Abstract

Robust Output Feedback Formation Control for Nonholonomic Mobile Robots

(NMRs)

by

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This paper addresses the systematic approach to design formation control for kinematic model of unicycle-type nonholonomic mobile robots (NMRs). These robots are difficult to stabilize and control due to their non-integrable constraints. The difficulty of control increases when there is a requirement to control a cluster of NMRs in a specific formation. In this thesis, the design of the control scheme is presented in a two-step process. Firstly, a robust state feedback point-to-point stabilization control is designed using Sliding Mode Control (SMC). The controller is modified as to address the tracking problem for the constant as well as time-varying reference trajectories. The proposed control scheme is shown to provide for desired robustness properties in presence of the parametric variations, in the region of interest. Proposed controller requires all states specially velocities. Therefore, the state-feedback control scheme is then extended to output feedback by incorporating a High Gain Observer. In the second step, the tracking problem of a single NMR is extended to formation control for a group of NMR in leader-follower scenario using Integral Terminal Based Sliding Mode Control (ITSMC) augmented with a stabilizing control. Starting with a mathematical model equation of NMR, the proposed control scheme ensures that the robots maintain a constant distance between each other to avoid collision. Proposed control scheme is extended to an output feedback formation control using a High Gain Observer (HGO). With the help of Lyapunov analysis and appropriate simulations, it is shown that the proposed output feedback control scheme achieves the required control objectives and provides for the desired performance in the presence of parametric variations. Furthermore, the closed loop system trajectories reach to desired equilibrium point in finite time, while maintaining the special pattern