Plenary Talk
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Measurement and Sensor Technology in the Digital Transformation Process

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Summary:

The use of digital technologies can also lead to an increase in productivity and functionality for measurement and sensor technology. The prerequisite is that sensors are made "smart" and become components of the "Internet of Things" in an IoT ecosystem. Then optimizations are possible in many ways.

Keywords: Internet of Things, IoT Ecosystem, Calibration, Soft Sensors, Information security

Industry 4.0 is the use of digital technologies, including especially the Internet technologies, in industrial automation. This transformation is expected to lead to enormous gains in productivity and flexibility. Measurement and sensor technology are an essential component of automation and is therefore doomed to participate in this transformation. Because of this late entry, however, it can rely on already existing, mature technologies and infrastructures, such as powerful hardware controllers, networks and cloud architectures from the IT and consumer world.

Smart sensors in an IoT Ecosystem

In order to be able to use and benefit from the methods of digitization, a number of important prerequisites must be met: the essential elements of a technical system, the sensors, but also the actuators must become "smart" [1]. They must have connectivity and communication capabilities to be part of the Internet of Things (IoT). And they must be capable of self-diagnosis and - as a goal - also be capable of their own maintenance, such as self-validation or even self-calibration. Then, an adapted architecture of the control system and a platform for the execution of the methods, the IoT ecosystem, is needed. For new technical systems to be created, this ecosystem can include the control system. However, the majority of today's implementations are based on the existing architecture of the automation pyramid and connect the IoT ecosystem via a separate communication channel at the field level.

Diagnostics and predictive maintenance

Digitization offers the potential to move from preventive maintenance to predictive maintenance, thus reducing maintenance costs and increasing the technical health of the system too. There are two different approaches. On the one hand, statistical methods, with which maintenance events can be predicted from a large amount of other information, and on the other hand - in knowledge of the underlying physical and chemical interrelationships - the recording of suitable indicators for maintenance requirements using sensors. In [2] the requirements for these sensors for condition monitoring and predictive maintenance for use in chemical process plants are described.

Calibration

To maintain its metrological quality, a sensor needs regular calibration, where its measured value must be traceable to a reliable reference and thus ultimately to the SI. In many cases, today, this requires the sensor to be removed from the system, which is costly and disadvantageous for operation. This traditional requirement is opposed to the necessary sharp increase in the use and application of measuring and sensor systems in automated and partially autonomous production. Desirable here would be sensors that either ideally no longer need to be calibrated I or having very long calibration intervals that are in line with the maintenance cycles of the respective technical system. One approach to the solution is sensor-internal verification. This involves subjecting all or most of the components relevant to the metrological

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quality of a sensor to ongoing internal sensor verification based on the available sensor internal and also external information, including the use of redundant information of the system under consideration., This therefore allows to reduce the probability of erroneous measurements combined with a reduction of the calibration effort. Of course, it would be ideal if a reference directly traceable to the SI were part of a sensor and calibration could be performed anywhere and anytime without external intervention. Such developments are already underway in some large metrology laboratories. There are interesting developments such as the NIST on a Chip [3] The NIST-on-a-Chip project [3] appears to be particularly advanced with micro-technologically realized traceable quantum-based reference standards built into the sensor [3].

Soft Sensors

Soft sensors are measuring systems where difficult to measure variables are determined from a number of more easily to measure variables (measurands). Either because the measurand cannot be measured directly, the measurement location is not accessible or a value to be measured in the future is required. The relationship of the measured quantities to the target quantity is either known, i.e. model-driven, or must be learned, i.e. data-driven. The latter is more appropriate, because it allows the mapping of complex dependencies with many input variables that are no longer easy to model [4]. However, there are also combinations of both methods in place. For the data-driven methods, the technique of machine learning comes into play. Machine learning has been booming in recent years. However, the necessary completeness and quality of training data is still a challenge. IoT Ecosystems are ideal platforms for implementing such Soft Sensors.

Information security for measurement and sensor technology

Smart sensors in IoT ecosystems are more vulnerable to cyberattacks than in isolated, proprietary systems because of their principle greater openness. Sensor data can be manipulated or unauthorized "overheard"; communication connections can be interrupted. Here too, measurement and sensor technology can build on the experience already acquired in information technology. A large arsenal of procedures and techniques is available for the information security of technical systems [5].

References

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