Multiagent Learning for Locomotion and Coordination in Tensegrity Robotics

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Abstract

Tensegrity structures are composed of pure compressional elements that are connected via a network of pure tensional elements. The concept of tensegrity promises numerous advantages to the field of robotics. Tensegrity robots are, however, notoriously difficult to control due to their oscillatory nature and nonlinear interaction between the components. Multiagent learning, a subtopic of artificial intelligence, provides the tools to address challenges of tensegrity robots. In multiagent learning, multiple entities simultaneously learn a task together while interacting with each other through the environment. This approach can be applied at two different levels: both to coordinate teams of multiple robots, and to control a single robot where different agents control different parts of the robot. In this work, we consider both cases, and apply two multiagent learning approaches (Reinforcement Learning and Evolutionary Algorithms) to tensegrity robotics problems at different levels. First, we take the model of an icosahedron robot, and use multiagent learning to control different parts. We use coevolutionary algorithms and fitness shaping to develop learning based robust rolling locomotion algorithm. After the locomotion aspect, we study multi-robot coordination using multiagent reinforcement learning and reward shaping methods. At this phase, we study reward shaping and develop methods to use reward shaping to improve the cooperation between multiple tensegrity robots. We explain how these results are simulated and validated by using physical tensegrity robots. Last, we explain how these results helped design and development of a tensegrity robot with rolling capability: SUPERBall.

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