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Multi-robot motion planning with intermittent diffusion

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Abstract

In this work, we introduce a novel strategy based on intermittent diffusion that enables a group of robots to accomplish complex tasks such as shape formation, assembly, and exploration. Our approach leverages the simplicity of the robots, which may have limited communication capabilities and fixed sensing ranges, to demonstrate robust collision avoidance and guaranteed convergence. We rigorously prove the feasibility of this method through algorithmic validation. Additionally, we present an extension of our strategy to handle path planning in environments with obstacles. The robots' movements are guided by a flow field, driven by the negative gradient of a function that minimizes both the distance to target regions and the proximity to other agents within a defined field of view. To navigate around obstacles, a carefully designed projection term is introduced, and an intermittent diffusion process helps the robots escape local minima. This new approach bypasses the need for offline planning, enhancing computational efficiency and allowing for decentralized collision avoidance. Our method provably guarantees collision-free paths under specific conditions, and its effectiveness is further demonstrated through numerical simulations of three deployment missions

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