Learning Approaches for Flexible and Resilient Multi-robot Cooperative Transport

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Abstract (should be within 1st page)

Multi-robot transportation has attracted attention in robotics and can be applied in fields such as delivery, logistics, and search and rescue. While previous studies have successfully derived control strategies for various tasks, they still have strong assumptions. Consequently, the robots cannot transport unknown objects or manage unexpected scenarios, where the number of robots differs from the training environment owing to batteries' discharges or actuators' failure. Therefore, this thesis proposes learning approaches for achieving flexible and resilient multi-robot transportation. Firstly, a learning framework is proposed to design communication and control strategies for various numbers of robots. The proposed method exploits a distributed policy to reconstruct global information using local information while determining the timing for communication. Therefore, it can balance communication savings and control performance for various numbers of robots. Secondly, we propose a learning framework of multi-robot task allocation for various numbers of robots and objects with unknown weights. The proposed method exploits a distributed policy that determines the timing for cooperative and independent actions. Therefore, it can reduce the transport time while transporting all the objects for various numbers of robots and objects with unknown weights. Lastly, an approach for object shape estimation is proposed to transport unknown-shaped objects. The proposed method adopts touch-based contact detection using accelerometers to supplement vision sensors. However, this method involves false-positive contact data because it reacts not only to actual contacts but also to the unstable behavior of the robot. Therefore, a robust shape estimation method is proposed to handle such false-positive contact data. I hope this thesis plays an essential role in achieving a flexible and resilient system that can deal with various transportation scenarios in real applications.