Numerical simulation of touchdown dynamics of
thermal-flying-height-control sliders
Jinglin Zheng and David B. Bogy
Computer Mechanics Laboratory
Department of Mechanical Engineering
University of California at Berkeley

Abstract
With the advent of thermal-flying-height-control (TFC) technology, the physical spacing in magnetic hard disk drives is now reduced to sub-1nm. At this limit, tribological flyability and reliability become critical issues for the performance of the read-write head. In this paper, a numerical approach is applied to study the touchdown dynamics of TFC sliders, by expanding a 3-degree-of-freedom slider dynamics model to a 250-degree-of-freedom head-gimbal assembly dynamics model and considering several significant tribological effects at this ultra-low clearance (adhesion, tribo-charge, friction, contact, etc.). The simulation results show that the slider’s vibration amplitude increases substantially at the beginning of touchdown, and it gets suppressed with further reduction in flying height. Analysis in the frequency domain shows the excitation of the second air bearing pitch mode when instability occurs. The expansion of the dynamic system to include a realistic model of the suspension is shown to be important in determining the frequency of the excited mode. Adhesion force is shown to play an essential role in exciting the second air bearing pitch mode and causing instability, while electrostatic force and friction force affect only the slider’s dynamics at instability. Friction force is also shown to be related to the excitation of the first air bearing mode.

Keywords: Thermal flying-height control, head-gimbal assembly, head-disk interface, interfacial forces