Distributed formation control via rigidity theory

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The distance-constrained formation control problem asks for schemes by which a collection of autonomously acting agents can maintain a desired spatial configuration, using only locally sensed information about the distances to a subset of the other agents. The case in which the sensing is symmetric in the sense that agent pairs sensing each other do so accurately has a classical solution based on a gradient potential structure, and there are many different analyses in the literature. I will describe a new, larger family of controllers based on lifting an “edge space" flow on the measurement set of the sensing graph to node space. This gives a new solution to the symmetric problem, and, more interestingly, provides the first general solution to more realistic “directed” variants of the problem, where the sensing is asymmetric.

Previous work on directed distributed formation control has centered on a combinatorial notion known as “persistence”. The rigidity-theoretic approach shows that persistence is neither necessary nor sufficient for local exponential convergence of the natural controller. I will describe an alternative combinatorial proposal called “algebraic admissibility” based on an algebraic relaxation of a semi-algebraic sufficient condition for local exponential convergence.

This is joint work with J Sidman and D Zelazo.