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Systematic Servo Control Design for Dual-Stage Actuators in Hard Disk Drives

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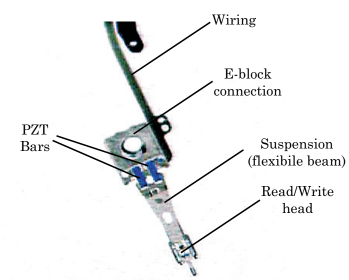
Introduction

The increase in aerial storage capacities of future magnetic hard disk drives have motivated the use of dual-stage actuators for high track density data recording. In hard disk drives, a dual-stage actuator combines the standard rotary actuation of the Voice Coil Motor (VCM) with an additional micro- or milli-actuation to accomplish high-bandwidth and highly accurate track following. Obviously, the resulting servo design problem becomes more challenging since both the VCM and the micro-actuator have to be controlled simultaneously.

The current research in servo design for track following with dual-stage actuators may be divided into classical approaches [1], that involves the shaping of open loop transfer functions, and modern control approaches [2,3], in which optimal control theory and optimization tools are used to compute feedback controllers. In this presentation, a systematic design procedure [4] is reviewed that is based on optimal control theory using H_∞-norm based control design. This approach can be used to construct a (multivariable) servo controller for any type of dual-stage actuator, where servo design specifications are formulated in terms of relatively simple weighting functions. Using this systematic approach, different possible servo control strategies are designed and compared on performance and energy consumption for a hard disk drive dual-stage actuator application.

Case Study

The presentation will include a case study, based on the Magnum 5e suspension, manufactured by by Hutchinson Technologies Inc. (HTI). This suspension is a piezo-electric milli-actuator on which two piezoelectric strips are mounted at the base of the suspension. The suspension is mounted on the E-block by means of a base plate and applying a voltage across the piezoelectric strips produces a displacement of the head relative to the E-block. For this case study, the systematic dual-stage servo controller design will be illustrated. Results based on this case study show that the systematic design approach yields a dual-stage servo controller that is able to perform high density track recording, with a significant increase in servo bandwidth and simultaneous reduction of the servo controller power consumption.



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