Multi-UAV Persistent Coverage for Multiple Target Visitation Frequencies

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MOTIVATION

- Path planning for **coverage** is integral to numerous applications in AI and Robotics.
- With improvements in computing power and sensing systems, it is common for multiple agents to **cooperate** and achieve a goal.
- We present the problem of **persistent coverage** for multiple energy-constrained **UAVs** in a discrete environment where each target cell has a **different visitation frequency**.

PROBLEM DEFINITION

- Consider $m \times n$ grid cells that need to be efficiently monitored by N UAVs. A visitation frequency $f_{i,j}$ implies that cell (i, j) should be revisited after every $f_{i,j}$ time steps.
- Each UAV must travel to a cell via an optimal path while maintaining a minimum number of bad cells at any time. A cell is bad if it has been neglected by all UAVs.

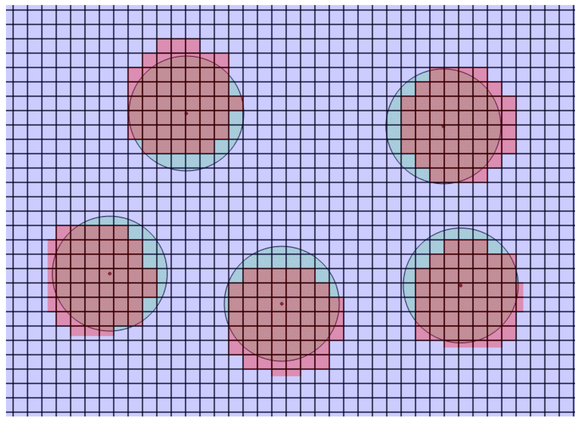


Fig. 2: Custom visualization using the Qt Graphics framework (in progress)

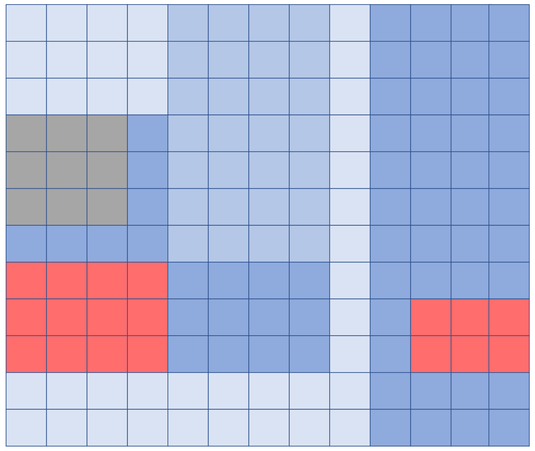


Fig. 1: Environment representation (red indicates 'badness', shades of blue indicate levels of urgency, and gray cells indicate no-fly zones)

ALGORITHM

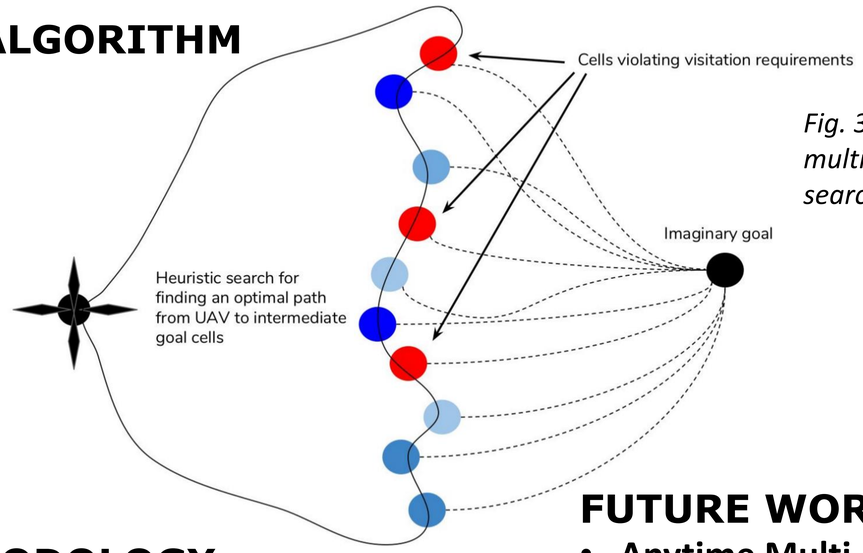
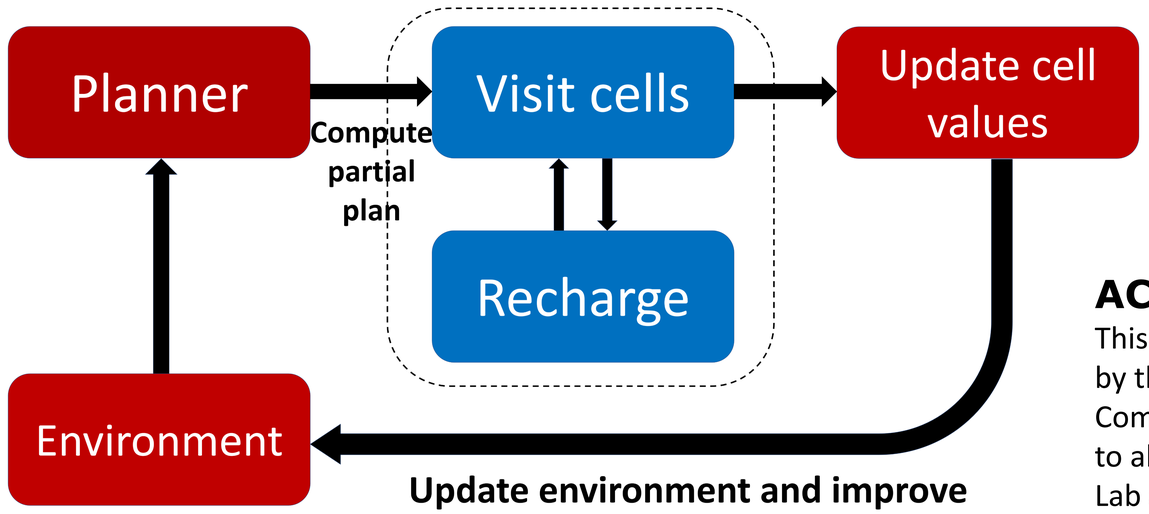


Fig. 3: Frontier-based multiple goal heuristic search.

METHODOLOGY



CONTRIBUTIONS

- Presenting the problem of multi-agent persistent coverage for multiple target visitation frequencies.
- An algorithm to generate feasible plans.
- A **custom visualization framework/GUI** built using Qt Graphics.

FUTURE WORK

- **Anytime Multi-Heuristic A*** search for anytime optimal plans.
- **Provable bounds** on suboptimality.
- **Scalability** with number of UAVs.
- **Learning** strategies through past experiences.

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REFERENCES

1. Butzke, J. and Likhachev, M., 2011, September. Planning for multi-robot exploration with multiple objective utility functions. In Intelligent Robots and Systems (IROS), 2011 IEEE/RSJ International Conference on (pp. 3254-3259). IEEE.
2. Mitchell, D., Chakraborty, N., Sycara, K. and Michael, N., 2015, September. Multi-robot persistent coverage with stochastic task costs. In Intelligent Robots and Systems (IROS), 2015 IEEE/RSJ International Conference on (pp. 3401-3406). IEEE.