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A Bayesian method for large-scale virtual calibrations of MEMS sensors

The EU Digital Decade Policy Programme 2030 strongly depends on safe and reliable cutting-edge technologies, like Micro-Electro-Mechanical Systems (MEMS) sensors, that are widely used in large sensor networks for infrastructural, environmental, healthcare, safety, automotive, energy and industrial monitoring. The massive production of these sensors, often in the order of millions per week, requires costly and time-consuming calibration processes, resulting in a lack of metrological traceability and a poor assurance of their performances. Hence, it is fundamental that a systematic metrology framework for a trustworthy calibration of digital sensing technologies on a large scale is developed and implemented.

A recently proposed solution for large-scale virtual calibrations of MEMS sensors relies on a Bayesian method allowing to statistically calibrate large batches of sensors with a considerable saving in time and costs. Prior knowledge derives from the experimental (in-the-lab) calibration of a 'benchmark'batch, representative of the whole production process. Then, the approach involves the experimental calibration of only a small sample of sensors drawn from an unknown large batch. Combining prior and updated information, the number of reliable sensors in the entire batch is inferred, an appropriate uncertainty value is assigned to all sensors, and the overall reliability of the batch is assessed in terms of appropriate (probabilistic) metrics. The approach was validated on a batch of 100 digital MEMS accelerometers calibrated at INRiM. Strategies based on hierarchical modelling are now under development to balance the effort required in the virtual calibration and the desired level of batch reliability and uncertainty.

Special/ Invited session

Classification

Both methodology and application

Keywords

Bayesian inference, sensor calibration, measurement uncertainty

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Track Classification: Reliability and Safety