World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:19, No:08, 2025

Evolutionary Swarm Robotics: Dynamic Subgoal-Based Path Formation and Task Allocation for Exploration and Navigation in Unknown Environments

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Abstract : This research paper addresses the challenges of exploration and navigation in unknown environments from an evolutionary swarm robotics perspective. Path formation plays a crucial role in enabling cooperative swarm robots to accomplish these tasks. The paper presents a method called the sub-goal-based path formation, which establishes a path between two different locations by exploiting visually connected sub-goals. Simulation experiments conducted in the Argos simulator demonstrate the successful formation of paths in the majority of trials. Furthermore, the paper tackles the problem of inter-collision (traffic) among a large number of robots engaged in path formation, which negatively impacts the performance of the sub-goal-based method. To mitigate this issue, a task allocation strategy is proposed, leveraging local communication protocols and light signal-based communication. The strategy evaluates the distance between points and determines the required number of robots for the path formation task, reducing unwanted exploration and traffic congestion. The performance of the sub-goal-based path formation and task allocation strategy is evaluated by comparing path length, time, and resource reduction against the A* algorithm. The simulation experiments demonstrate promising results, showcasing the scalability, robustness, and fault tolerance characteristics of the proposed approach.

Keywords : swarm, path formation, task allocation, Argos, exploration, navigation, sub-goal
Conference Title : ICSRI 2025 : International Conference on Swarm Robotics and Intelligence
Conference Location : Moscow, Russia
Conference Dates : August 30-31, 2025