Sensor Positioning for Radar
Final Report
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1 Participants

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2 Problem Description

2.1 Problem statement

The objective was to find a model that will allow us to choose the antenna locations that maximize area coverage and image quality within a city. More specifically, the goal was to develop a model that allows us to optimize backprojection image quality (in the sense of the width of the point-spread function) and scene coverage as a function of sensor locations.

Solving this problem will contribute to improving city-wide security surveillance (vehicle tracking and identification, etc) in all-weather scenarios.

2.2 Reasonable assumptions

- Single scattering is OK
- The number of antennas is fixed; assumed stationary
- Each antenna node is capable of transmission and reception of signals

- A 3D model of the city is assumed known (given as a triangle mesh surface); occlusions should be considered
- Assume an algorithm is available to compute line of site (LOS) angles for each pixel
- Certain areas (street corners, bus stops, etc) may have more importance than others; so a weight function may be provided along with the Digital Elevation Map (DEM)

3 Summary of work on the problem

3.1 Overall strategy

1. Compute visibility maps for potential sensor configurations determined by geometry
2. For a given configuration of sensors:
   (a) Plot Fourier (k-space) components provided by sensor locations
   (b) Compute optimal weights in a resolution metric
   (c) Evaluate resolution metric
3. Update estimate and return to 2)

3.2 Accomplishments

We developed another approach to obtain optimal weights for irregular k-space plots. When this is used as part of the optimization for the sensor positions, the resulting optimization problem seems intractable. We came to the conclusion that a more promising approach is to focus instead on sensor placement that maximizes visibility while obtaining the most spread-out k-space plot.

It maybe possible to develop bounds, approximations, or inequalities for the weights that will justify the above approach.

3.3 Questions and conjectures

- When can we use the same weight for all frequencies for a given source-receiver pair? This would imply that we only need to consider monochromatic data
- Conjecture: For a larger region in k-space, there is some weight vector for which the achievable resolution is better than that of a smaller region in k-space. This would mitigates the need to estimate weights. To prove this conjecture, it is necessary to quantify the size of the k-space dataset.
- Conjecture: The best approach is to find sensor positions that maximize viewed area, and for those positions, choose the most spread-out one (maximize energy).