UAV Route Planning Strategies for Efficient Coverage Search in Complex Environments

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DIPARTIMENTO MATEMATICA

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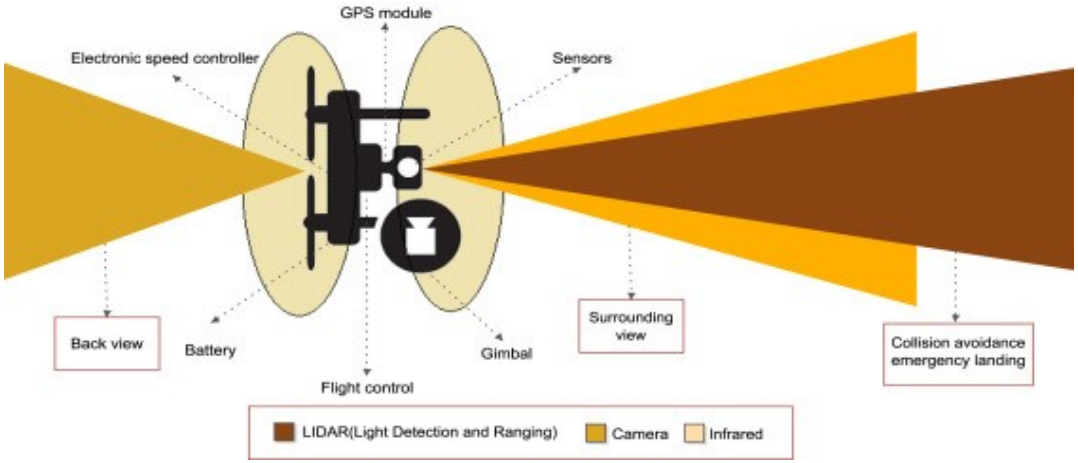
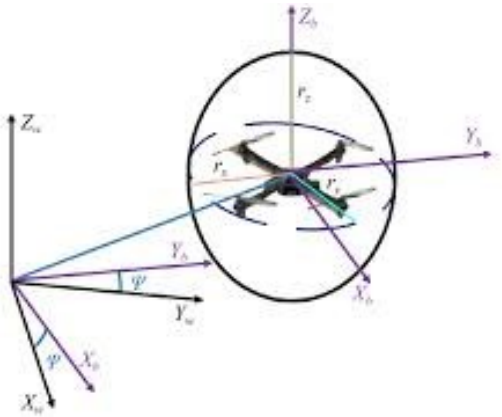
UAV Route Planning





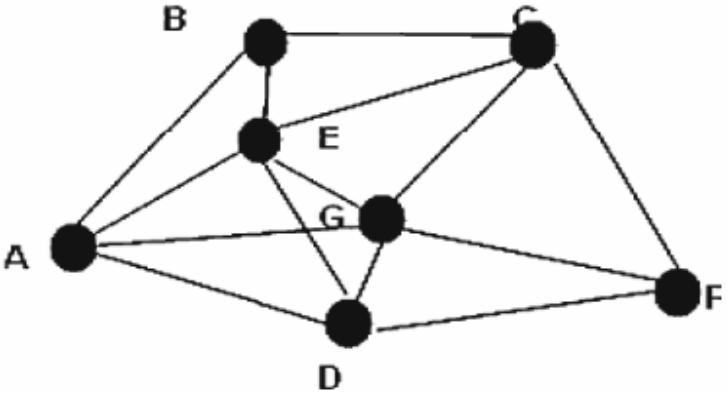
Reference: https://www.sciencedirect.com/science/article/pii/S0140366419308539

Overview of approaches

- Classical algorithms
- Probabilistic methods
- Nature-inspired algorithms
- Multi-UAV coordination
- Environment-specific approaches
- Military applications

Classical approaches

- Dijkstra's Algorithm
- A* Algorithm
- Bellman-Ford Algorithm
- Floyd-Warshall Algorithm



$$A[i][j] = \begin{pmatrix} 0 & 1 & 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 1 & 0 & 0 & 0 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 1 & 1 & 0 & 0 & 1 \\ 0 & 1 & 1 & 1 & 1 & 1 & 0 \end{pmatrix}$$

Reference: Multiple UAVs path planning algorithms: a comparative study (Paper 1)

Classical approaches

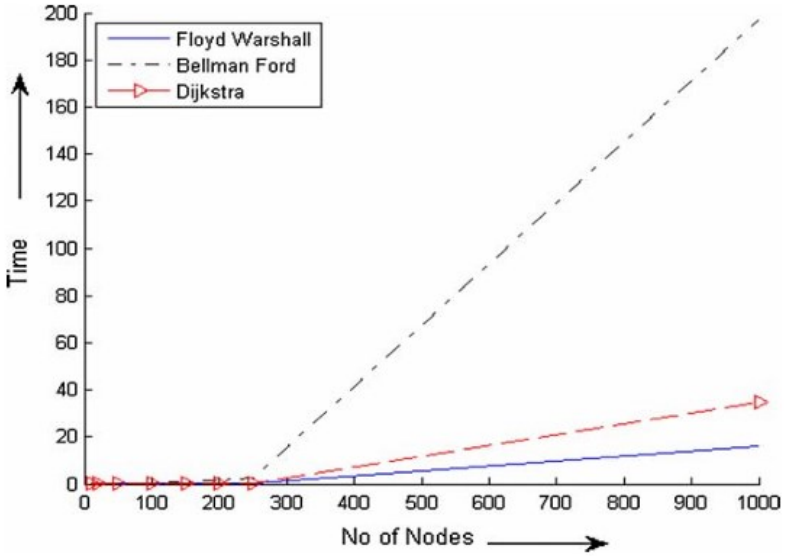


Fig. 5 Computation efficiency of search algorithms

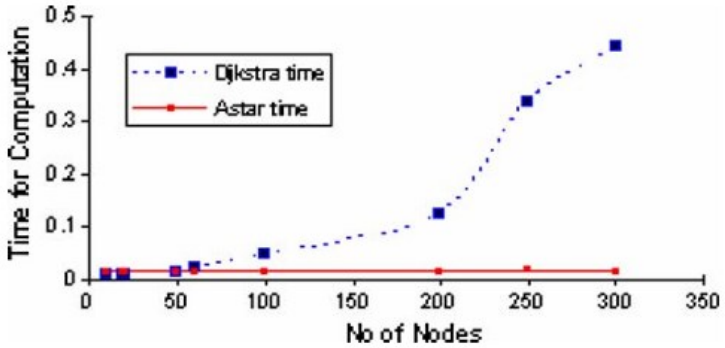
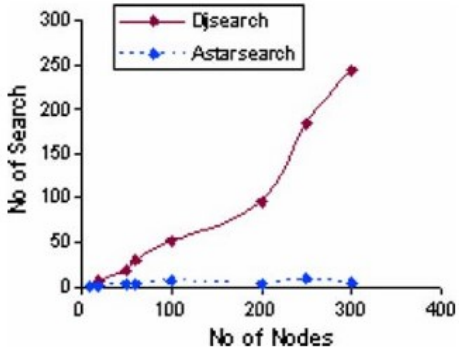


Fig. 6 Astar versus Dijkstra search

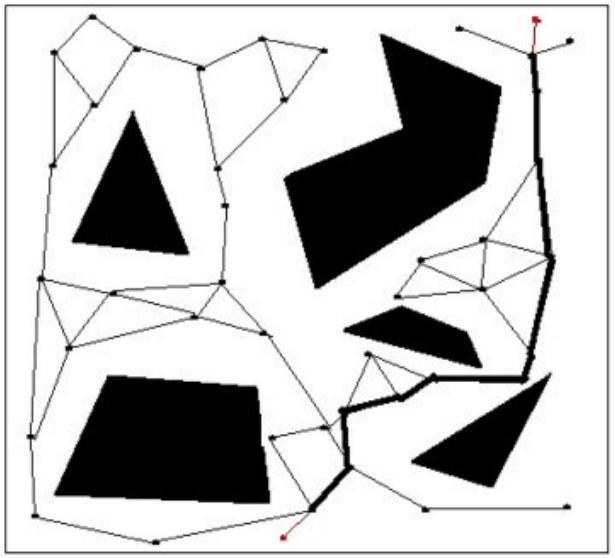
Fig. 7 Dijkstra versus astar



Reference: [Multiple UAVs path planning algorithms: a comparative study] (Paper 1)

Probabilistic methods

- Probabilistic Roadmap Method (PRM)
  - Efficient for high-dimensional configuration spaces
  - Two phases: learning phase and query phase
  - Handles complex 3D environments effectively
- Key features
  - Random sampling of configuration space
  - Creation of roadmap for path planning
  - Efficient for large/complex environments



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Probabilistic methods

- Enhancements for UAV Applications
  - Octree-based environment representation
  - Safety-aware sampling
  - Bounding box array for focused sampling
  - Connectivity evaluation for feasible paths

- Advantages
  - Handles obstacle avoidance well
  - Computationally efficient for large environments
  - Adaptable to different types of environments

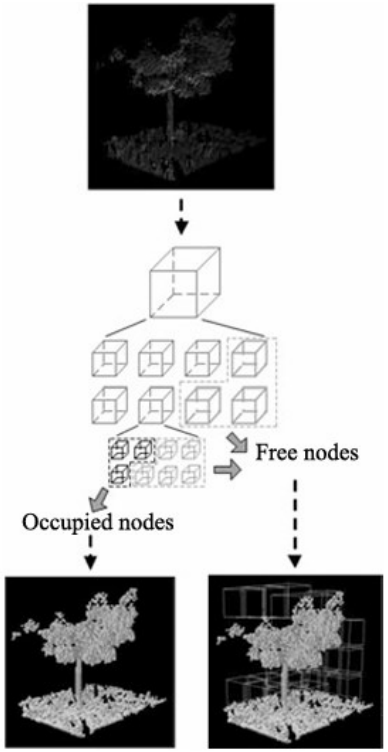

Fig. 1 The occupied voxels and free voxels are extracted from 3D data during octree building

Reference: Path Planning in Complex 3D Environments Using a Probabilistic Roadmap Method – (Paper 2)

Nature-inspired algorithms

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Multi-UAV coordination

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Environment-specific approaches

- aa

Military applications

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Comparison of approaches

- aa

Future challenges and research directions

- aa

Conclusions

- aa