Vibration Control of Cable-Driven Parallel Robot for 3D Printing

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Abstract

These last years, the additive manufacturing and 3D printing technologies have known some major breakthroughs. The motion of a printer head can be made with cable transmission. The deployment of the cable-driven parallel robots (CDPR) in the industry is studied in very various application fields for their low cost and large workspace. Furthermore, the use of cables for the transmission induces a reduction of the mobile parts' masses, compared to a rigid transmission, which enables to reach higher accelerations. Moreover, the structure of a CDPR is modular and reconfigurable thanks to the repositioning of the actuators' anchor points. However, the lack of rigidity of a CDPR raises issues of accuracy and the rise of vibrations, which can be generated by the trajectory of the mobile parts, the actuators, the friction between pullies and cables or disturbances.

Several dynamic models of cables have been studied to understand the vibrating behaviour of a CDPR: a simple elastic model of springs with positive tensions, a lumped mass-spring model and a finite elements model based on a continuous one for the cables dynamics. The numerical simulation of the dynamic behaviour of the CDPR with these models enables the analysis of an appropriate control system and the design of a controller. Its aims to ensure an accurate positioning and a decrease of vibrations.

In this contribution, we will firstly present the dynamic behaviour's model and the issue of the actuation's redundancy, systematically present on these robots to guarantee stiffness with the tension in the cables. Then, several strategies of command will be suggested, comparing the effect of the models on the conception and the performance of the controllers. Thus, we explain that significant decreases in the vibration levels may be observed with the use of PID controllers. The generalisation of the command, the use of active control technologies and an experimental validation will be the next steps of this study.

Key Words: CDPR, Dynamic modelling, Numerical simulation, Control

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