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SYNCHRONIZATION CONTROLLER SYNTHESIS OF MULTI-AXIS MOTION SYSTEM

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Abstract. *This paper investigates motion synchronization of a multiple axes system. Three different control schemes: a cross-coupling controller in feedback loop, a linear quadratic optimal controller and an adaptive controller, were used to synthesize the synchronization compensator with the cross-coupling dynamics among the axes for both nominal and coefficient varying systems. With these strategies, the asymptotic convergence of both tracking and synchronization errors can be achieved. Simulation and experimental results of a three-axis motion system illustrate the effectiveness of the proposed approaches.*
Keywords: Multi-axis motion system, Synchronization control, LQ control, Adaptive control

1. **Introduction.** In industrial manufacturing systems, one often encounters situations in which motions in two or more axes need to be coordinated. In particular, with the increasing demand of manufacturing platforms with multiple robotic arms or conveyors, synchronization for multi-axis motion systems has drawn much more attention recently. For example, motion synchronization is a crucial part of precise motion control fields, such as plotters, robotic arms, numerical control machines and hydraulic lift systems. In such kinds of control applications, the system performances depend more on the coordination of multiple motion actuators than on individual motion actuators. The demands for improvements in system accuracy lead to the research activities in this area.

Early researches in motion synchronization found that the coordination performance can be improved by compensating for the differences in dynamics of individual actuators [1]. However, the controllers were synthesized independently without taking the coupling among different axes into consideration. It is recognized that poor synchronization of relevant axes results in diminished dimensional accuracy. Therefore, since the 1980s, various research groups have proposed different coordinating schemes and cross-coupled controllers for multiple axes to improve the synchronization performance. In 1980, Koren [2] first introduced a cross-coupled controller for dual-axis feed drive systems to improve the synchronization performance between two independent motion axes. Based on the coupling between two different axes, other approaches [3, 4, 5, 6] were also proposed to