Flexure positioning stage based on delta technology for high precision and dynamic industrial machining applications

M. Bianchi[1], G. Rigamonti[2], S. Bottinelli[2], Y. Mabillard[2]

[1]Scuola universitaria professionale della Svizzera italiana, Switzerland

[2]Mecartex SA, Switzerland

mikael.bianchi@supsi.ch

Abstract

Due to the continuous miniaturization requirements of the products and emerging technologies for the micromachining, highly dynamic and precise positioning systems for micro machining devices are nowadays required in the market. An improvement in terms of precision and dynamics presupposes a new vision of the machining process. For this task a problem-solving strategy combined with the optimization of all components is required. The implementation of a new innovative solution is proposed in this paper, which improves considerably the performances and productivity of the moving stage based on flexures with parallel kinematics.

To enhance mechanical precision and high dynamics an optimized delta robot using flexure bearings is proposed. The complexity of stage's dynamical couplings and coordinate transformations are considered in the control concept, resulting in a controlled stage comparable with a simple cartesian motion system that can be commissioned in a simple way. A feedforward technique applied to the coupled system is also implemented in order to achieve highest dynamics on the position tracking. The optimal coupled control parameters for the single motors are determined automatically from control algorithm using the delta robot model. Parametric identification algorithms allow to estimate and validate the coupled model of the delta robot.

The connection with standard CNCs is also optimized using a synchronised industrial communication, where the information available about the reference trajectory is extracted from the CNC, in order to reconstruct the motion profile in an optimal way, without losing precision and dynamics.

The final system includes a position and current control loop that is able to calculate and achieve the reference current value within 50 microseconds, after measuring currents and position, delivering

high rigidity on the controlled system. Thanks to the combined dedicated mechatronic optimizations of the delta robot, the new controlled stage can follow independently the XYZ trajectories at highest dynamics reaching mechanical tracking precision about 500nm with accelerations up to 20m/s^2. For slower accelerations a tracking errors of less than +/-5 nm can be reached.

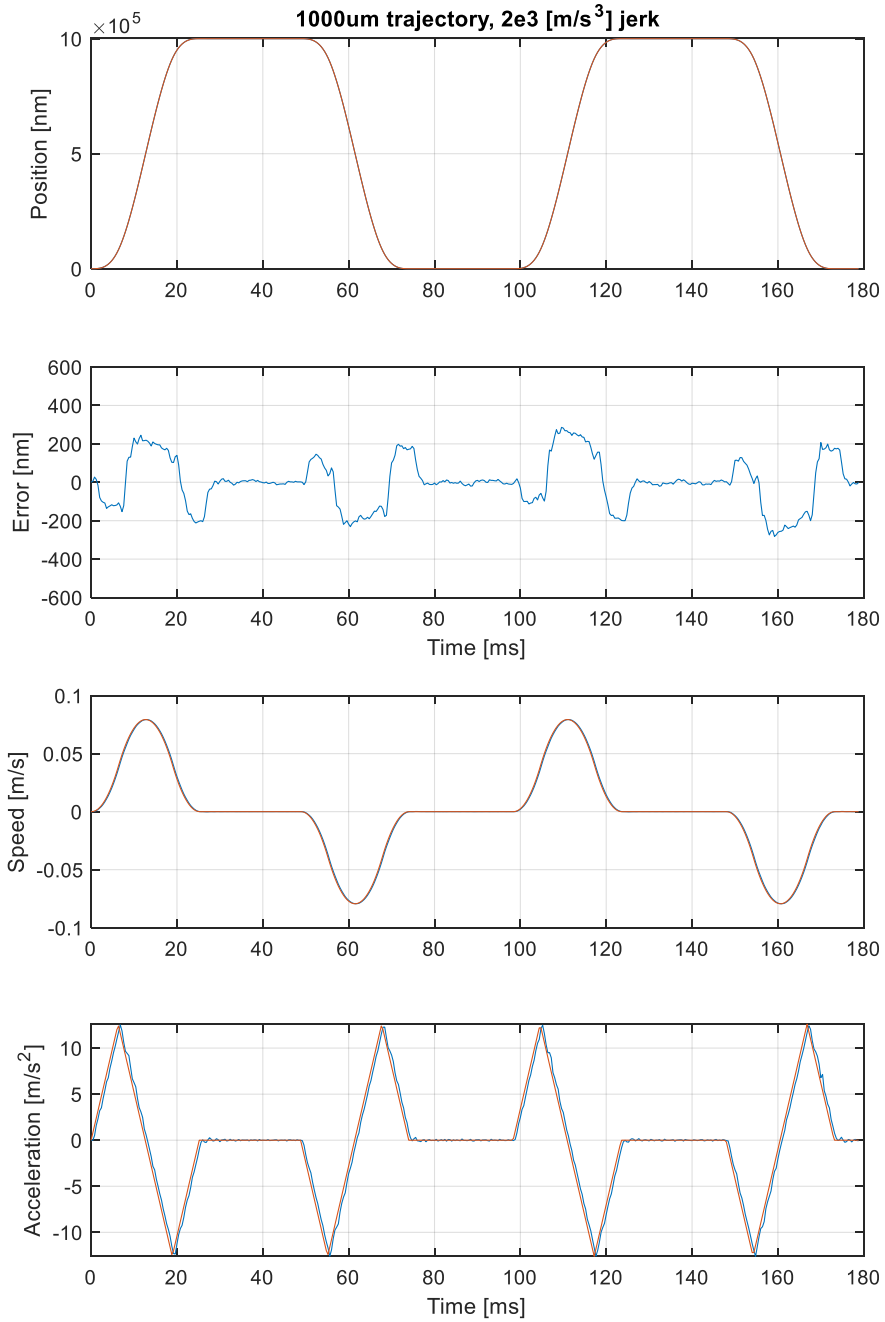

Figure 1: High dynamical trajectory tracking for one axis, 1 mm displacement within less than 30ms with a maximal tracking error of 300nm