Coverage Control under Connectivity Constraints

Shota Kawajiri, Kazuki Hirashima, and Masashi Shiraishi (Mitsubishi Electric Corporation)

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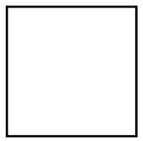
1. Introduction

Coverage Control

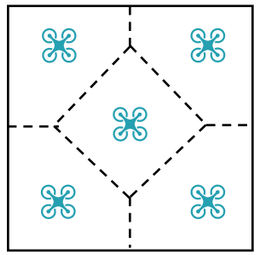
Cooperative agents

Coverage Region



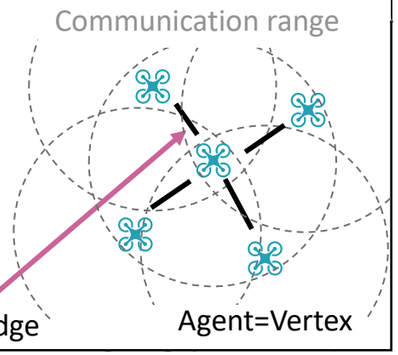
Deploy

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

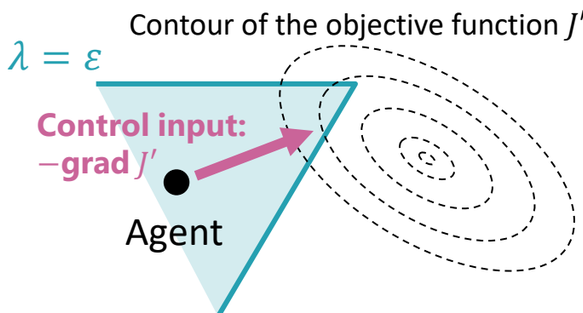
Approach: Formulation of the problem as a continuous optimization problem with an inequality constraint

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

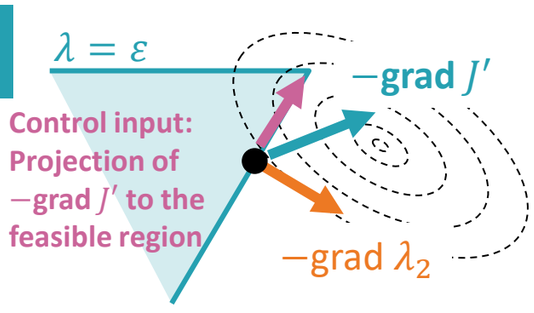
Algebraic connectivity $\lambda_2 \geq \varepsilon$ (small positive value)
- Sufficient condition for the connectivity
- λ_2 is a function of agent positions
- The graph is disconnected if $\lambda_2 = 0$

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

First: $\lambda_2 > \varepsilon$

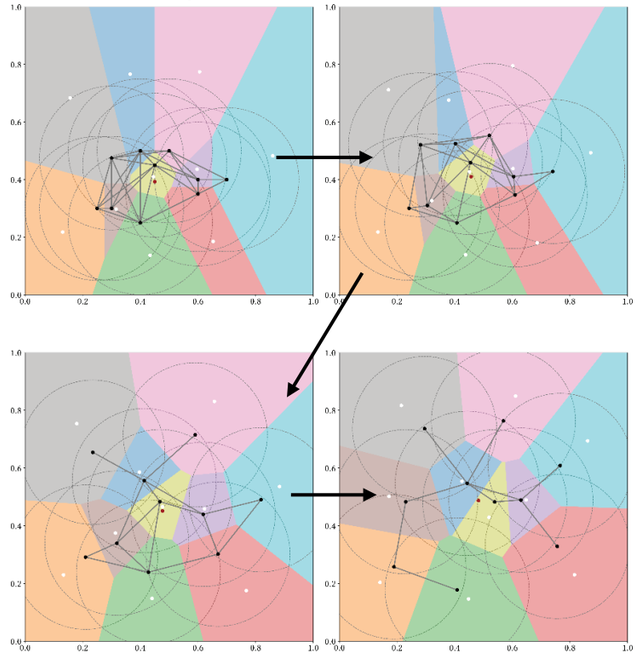


After a certain time: $\lambda_2 = \varepsilon$



3. Simulation Results

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



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