MULTI-SCALE DEEP LEARNING MODEL FOR UNCERTAINTY QUANTIFICATION AT THE MICROSCALE

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Abstract

Smart, bio-inspired devices can be characterized by a hierarchy of length- and time-scales, and by different physical phenomena affecting their properties. Data-driven formulations can then result helpful to deal with the complexity of the multi-physics governing their response to the external stimuli. Referring to a single-axis Lorentz force micro-magnetometer adopted for navigation purposes, if an alternating current with an ad-hoc set frequency is let to flow longitudinally in a slender beam, the system is driven into resonance and the sensitivity to the magnetic field to be sensed may get enhanced. In former activities, a reduced-order physical model was developed for the movable parts of the device, to feed a multi-physics and multi-objective topology optimization procedure. This model-based approach did not account for stochastic effects, which are responsible of the scattering in the experimental data at this micrometric length-scale. A recently proposed formulation is here discussed to allow for such stochastic effects through a multi-scale deep learning model featuring: at the material scale, a deep neural network adopted to learn the scattering in the mechanical properties of polysilicon induced by its morphology; at the device scale, a further deep neural network adopted to learn the most important geometric features of the movable parts that affect the overall performance of the magnetometer. Some preliminary results are discussed, along with a proposal to frame the approach as a kind of multi-fidelity, uncertainty quantification procedure.

Presentation time

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