Controlling a Swarm of Robots Using Global Inputs

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LECTURE ABSTRACT

There are driving applications for large populations of tiny robots in robotics, biology, and chemistry. These robots often lack onboard computation, actuation, and communication. Instead, these "robots" are particles carrying some payload and the particle swarm is controlled by a shared control input such as a uniform magnetic gradient or electric field. In previous works, we showed that the 2D position of each particle in such a swarm is controllable if the workspace contains a single obstacle the size of one particle.

Requiring a small, rigid obstacle suspended in the middle of the workspace is a strong constraint, especially in 3D. This paper relaxes that constraint, and provides position control algorithms that only require non-slip wall contact in 2D. Both in vivo and artificial environments often have such boundaries. We assume that particles in contact with the boundaries have zero velocity if the shared control input pushes the particle into the wall. This paper provides a shortest-path algorithm for positioning a two-particle swarm, and a generalization to positioning an n-particle swarm. Results are validated with simulations and a hardware demonstration.