EMPIR Call 2017 – Industry, Fundamental, Normative and Research Potential

Selected Research Topic number: **SRT-i16**
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Title: Metrology for the Factory of the Future

Abstract

To remain competitive, European industrial production and assembly lines have to be transformed following the concept of the "Factory of the Future" – a manufacturing environment of inter-connected devices and with an autonomous flow of information leading to automated decisions. This requires reliable and formally described information about the manufacturing processes, derived from trustworthy measurement data at every stage of data analysis. However, currently there is no corresponding metrological infrastructure to support these developments, and therefore a measurement and data analysis infrastructure addressing validated calibration methods, industrial testing and quality assessment is needed to support the digitisation of European industry and the "Factory of the Future".

Keywords

Factory of the future (FoF), sensor networks, digitisation, digital sensor, sensor calibration, dynamic measurement, infrastructure, large data analysis, data quality, trustworthiness, uncertainty, machine learning

Background to the Metrological Challenges

European industry is set to increase by 60 % in terms of productivity growth and an estimated €110 billion in annual revenue due to the digitisation of products and services in Europe in the next five years. However, despite this trend manufacturing productivity is currently down across Europe as it has been outpaced by wages. Therefore along with a growing need to fabricate ever more complex products manufacturers such as those in the automotive and aerospace industries are increasingly seeking ways to take advantage of interconnected, digital sensors and integrated modern data analysis tools.

What is key for the supply chain in most manufacturing industries, and which in turn affects their productivity, efficiency and integrity is that measurements and calibrations are traceable and reliable, i.e. measurements that are not traceable back to a common standard are not reliable, and suppliers cannot guarantee that their product meets the manufacturer's specification. Many measurement systems in factory of the future environments provide only digital output of pre-processed data and calibration information is typically sparse. However reliable information is needed to evaluate data quality. This can be addressed by developing a calibration framework for distributed networks of sensors with the ability to extrapolate measurement uncertainty derived from individually calibrated sensors to other individual sensors of the same type in a dynamic measurement environment. Thus there is a need to develop methods for the calibration of networks of industrial sensors and for the aggregation of data, as well as to establish common standards and guidelines and to agree a reference metrological infrastructure.

In particular, for the development of a metrological infrastructure for the "Factory of the Future", reliable decision-making based on sensor network data in the context of the economic constraints and sustainability requirements are needed. Therefore, recent advances in the analysis of big data sets, time series analysis, system and control theory and recently developed metrology for dynamic measurements should be combined with new approaches for the characterisation of sensors with digital pre-processed output.

Owing to the volatility of data and information in "Factory of the Future" environments, data analysis has to be carried out in real-time or close to real-time. However, the machine learning methods employed to do this, using statistical methods or artificial neural networks, currently lack any associated methodologies for assessment of the reliability and quality of such methods in a metrologically acceptable way. Therefore, such data analysis methods are required, and should also reduce uncertainty and increase trust in data through the corroboration of other measureands in "Factory of the Future" sensor networks.

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Finally, in order to effectively implement new metrological infrastructures for “Factory of the Future” sensor networks and improve existing infrastructures the practicality of any new approaches will require testing in factory like environments so that the new techniques can be demonstrated in action and to allow trouble-shooting and validation prior to commissioning.

Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The JRP shall focus on the development of metrological capacity for industrial sensor networks needed for the factory of the future/the digitisation of European industry.

The specific objectives are

1. To develop reliable and validated calibration methods for distributed networks of industrial sensors with digital pre-processed outputs and internal signal processing. This should include the measurement capabilities of the sensors’ for evaluating data quality, methods for extrapolating the measurement uncertainty from individually calibrated sensors to other individual sensors of the same type, and dynamic parameters and effects.
2. To develop a metrological infrastructure for the aggregation of data from industrial sensor networks. Such an infrastructure should address the synchronisation of measurements, make use of redundancies of measurements of ambient conditions, balance the potential of multiple low-cost sensors versus the performance and reliability of one expensive sensor, and explore methods to identify the measurement coverage and accuracy required for process output quality targets.
3. To develop real-time or close to real-time machine learning methods for industrial sensor networks including methods for assessing their quality, reliability and accuracy.
4. To apply the methods of objectives 1-3 in an industrial test environment, demonstrate their effectiveness and conclude recommendations for improving existing infrastructures for industrial sensor networks.
5. To facilitate the take up of the technology and measurement infrastructure developed in the project by the stakeholders, especially the manufacturing industry.

Proposers shall give priority to work that meets documented industrial needs and include measures to support transfer into industry by cooperation and by standardisation. An active involvement of industrial stakeholders is expected in order to align the project with their needs – both through project steering boards and participation in the research activities.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this. In particular, proposers should outline the achievements of the EMRP projects NEW04, IND09 and ENG63 and EMPIR project 14SIP08 and how their proposal will build on those.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 1.5 M€, and has defined an upper limit of 1.8 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution to the project.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded partners.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the “end user” community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Feed into the development of urgent documentary standards through appropriate standards bodies,

- Transfer knowledge to the manufacturing sector.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects (JRPs)”

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of up to 3 years duration.