Coordination of Multi-Robot System under Delayed Measurements: A Design for Fast Consensus

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Opportunity

Abstract
Achieving fast consensus in a network of wheeled robots is challenging, especially when the robot states are not measured instantaneously. Many systems have an inherent delay that must be considered when designing a controller. In this presentation, we show how the controller gains can be tuned using previously established observers in order for the robots to achieve fast consensus despite any system delays. We then present a faster consensus design by combining a PR controller framework along with the tuned observer. The addition of the PR controller decreased the response time of the system for a wide range of inherent delay values. Analytical and simulation results are provided and compared with previous work.

Motivation
- Remote multi-robot coordination control
- Basic problem: Consensus

Obstacles
- Nonlinear dynamics of differential-wheeled robot
- Delayed feedback due to signal transmission/processing

Goal
- Linearize system dynamics under delayed feedback
- Achieve fast consensus

Approach

State Estimation: Estimate the delayed states based on delayed measurements (Observer/Predictor
Robot Linearization: Linearize robot dynamics by using estimated states (Feedback Linearization)
Consensus Acceleration: Replace classic consensus protocol by PR protocol

Simulations under large delay

Trajectories comparison
• Consensus without observer
• Consensus with observer

Average distance comparison

Settling time comparison

Impact
This work applies an observer-based framework to stabilize the delayed multi-robot system and achieve a faster consensus performance by introducing PR controller.