Title

Coverage Optimization with a location dependent Sensing Quality (MAS 7)

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Publication Date

2006

Coverage Optimization with *location dependent* Sensing Quality

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Introduction: Deployment of cameras for outdoor surveillance

Outdoor Deployment

- a network of cameras to monitor a bounded area.
- eg. detect intruders, estimate number of visitors, etc
- focus on outdoor environments

Cyclops

Key Challenge

• The performance varies depending on
  • obstacles,
  • lighting conditions,
  • background contrast,
  • luminance, etc.

• Except obstacles, other factors are difficult to model.

Problem Description: Path Coverage

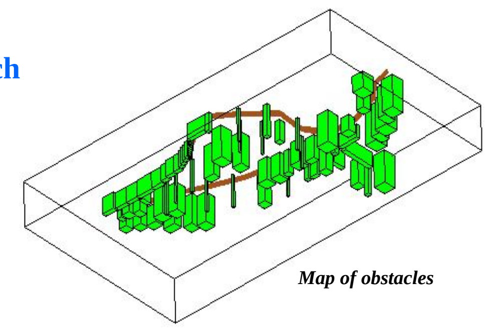
Given a path of arbitrary complexity, find an arrangement of limited-view, location-dependent cameras that minimizes the number of cameras while ensuring that every point in the path is covered.

Complexity:
• This is equivalent to the Set Cover problem which is NP-Complete.

Proposed Solution: A data-driven approach

Centralized, Incremental Approach

• Map obstacles in the environment
• Start with a uniform deployment
• Gather detection data and estimate the camera's detection range at different points (and different directions) along the path.

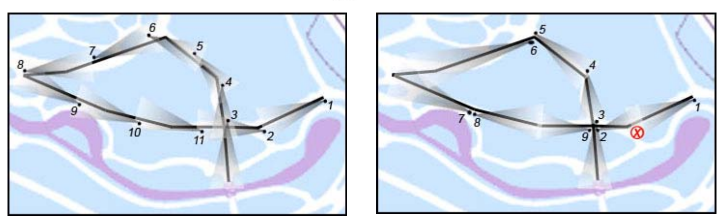


Map of obstacles

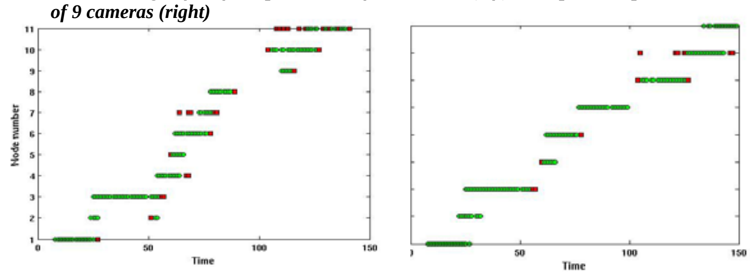
- **Greedy algorithm:**

1. Pick a start point on the path
2. Sequentially choose the camera location and direction that adds most coverage value
3. Repeat step 2 till the path is covered.

- This algorithm is optimal if the path does not intersect itself.
- Otherwise number is additional cameras used is at most equal to the number of self intersections.



Path Coverage of uniform placement of 11 cameras (left) and optimized placement of 9 cameras (right)



Experimental results for uniform placement of 11 cameras (left) and optimized placement of 9 cameras (right) at UCLA botanical gardens.

Distributed, Iterative Approach

• Estimate the range function on-the-fly based on range readings of neighboring nodes.
• Move to the location that maximizes additional coverage value.

Performance of distributed approach

Future work

• Analyze convergence properties.
• Extend the distributed solution to general 2D and 3D domains.