Graduate School of Science and Technology Master's Thesis Abstract

Laboratory name (Supervisor)	Robot Learning (Takamitsu Matsubara (Professor))		
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Thesis title	Cooperative Grasping and Transportation Using Multi-agent Reinforcement Learning With Ternary Force Representation		

Abstract

Cooperative object grasping and transportation by multiple robots require effective communication to coordinate actions with each other. Implicit force-sensing communication uses force sensors to perceive the applied force on an object by other robots, enabling robots to communicate their states implicitly through force feedback. While this method avoids the issues of delay or interruptions as in explicit communication, it is vulnerable to grasping environment variability such as variations in grasping force can disrupt signals significantly. We propose multi-agent reinforcement learning (MARL) with ternary force representation, a novel force representation that maintains consistent representation against variations in grasping environments. To resolve the partial observability introduced by the simplified ternary representation, we use asymmetric actor critic structure on top of MARL to train policies with rich force information during training and deploy them with the ternary force representation during execution. Our simulation experiments demonstrate that our method is robust to variations in grasping force, different grasped object geometries, and force sensor model discrepancies compared to methods using raw force signals. Additionally, our real robot experiments show that our method, trained in simulation, is robust to inherent grasping environment variations between simulated and real-world environments and outperforms methods based on raw force signals.