STABLE SYNCHRONIZATION OF RIGID BODY NETWORKS

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Abstract. We address stable synchronization of a network of rotating and translating rigid bodies in three-dimensional space. Motivated by applications that require coordinated spinning spacecraft or diving underwater vehicles, we prove control laws that stably couple and coordinate the dynamics of multiple rigid bodies. We design decentralized, energy shaping control laws for each individual rigid body that depend on the relative orientation and relative position of its neighbors. Energy methods are used to prove stability of the coordinated multi-body dynamical system. To prove exponential stability, we break symmetry and consider a controlled dissipation term that requires each individual to measure its own velocity. The control laws are illustrated in simulation for a network of spinning rigid bodies.

1. Introduction. In this paper, we derive a decentralized control methodology to coordinate and stabilize a network of rigid bodies moving in three-dimensional space. Coordination here refers to synchronization of the orientations and positions of the rigid body network. A motivating application is the use of a coordinated cluster of satellites carrying telescopes for astronomical interferometry. The goal is to synchronize the motion of the satellites so that using the telescopes together enhances resolution. Our results provide provably stable control laws that align the orientations and synchronize the angular velocities of a network of \( n \) spinning rigid bodies.

We are likewise motivated by the application of a fleet of sensor-equipped underwater vehicles that move together in an organized pattern to identify and track features in the ocean. An important goal is to synchronize the motion of the vehicles so that resolution of the sensing array is optimized to minimize estimation error in the sampled environment. In the case that the vehicles are used as an acoustic array, synchronization of vehicle orientation also becomes critical. Our results provide

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