Motion coordination and territory partitioning for minimalist robots

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Motion coordination is an extraordinary phenomenon in biological systems and a powerful tool in man-made systems. Although individual agents have no global knowledge of the system, complex behaviors emerge from local interactions. The subject of this talk is the design of motion-enabled robotic networks, i.e., networks where agent motions are purposefully induced in order to perform useful tasks. Two example tasks are how to respond to service requests in an environment and how to deploy sensor nodes in locations of interest. For these two tasks, a key technical challenge is the design of adaptive behaviors that tolerate asynchronicity and communication/process failures. For these tasks, we review a well-known approach based on localization optimization, gradient flows, synchronous communication and connectivity. Furthermore, we propose a recent deployment and partitioning algorithm that requires only pairwise asynchronous gossip communication. A key novel idea is the description of the deployment problem as a dynamical system on the space of partitions.

Biosketch: Francesco Bullo received the Laurea degree in Electrical Engineering from the University of Padova in 1994, and the Ph.D. degree in Control and Dynamical Systems from the California Institute of Technology in 1999. From 1998 to 2004, he was affiliated with the Coordinated Science Laboratory at the University of Illinois at Urbana-Champaign. He is currently a Professor with the Mechanical Engineering Department at the University of California, Santa Barbara. His students' papers were finalists for the Best Student Paper Award at the IEEE Conference on Decision and Control (2002, 2005, 2007), and the American Control Conference (2005, 2006). He is the coauthor of the book "Geometric Control of Mechanical Systems" (Springer, 2004) and of the book "Distributed Control of Robotic Networks" (Princeton, 2009). His research interests include motion planning and coordination for autonomous vehicles, and geometric control of mechanical systems.