Angular disturbances compensation by differential deconvolution in nanoforce sensing using diamagnetic levitation

Research framework

Nanoforce sensors using passive magnetic springs associated to a macroscopic seismic mass (several milligrammes) are known to be a possible alternative to force sensors based on elastic microstructures if the nanoforces that have to be measured are characterized by a bandwidth limited to a few Hertz. Despite their high performances, such force sensors are extremely sensitive to low frequency environmental mechanical disturbances, like the small angular variations of the anti-vibration table supporting the device. These variations induce a very low frequency drift in the force estimation (done by deconvolution) over long period of time (several minutes) that need to be compensated.

Proposed approach

A passive compensation strategy of the very low frequency angular disturbances using a differential deconvolution is proposed. This approach does not necessitate to add a very high resolution and low frequency inclinometer in the measurement chain. It is based on two nanoforce sensors using diamagnetic levitation (developed in the last decade). the first one is used classically for force measurement, while the second one estimates the angular disturbance in order to reject it in the first one. To be effective, the rejection scheme must consider the masses ratio of the two force-displacement transducers. This ratio can be easily determined using a precision balance. In term of performances, the standard deviation of the force estimation remains below the nanonewton level after compensation over periods of time of several minutes when external temperature remains constant.

Major article: M. Billot, E. Piat, J. Abadie, J. Agnus, P. Stempflé, External mechanical disturbances compensation with a passive differential measurement principle in nanoforce sensing using diamagnetic levitation, Sensors and Actuators: A Physical, to be published in 2016.

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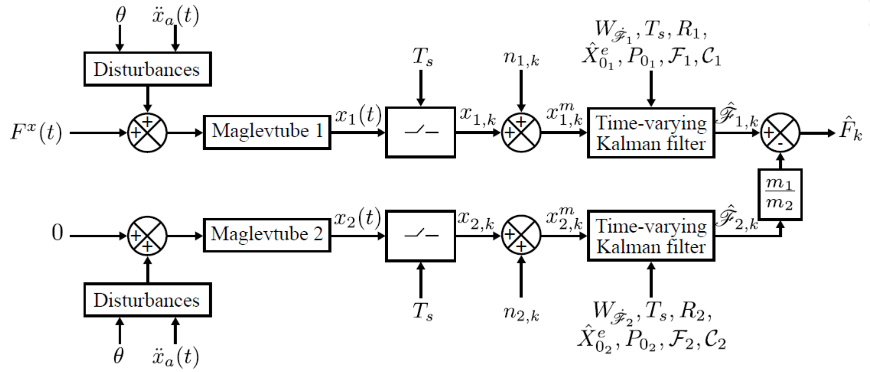
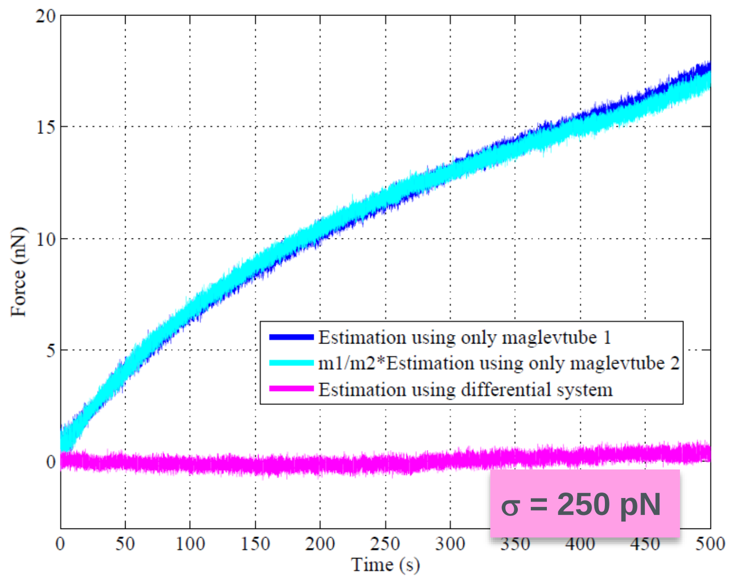


Differential deconvolution principle using two nanoforce transducers with masses m_1 and m_2



Force estimation (using and not using differential principle) versus time with θ influence for an external force F(t) = 0.

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