EURAMET session at the IMEKO TC6 M4Dconf 2022 September 19, 15h30-17h15 CEST

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Metrology for sensor networks

Sensor networks (*i.e.*, complex architectures that integrate multiple layers, sensors and systems) are becoming an integrated element in diverse applications in areas encompassed by Legal metrology (*e.g.*, energy, water, gas and heat consumption), Industrial Metrology (*e.g.*, low-cost Internet of Things for Industry 4.0), and fundamental metrology (*e.g.*, multi-sensor secondary standards).

The associated R&D initiatives call for a convergence of existing techniques and approaches in disciplines regarding the information and communication technology (ICT) and data science, but also as to metrological regulatory aspects, in order to address the industrial and societal needs for such sensor networks. The underlying metrological challenges will be considered, including potential methods to accommodate these new sensor networks within the so-called *systems of systems approach* (SOS), to provide new features such as anomaly detection, condition monitoring, state estimation/prediction and automatic determination of measurement data quality.

Metrology for machine learning

Machine learning (ML) is a powerful tool for digital transformation which leverages the availability of large volumes of data to extend capability beyond known models and to enable automation. Ensuring the trustworthiness of ML is crucial to its wide acceptance, and one important aspect of trustworthy ML is uncertainty evaluation. Several challenges in this area will be discussed and illustrated with examples from X-Ray diffraction imaging and land use classification.

Metrology for advanced and sustainable manufacturing

Metrology already supports advanced manufacturing processes through the provision of information for efficient use of resources and for the determination of the optimal product quality, in both R&D laboratories and the production stream. Yet certain manufacturing processes, such as finishing of mirror surfaces for lithography in semiconductor manufacturing, are still limited by the accuracy of the available characterisation techniques. The large amount of measurement data and the complex algorithms for process control require digital processing of the information. Examples from the industrial community will be brought-in, illustrating how the digital integration of metrology is progressively becoming standard practice in modern factories, as the sector is striving to meet the increasing demand for manufacturing sustainability.

Quantum digital technologies

The integrated physical and digital world requires metrology to test and evaluate its digital and data technologies, while these technologies also provide measurement data. NMIs have a role to play in validating technologies used to collect, transmit/store and interpret data, and in developing robust methods for validating and analysing vast amounts of data. *Quantum* is likely to enhance all digital technologies; examples of 'quantum' digital technologies include advanced sensing and imaging, enhanced communications, timing, and quantum data processing. Some of the metrology challenges and progress in quantum will be discussed