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Lecture 4A

Bearing-only tracking: From EKF to particle filter

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Example application: Bearings-only tracking

A challenge that has defeated solution attempts since the late 70s.

Problem statement

- Own-ship state: $\mathbf{x}^o = [x^o, y^o, \dot{x}^o, \dot{y}^o]^\mathsf{T}$. Both state vector and orientation known.
- Target state: $\mathbf{x}^\tau = [x^\tau, y^\tau, \dot{x}^\tau, \dot{y}^\tau]^\mathsf{T}$.
- Kinematics model (to be discretized using standard linear techniques):

$$\dot{\mathbf{x}}^\tau = \begin{bmatrix} \mathbf{0}_{2\times 2} & \mathbf{I}_2 \\ \mathbf{0}_{2\times 2} & \mathbf{0}_{2\times 2} \end{bmatrix} \mathbf{x}^\tau + \mathbf{v}(t)$$

- Measurement model:

$$\mathbf{z}_k = \operatorname{atan2}(y_k^\tau - y_k^o, x_k^\tau - x_k^o) + \mathbf{w}_k$$

- Noise processes assumed zero-mean white mutually independent Gaussian.

Challenges

- The measurement model is nonlinear.
- The problem is not observable unless own-ship executes manoeuvres.

Let’s attempt a standard EKF