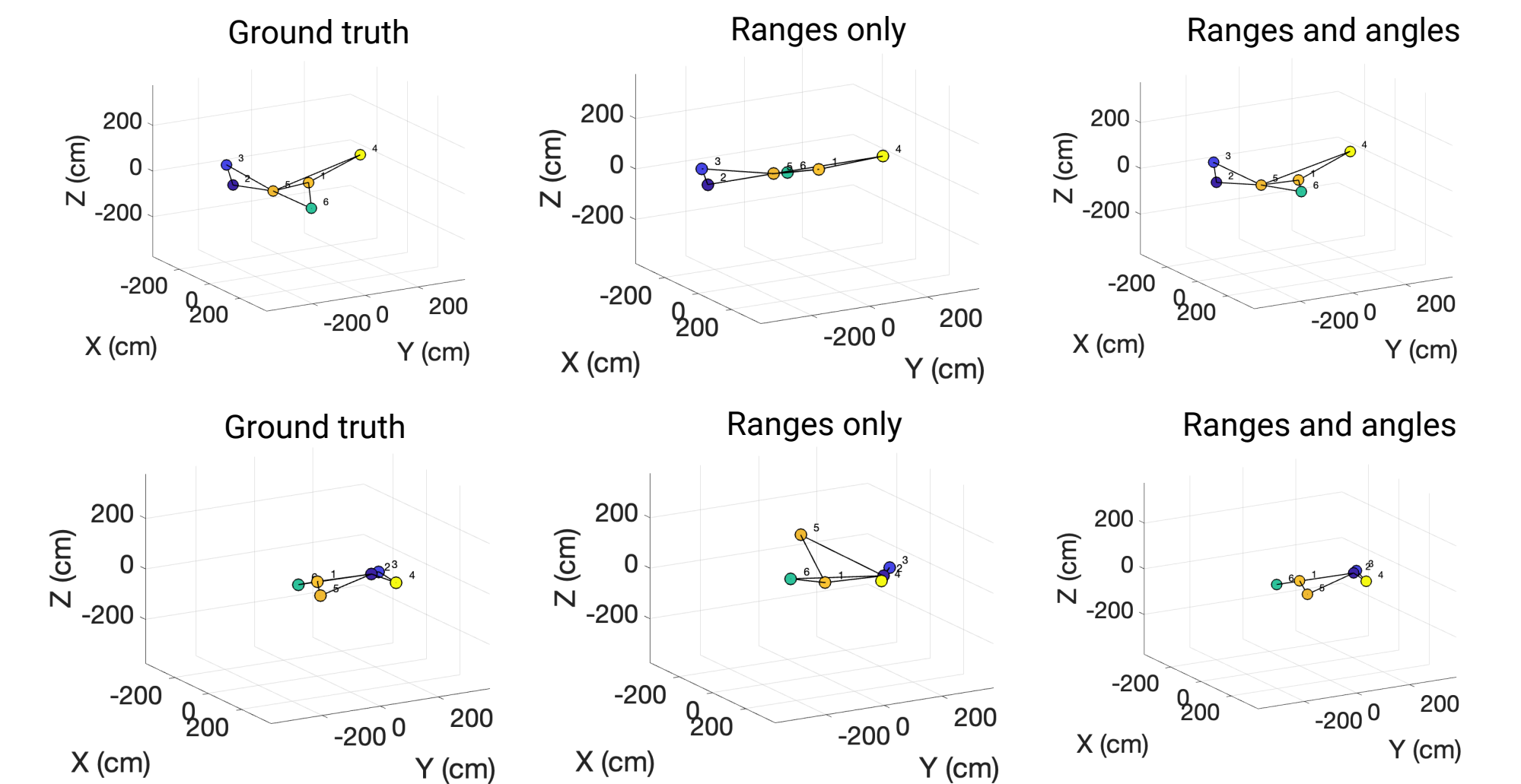CONVEX
GLOBAL MINIMA

$$\min_X \sum_i \sum_j w_{ij}(\hat{d_{ij}} - d_{ij}(X))^2 + w'_{ij}(1 - cos(\hat{\theta}_{ij} - \theta_{ij}(X)))$$
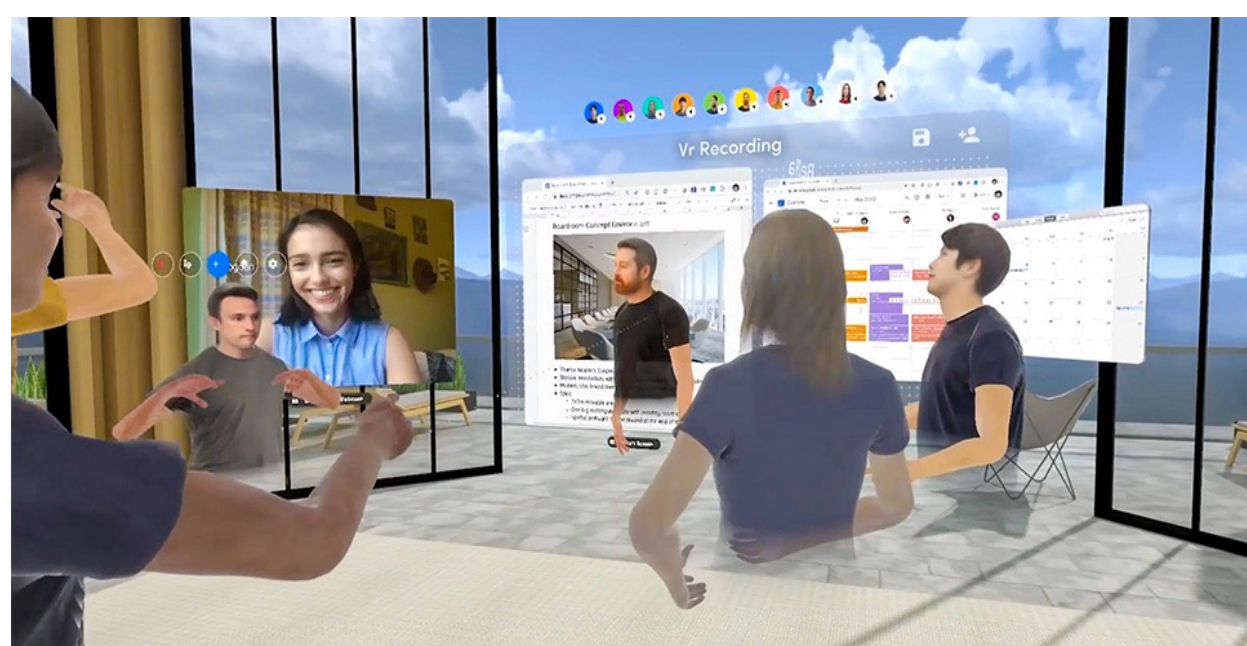
Edge-selection to minimize latency

Edges: 7/7

Edges: 5/7

Edges: 3/7
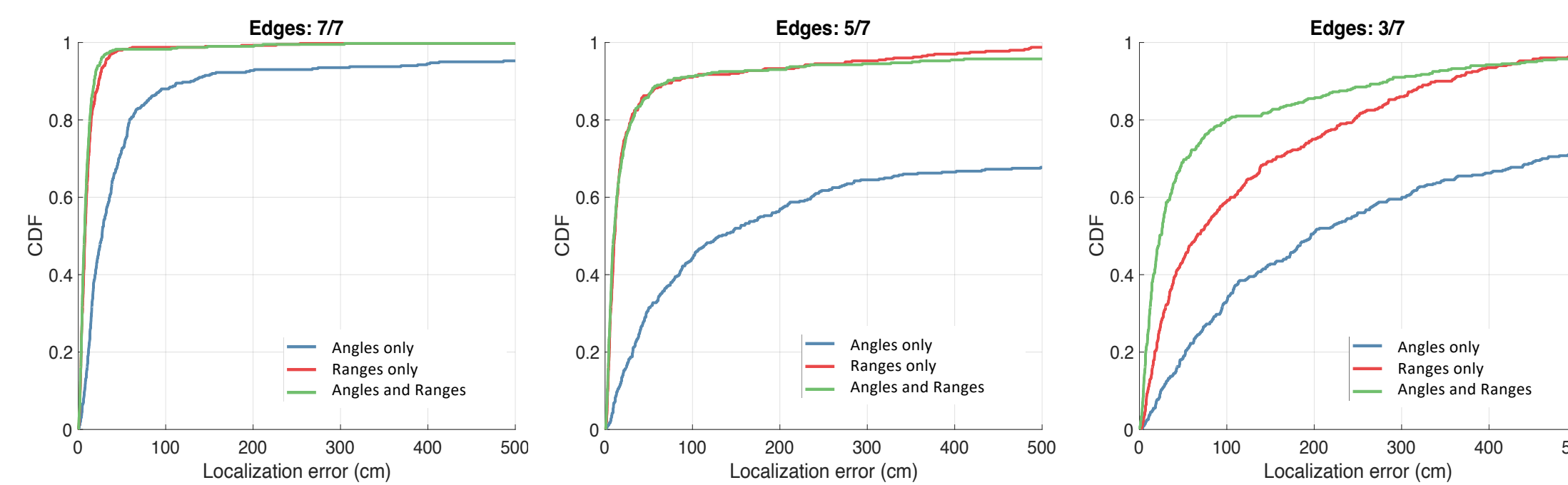
- Adding angular information to the measurements doesn't take extra time
- It adds an additional layer of constraint to the topology

Results

Ground truth   Ranges only   Ranges and angles

Ground truth   Ranges only   Ranges and angles

Applications

Users sharing AR space

Grocery shopping

Human robot collaboration

Education