Motivation

**Virtual Base Stations**

Localization scenario with $M = 3$ base stations to localize object at $(x_0, y_0)$ by means of direction information.

**Contributions**

**Lemma 2.1** Given point $(\hat{x}, \hat{y})$, point $(x_m^{(s)}, y_m^{(s)})$ along a line $(y - y_m) = a_m(x - x_m)$ closest to $(\hat{x}, \hat{y})$ is given by

$$x_m^{(s)} = \frac{1}{1 + a_m^2}(\hat{x} + a_m \hat{y}) - \frac{a_m}{1 + a_m^2}(y_m - a_m x_m),$$

$$y_m^{(s)} = \frac{a_m}{1 + a_m^2}(\hat{x} + a_m \hat{y}) + \frac{1}{1 + a_m^2}(y_m - a_m x_m).$$

**Lemma 2.2** The minimum sum squared distance is found for point $(\hat{x}(B), \hat{y}(B))$ that satisfies the following set of linear equations:

$$\begin{bmatrix}
\sum_{m=1}^M A_{2,m} - \sum_{m=1}^M A_{1,m} L_m \\
- \sum_{m=1}^M A_{1,m} L_m
\end{bmatrix}
\begin{bmatrix}
\hat{x}(B) \\
\hat{y}(B)
\end{bmatrix}
= - \begin{bmatrix}
\sum_{m=1}^M A_{1,m} L_m \\
\sum_{m=1}^M A_{0,m} L_m
\end{bmatrix}.$$

**Simulation Results**

Experimental setup starting with three base stations (circles) on the right and gradually increasing their number. The receiver location is along the x axis (crosses).

Comparison of beam based and radius based method (converted into virtual beams).

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