Distributed Sensing

Distributed Intelligent Systems
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Lab Structure

- Multiple basic case studies going through typical topics in distributed sensing:
  - performance evaluation
  - space-division scheduling
  - time-division scheduling
  - static vs. mobile sensor networks
  - controlled vs. uncontrolled mobility

- network of 16 robots
- sensing light field
General Performance Metric

\[ M_{C}(\alpha, \beta, \gamma, \delta) = \alpha \cdot \left( 1 - \frac{1}{\varphi_{\text{max}} - \varphi_{\text{min}}} \cdot \sqrt{\frac{\sum_{n=1}^{N}(\hat{\varphi}_{n}(x, y, t) - \varphi_{n}(x, y, t))^2}{N}} \right) + \beta \]

- \( \alpha \cdot \left( 1 - \frac{\sum_{k=1}^{K} S_k}{K \cdot T \cdot F_s / L_s} \right) \) Measurement cost
- \( \gamma \cdot \left( 1 - \frac{\sum_{k=1}^{K} P_k}{K \cdot T \cdot F_m} \right) \) Communication cost
- \( \delta \cdot \left( 1 - \frac{\sum_{k=1}^{K} V_k}{K \cdot T \cdot \nu_{\text{max}}} \right) \) Mobility cost

Estimation error
Backcasting
Backcasting
Backcasting
Time Adaptive Sampling

Assumption: linear model of sensed process

\[ \hat{x}_t = \alpha \cdot x_{t-1} + \beta \]
Controlled vs. Uncontrolled Mobility

- Random walk
  - varying field dynamics

- Guided mobility
  - local communication
  - personal/neighborhood best (highest observed gradient)
  - inertia & randomness
  - **Hint:** Similar to lab 4, there is a function for how to navigate a differential wheel robot towards a goal position