Tracking control scheme for an underwater vehicle-manipulator system with single and multiple sub-regions and sub-task objectives

Abstract:

This study presents a novel tracking control scheme for an underwater vehicle-manipulator system (UVMS) where the proposed controller is not only used to track the prescribed sub-region but also allows the use of the self-motion to perform various sub-tasks (i.e. drag minimisation, obstacle avoidance and manipulability) because of the kinematically redundant system. In the proposed control scheme, the desired primary task of the UVMS is specified as two sub-regions that are assigned for the vehicle and end-effector. Despite the parametric uncertainty associated with the underwater dynamic model, the controller ensures the sub-task tracking without affecting the sub-region and attitude tracking control objective. The Lyapunov-type approach is utilised to design the controller and an extension to an adaptive-robust control scheme with multiple sub-regions and sub-task objectives is also performed to illustrate the flexibility of the approach. The presence of variable ocean currents creates hydrodynamic forces and moments that are not well known or predictable, even though they are bounded. Therefore the control task of tracking a prescribed sub-region trajectory is challenging because of these additive bounded disturbances. Furthermore, multiple sub-task criteria that are formulated using a weighted-sum approach are added to the control objective. Simulation results are presented to demonstrate the performance of the proposed control law.