

Moving Depot (MOD): An Efficient Depot Motion Strategy for Multi-Robot Foraging

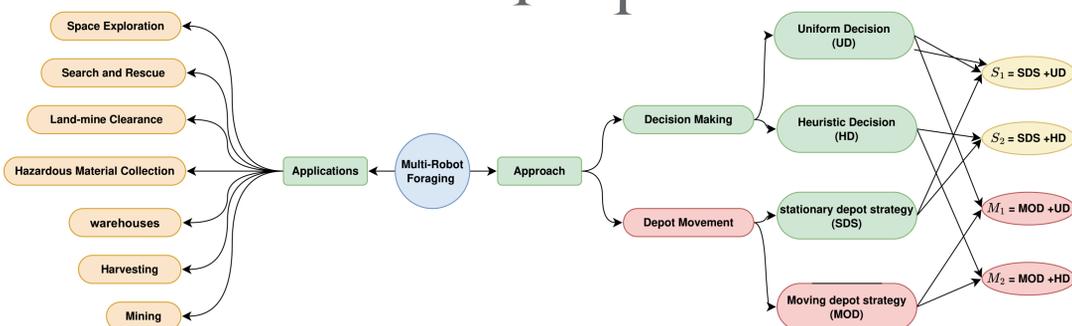
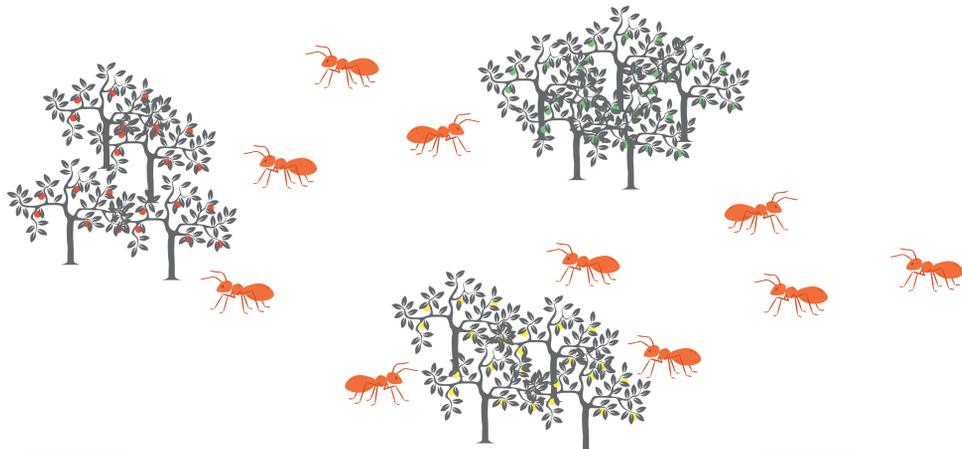
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01. Introduction

In dynamic environments where foraging qualities and obstacles change, the effectiveness of a multi-robot system using a stationary depot strategy (SDS) may be limited. The primary focus of SDS is on the decision-making aspect of agents to improve foraging performance. However, can we enhance decision-making efficiency further? Is there an alternative approach? Yes, there is, and it's called the Moving Depot Strategy (MOD) algorithm. MOD incorporates a weighted centroid of foraging patches, their quality, and a potential field-based method to dynamically adjust the depot location while simultaneously avoiding obstacles.

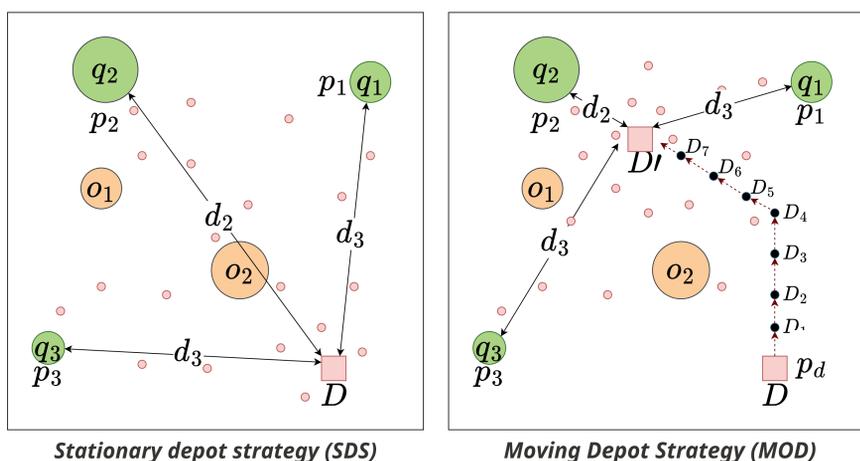
02. Objective

- Improve foraging performance
- Work in an unknown dynamic environment
- Maximize Gain/Cost ratio
- Avoid obstacles

03. Contributions

- Obstacle avoidance while 50% improvement in foraging performance
- Reduction of cost of motion
- Highly suitable for a dynamic environment

03. Methodology



The environment consists of patches (p) with varying resource quality (q), along with obstacles (O) and an initial depot position (D).

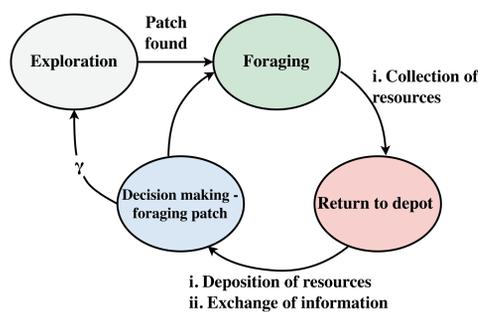
Decision Making for m Patches

Uniform Decisions

$$P_{Uni}(Z = p_i) = \frac{1}{m} \forall i \in \{1, 2, \dots, m\}$$

Heuristic Decisions

$$P_{Heu}(Z = p_i) = \frac{d(p_i, D)}{\sum_{i=1}^m d(p_i, D)} \forall i \in \{1, 2, \dots, m\}$$



Finite state machine of the individual robot behaviour.

Path Planning

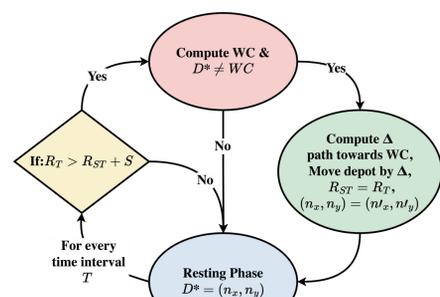
Potential Field based path planning

$$U(w) = U_{att}(w) + U_{rep}(w)$$

Attraction --> Resources Patches
Repulsion --> Obstacles

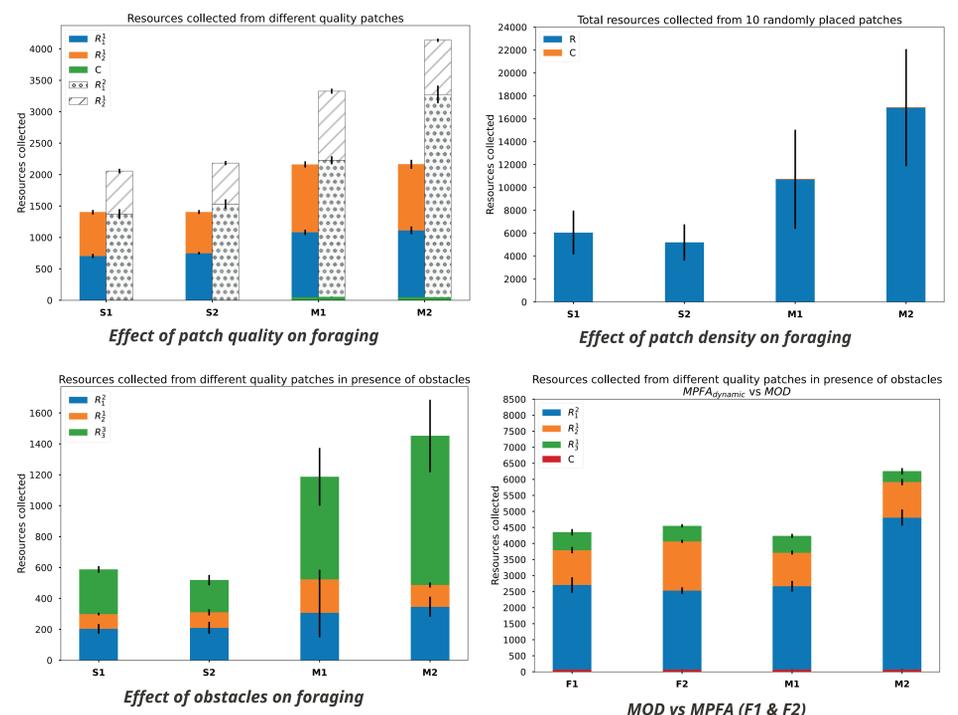
Weighted Centroid of patches

$$WC = \begin{cases} X_c = \frac{\sum_{i=1}^m q_i x_i}{\sum_{i=1}^m q_i} \\ Y_c = \frac{\sum_{i=1}^m q_i y_i}{\sum_{i=1}^m q_i} \end{cases}$$

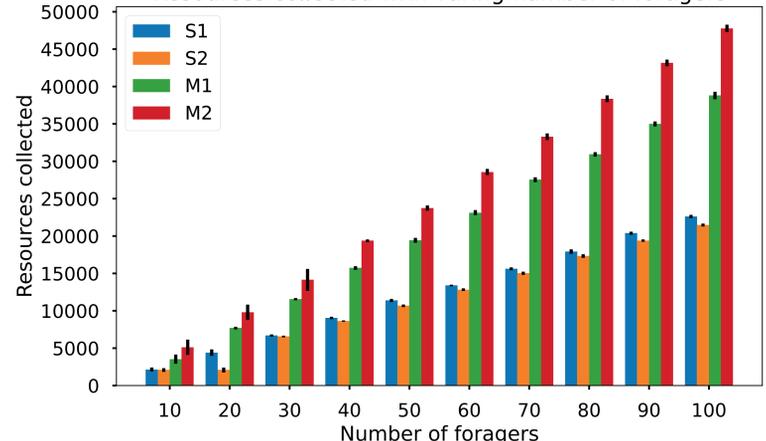


Finite state machine of the depot behaviour

04. Results



Resources collected with varying number of foragers



Effect of change in the number of foragers

06. Conclusion & Future Work

- MOD is a practical, decentralized search-and-collection algorithm for ant-like robot swarms.
- Replace potential path planning with Multi-robot RL planning.