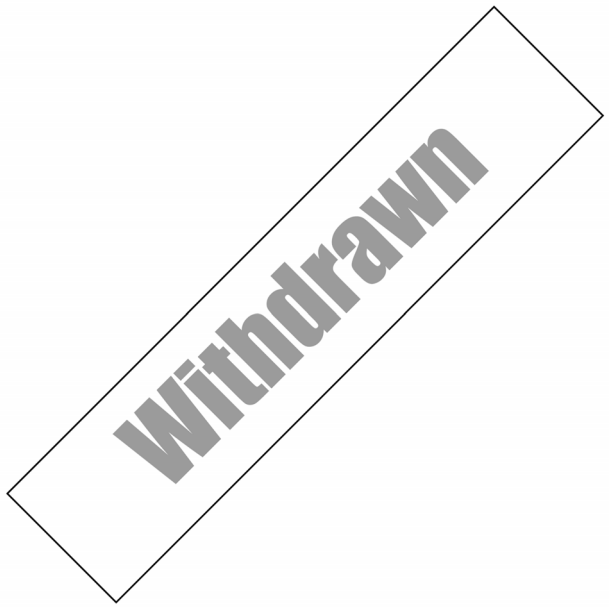
BD11



BP01

Disturbance Attenuation Using Adaptive Disturbance Observer in HDDs

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Sensorless disturbance observers (DO) [1] have been applied to hard disk drive (HDD) servo control for rejection of low frequency disturbances, like shock and rotary vibrations [2]. However, the drawbacks of the method include significant phase margin drop as well as increase of peak magnitude of sensitivity function. In Fig. 1, the block diagram within the red dashed lines is a typical DO. The plant $P(s)$ is subject to an external disturbance $d(t)$ and measurement noise $\xi(t)$. $P_n(z^{-1})$ represents the inverse of the plant model. $B_2(z)$ is usually a low-pass filter in traditional DO. To maintain system stability margin and not to amplify the disturbance at mid-frequency range, the bandwidth of the $B_2(z)$ should be kept as low as possible. But the performance of disturbance rejection is highly dependent on the bandwidth of $B_2(z)$, and $B_2(z)$ with lower bandwidth implies less disturbance rejection.

In this paper, a novel disturbance rejection control scheme (Fig. 1) based on DO is presented. The center frequency of the dominant disturbance within the bandwidth of the band-pass filter $B_1(z)$ is identified first through a fast online adaptive algorithm [3]. Unlike in traditional DO, here $B_2(z)$ is designed as an adaptive band-pass filter, whose center frequency is adjusted according to the estimated disturbance frequency $\bar{\omega}$. The bandwidth of $B_2(z)$ can be chosen according to real situation. The proposed design can greatly reduce the phase loss at open-loop crossover frequency as well as amplification of the mid-frequency noise. Moreover, as the bandwidth of $B_2(z)$ can be designed to be very narrow, the proposed scheme can be applied to reject external disturbance close to open-loop crossover frequency. The proposed method has been applied to a commercial HDD product, and the experimental results have confirmed the effectiveness.

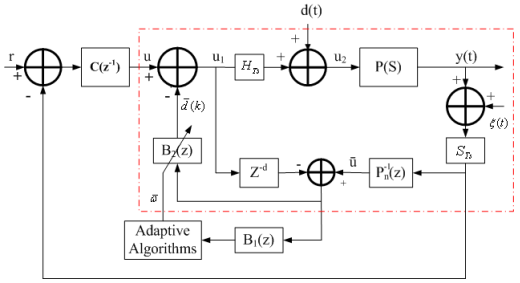

Fig. 1. The block diagram of the proposed scheme.

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[3] G. Hillerstrom, "Method for measuring the frequency of a sinusoidal signal," US Patent 6,598,005 (2003).