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ON FRACTIONAL ORDER DISTURBANCE OBSERVER

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ABSTRACT

In this paper, for the first time, the fractional order disturbance observer (FO-DOB) is proposed for vibration suppression applications such as hard disk drive servo control. It has been discovered in a recently published US patent application (US20010036026) that there is a tradeoff between the the phase margin loss and the strength of the low frequency vibration suppression. Given the required cutoff frequency of the low pass filter, also known as the Q-filter, it turns out that the relative degree of the Q-filter is the major tuning knob for this tradeoff. As a motivation for the fractional order Q-filter, a solution based on integer order Q-filter with a variable relative degree is introduced which is the key contribution of US20010036026. Then, a fractional order disturbance observer based on the fractional order Q-filter is proposed. The implementation issue is also discussed. The nice point of this paper is that the traditional DOB is extended to fractional order DOB with the advantage that the FO-DOB design is now no longer conservative or aggressive, i.e., given the cutoff frequency and the desired phase margin, we can uniquely determine the fractional order of the low pass filter.

Key words: Disturbance observer, fractional order calculus, variable relative degree, Q-filter, vibrational suppression, rational approximation, frequency domain fitting.

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