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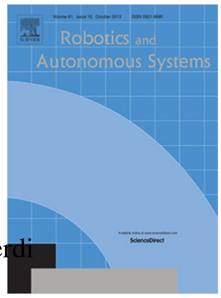

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Abstract

The closed-loop dynamic control of parallel mechanisms is a challenging field due to the high complexity of their dynamic behavior, especially those with prismatic actuators. Prismatic joints usually provide considerable amount of friction which could vary along its axis. This paper addresses the application of different control algorithms in order to tackle the challenges in closed-loop control of an overconstrained 3-DOF decoupled parallel mechanism which compromises three prismatic actuators with variable frictions along each axis. In addition, a Kinect vision sensor, as the position feedback, is installed. Since the Kinect RGB sensor performs at 30 frame per second, there is a 33 ms delay in the feedback of the control unit which restricts the control loop frequency to maximum value of 30 Hz. Then, based on the models obtained from the identifications of step response, kinetic friction and inverse dynamic model, various attempts have been made in order to obtain a controller with a reasonably performance. First, the conventional PID and sliding mode controllers are applied. Then, the position-velocity controller based on the obtained experience of the mechanism performance is proposed, in which a feedforward unit as the friction compensator is added to the latter feedback-based control units. Eventually, a feedback-feedforward controller based on PID controller and a compensator based on the identified inverse dynamic model is applied to the mechanism which was able to improve the performance of the control unit to a sufficient level.

Keywords: Dynamic Control, Inverse Dynamics, Overconstrained Parallel Mechanisms, PID Controller, Sliding Mode Controller, Feedforward Compensator, Vision Feedback

1. Introduction

From a theoretical standpoint, Parallel Mechanisms (PMs) are known to exhibit a better dynamic performance than the manipulators with a serial kinematic chain [1]. Consequently, they have stimulated the interests in to wider range of application, including, among others, machine tools, known as Parallel Kinematic Mechanisms (PKM) [2], and motion simulators [3]. Model-based control algorithms are necessary to take advantage of the possibilities offered by such structures [4, 5]. In contrast to the vast amount of literature propounded on the identification of serial robots, there are much fewer number of publications conducted on the experimental identification of the dynamics of fully parallel mechanisms [6–9]. The dynamic modeling of a multi-body mechanism consists in describing the relationship over time between external loads and required driving forces/torques at active joints. One category of the PMs is the overconstrained PM, which

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