

RESEARCH ARTICLE

# Autonomous Multi-Robot Coordination in Unstructured Environments Using Swarm Intelligence

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**Abstract:**

We present a novel swarm intelligence framework for autonomous multi-robot coordination in unstructured environments. Our approach combines bio-inspired ant colony optimization with reinforcement learning to enable real-time collaborative task allocation, path planning, and obstacle avoidance for heterogeneous robot teams. Experiments in simulated disaster response scenarios with teams of 50-200 robots demonstrate robust performance with a 97% task completion rate, even when 30% of robots experience communication failures. The framework scales linearly with team size and adapts to dynamic environmental changes within 200 milliseconds.

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