Coverage Control under Connectivity Constraints

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1. Introduction

Coverage Control
Cooperative agents

Minimize a coverage function by optimizing agent positions

Connectivity constraints on a communication graph

- Consideration of the communication range of agents
- Constraint that the communication graph is connected

Proposal of a distributed control law for coverage control under connectivity constraints

2. Method

Approach: Formulation of the problem as a continuous optimization problem with an inequality constraint

Minimizing the sum of the coverage function and a function to avoid agents being trapped in bad local minima

Algebraic connectivity $\lambda_2 \geq \varepsilon$ (small positive value)
- Sufficient condition for the connectivity
- $\lambda_2$ is a function of agent positions
- The graph is disconnected if $\lambda_2 = 0$

Proposed law: Based on the active set method (a well-known algorithm for constrained optimization)

First: $\lambda_2 > \varepsilon$

Control input: $-\nabla J'$

Contour of the objective function $J'$

After a certain time: $\lambda_2 = \varepsilon$

Control input: Projection of $-\nabla J'$ to the feasible region

Legend
- : Agent
- : Centroid of the agent positions
White Circle: Centroid of a Voronoi region assigned to an agent
Dotted Circle: Communication range
Gray Line: Edge of the graph

3. Simulation Results

As expected, the agents deploy over the coverage region while maintaining connectivity

Coverage Control
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Deploy

Coverage Region

Communicable -> connected by Edge
Agent=Vertex