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DYNAMIC COORDINATION OF A MULTI-DOF MANIPULATOR-PLATFORM SYSTEM

Abstract

Space manipulator systems have demonstrated their importance in the support of space operations, and the feasibility and potential of their utilization onboard dedicated space servicing vehicles have been extensively investigated in the last decades. In this context, the study of the properties and potentials of multi-manipulator systems represents an innovative matter of research. A spacecraft platform mounting a multi-manipulator system can be operated by means of a centralized dynamic control, in which coordination strategies can be implemented in order to perform desired end-effector motions and in the meantime control the spacecraft attitude and the base reaction forces and torques. In this paper, dynamic coordination logics are presented, taking into account different cooperation and redundancy conditions, by extending the base reaction control framework recently developed by the authors, in order to perform the desired manipulator maneuvers and maintain the balance of the base reactions. Kinematic control logics are proposed, by means of an acceleration-level problem formulation and least squares optimization methods, which lead to solutions suitable for real-time implementations. The first studied test case considers a non cooperative system composed of a master-and-slave manipulator pair, in which the first one performs a desired maneuver, while the second one is dedicated to the reaction compensation. Local optimal solutions are provided that minimize the resultant base reaction, and criteria for the full reaction compensation are given. The second studied test case considers a cooperative multi-arm system. The level of dynamic coordination that can be achieved exploiting the system overall kinematic redundancy in the case of two operative manipulators is investigated, and criteria for the full compensation of the base reactions are given. Moreover, the performance in the reaction compensation of the cooperative system is compared to the non-cooperative one. The proposed logics are implemented on a multi-manipulator dynamic simulator, and a simulation campaign has been carried out in order to evaluate the performance of the proposed schemes and the conditions for their profitable utilization.