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Stability and Robustness of Collective Dynamics

Given the joint challenge to explain the enabling mechanisms of collective behavior in social animal groups and to define provable mechanisms of collective behavior for networked robotic groups, it is of great value to develop systematic means to study stability and robustness of collective dynamics for multi-agent systems. When distributed feedback laws used by individual agents depend only on measurements of relative states of others, the closed-loop dynamics retain a symmetry, and synchrony measures can be used to parametrize solutions in shape space. I will discuss stability of synchronized behaviors and robustness of synchrony to input heterogeneity, as a function of the (directed) inter-agent sensing topology. Dispersion, which measures the distance from synchrony, is examined for networked dynamical systems in the presence of external input disturbances with bounded L_2 norm. Robustness is formalized with an L_2 gain condition and the dependence is derived of the L_2 gain on the sensing topology and on properties of the individual agent dynamics. Other robustness measures are considered for classes of systems.