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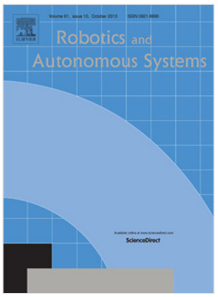

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Human-Robot Collaboration for Safe Object Transportation Using Force Feedback

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Abstract

This work presents an approach based on multi-task, non-conventional sliding mode control and admittance control for human-robot collaboration aimed at handling applications using force feedback. The proposed robot controller is based on three tasks with different priority levels in order to cooperatively perform the safe transportation of an object with a human operator. In particular, a high-priority task is developed using non-conventional sliding mode control to guarantee safe reference parameters imposed by the task, e.g., keeping a load at a desired orientation (to prevent spill out in the case of liquids, or to reduce undue stresses that may compromise fragile items). Moreover, a second task based on a hybrid admittance control algorithm is used for the human operator to guide the robot by means of a force sensor located at the robot tool. Finally, a third low-priority task is considered for redundant robots in order to use the remaining degrees of freedom of the robot to achieve a pre-set secondary goal (e.g., singularity avoidance, remaining close to a homing configuration for increased safety, etc.) by means of the gradient projection method. The main advantages of the proposed method are robustness and low computational cost. The applicability and effectiveness of the proposed approach is substantiated by experimental results using a redundant 7R manipulator: the Sawyer collaborative robot.

Keywords: cooperative task, robot system, force control, sliding mode control