Modélisation, Identification et commande d'un robot parallèle

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Abstract

In contrast to the six degrees of freedom (dof) presented in the literature which involves six limbs, this work treats a 6-dof parallel robot with only three limbs. This thesis is formed by three parts:
In the first part the robot modeling problem is considered. Some particular proprieties related to the geometric and kinematic models are presented. We prove that the inverse kinematic problem has an analytical solution. However, to solve the direct kinematic problem, an efficient numerical procedure is proposed. The kinematic study is broaden by the determination of the robot's end effector reachable workspace, and where the internal geometric constraints are taking into account. Finally, using the lagrangian approach, the robot's dynamic model is achieved. In order to eliminate the lagrangian multipliers from the equation of motion, a minimal number of constraints equations, which are naturally independently, is obtained.
The second part deals with the identification problem of the standard and minimal dynamic parameters of the robot and frictions. Based on these results, a minimal and optimized dynamic model was established.
In a third part, we consider the problem of elaboration of a nonlinear feedback law for the parallel robot. The tracking control problem including the generally neglected electrical actuator dynamics is addressed. The proposed control law is armatures input voltages is investigated with the consideration of some inaccessible states such that velocities and torque variables but under the assumption of a well model knowledge. The formulated model in standard from allows the application of singular perturbation techniques. The validity of the control law is obtained using the passivity approach. Computer simulations show the efficiency of the two time-scale decomposition and the performance of the proposed controller-observer with a good trajectory tracking.

Keywords: Parallel robot, kinematics, dynamics, symbolic computation, minimal dynamic parameters, singular perturbation approach, passivity control, controller-observer design, sliding mode techniques.