Yong, Y.K.; Mohemani, S.O.R., "Design of an Inertially Counterbalanced $Z$-Nanopositioner for High-Speed Atomic Force

Abstract: In many conventional atomic force microscopes (AFMs), one of the key hurdles to high-speed scanning in constant-force contact mode is the low-feedback control bandwidth of the $Z$-axis loop. This paper presents the design of a fast $Z$-nanopositioner to overcome this limitation. The $Z$-nanopositioner has its first resonant mode at 60 kHz and a travel range of 5 $\mu$m. It consists of a piezoelectric stack actuator and a diaphragm flexure. The flexure serves as a linear spring to preload the actuator and to prevent it from getting damaged during high-speed operations. The $Z$-nanopositioner is mounted to an XY-nanopositioner. To avoid exciting the resonance of the XY-nanopositioner, an inertial counterbalance configuration was incorporated in the design of the $Z$-nanopositioner. With this configuration, the resonances of the XY-nanopositioner were not triggered. A closed-loop vertical control bandwidth of 6.5 kHz is achieved. High-speed constant-force contact-mode images were recorded at a resolution of 200 $\times$ 200 pixels at 10, 100, and 200 Hz line rates without noticeable image artifacts due to insufficient control bandwidth and vibrations. Images were also recorded at 312- and 400-Hz line rates. These images do not show significant artifacts. These line rates are much higher than the closed-loop bandwidth of a conventional AFM in which this nanopositioner was tested.

URL: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6380626&isnumber=6475295
Fang, Y.; Zhang, Y.; Qi, N.; Dong, X., "AM-AFM System Analysis and Output Feedback Control Design with Sensor Saturation

Abstract: This paper analyzes the dynamics of an amplitude-modulation atomic force microscopy (AM-AFM) system, and designs a novel output feedback robust adaptive control (OFRAC) law to improve the scanning performance of the AM-AFM system. That is, a control-oriented reduced model is proposed to approximate the mapping from tip–sample separation to oscillation amplitude, whose accuracy is verified by experimental results. Considering the facts that the parameters of an AM-AFM system vary with different combinations of piezo-scanner and cantilever as well as detected samples, and measurement saturation occurs frequently in dynamic AFM systems, an OFRAC strategy for the piezo-scanner is designed to keep the oscillation amplitude of the cantilever staying at the desired setpoint under various complex situations. It is shown theoretically that the proposed control strategy pushes the system away from the saturation state in finite time, and it ensures uniform ultimate boundedness result for the control error. The OFRAC strategy is applied to a virtual AM-AFM system, and the collected results clearly demonstrate that it presents superior imaging performance for high-speed scanning tasks.

URL: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6419837&isnumber=6475295

Rana, M.S.; Pota, H.R.; Petersen, I.R., "High-Speed AFM Image Scanning Using Observer-Based MPC-Notch Control,"

Abstract: This paper presents the design and experimental implementation of an observer-based model predictive control scheme with a notch filter to achieve accurate tracking and fast scanning for an atomic force microscope (AFM). The proposed controller reduces the tracking error by improving the damping of the resonant modes of the AFM piezoelectric tube scanner (PTS). The design of this controller is based on an identified model of the PTS. A Kalman filter is used to obtain full-state information in the presence of position sensor noise. A comparison of the experimentally obtained scanned images using the proposed controller and the existing AFM PI controller is given. The experimental results demonstrate the efficacy of the proposed controller.

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From compression to compressed sensing
Shirin Jalali and Arian Maleki

Abstract—Can compression algorithms be employed for recovering signals from their underdetermined set of linear measurements? Addressing this question is the first step towards applying compression algorithms for compressed sensing (CS). In this paper, we consider a family of compression algorithms CR, parametrized by rate R, for a compact class of signals Q ⊂ R^n. The set of natural images and JPEG2000 at different rates are examples of Q and CR, respectively. We establish a connection between the rate-distortion performance of CR, and the number of linear measurement required for successful recovery in CS. We then propose compressible signal pursuit (CSP) algorithm and prove that, with high probability, it accurately and robustly recovers signals from an underdetermined set of linear measurements. We also explore the performance of CSP in the recovery of infinite dimensional signals. Exploring approximations or simplifications of CSP, which is computationally demanding, is left for the future research.