Tech Now

SENSORS CONNECT THE ANALOG AND DIGITAL WORLDS

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The success of Industrie 4.0 depends on reliable, local data collection using sensor technology. A new guideline, a demonstrator and practical tips from VDMA members help in the development of low-cost sensor technology.

By Nikolaus Fecht

For Prof. Dr. Jürgen Fleischer, Director of the wbk Institute for Production Technology in Karlsruhe, the use of sensor technology in the context of Industrie 4.0 is primarily a matter of price. He is interested in sensors whose low cost allows them to be used across the board. “A reduction in costs here has a big impact on the feasibility of many applications.”

Requirements start out vague

Before Industrie 4.0 solutions can be implemented, it is important to re-examine the way we think about sensor solutions and to take an unbiased view in evaluating which sensor systems a company could use, says Fleischer. “For Industrie 4.0 in particular, the benefits and requirements of the applications are often very vague to begin with,” emphasizes the scientist. “Testing different sensors early on is helpful for developing a better understanding of one’s own application.”

The wbk uses intelligent feed axes - which have a nut for ball screws with a new kind of sensor technology for adaptive lubrication - as an example to demonstrate innovative sensor applications. Connection via OPC UA makes communicating with sensors, actuators and higher-level systems significantly easier.

Guideline provides orientation

The guideline “Sensors for Industrie 4.0” offers support for getting acquainted with sensor use. To compile it, the wbk developed, in cooperation with VDMA and a range of sensor users and manufacturers, guiding questions and supportive tool kits. These support companies on their journey towards sensor application. “The guiding questions provide a systematic approach, while the associated tool kits deliver clear support in how to answer them,” explains Fleischer.

But the hardware alone is not enough: As applications become more complex, the importance of services for sensor technology is growing. Looking to the future, “targeted support for users, be it in programming, data interpretation or diagnosis, will become an important sales argument,” says Fleischer.

Early detection of errors using sensors

The guideline has already been used by the spinning system and texturing machine manufacturer Oerlikon Textile GmbH & Co. KG from Remscheid. Certain processes in their production plants involve treating artificial fibers with a series of spinning rollers. In one of the manufacturer’s large plants, multiple modules (positions) in a single machine work with many rollers, known as godets, in a draw panel. The failure of a godet would bring the module to a standstill. The manufacturer was therefore looking for additional sensor technology that could detect damage to godets timely, so that secondary damage could be prevented.

“Our plan was to use the data from the extensive sensor technology we already had in a more targeted way for the end customer,” reports Ulrich Friedrichkeit, who works in the R&D department Electrical and Software. “Using the demonstrator, we also investigated whether vibration measurement on the draw panels

could be used to develop a measuring system that warns the end customer about outages or heavy damage to godets," explains Friedrichkeit. In addition, Oerlikon wanted to find out whether a low-cost solution could be developed for series production. The wbk supported Oerlikon in operating the demonstrator and collecting and analyzing the data. A multi-sensor system, among others, was used to measure data from the acceleration sensors used in the test.

"The trial with the demonstrator and a multi-sensor system served as a pilot system for evaluating whether the sensor type can be used for a sensor solution," says Friedrichkeit. "We also used the guideline for this, which proved very useful." The structured approach in the guideline helped Oerlikon to define the specific requirements and pave the way for further step-by-step implementation. The first test run showed that the sensor type and the method of data editing did not meet all the requirements. "We might now work with a manufacturer to tackle the development of a sensor suitable for our needs on a larger scale," predicts Friedrichkeit.

Evaluation: Multi-sensor systems help

Arguments for working with the guideline and demonstrator include the structured approach and the fast accumulation of experience with sensor systems. One of the ways this was achieved in the demonstrator was through the use of a multi-sensor system that provides a large number of sensors in order to develop, test and evaluate new measuring technology solutions. A system with an acceleration sensor, gyroscope, magnetometer, position sensor, ambient sensors for humidity, temperature and pressure, a microphone and a light sensor were used in this case.

Guaranteeing precision at all times

Sensor technology plays a key role for Homag AG, a manufacturer of plants and machinery for wood processing based in Schopfloch. "We use sensors at all the key points in our systems when we want to find out about the status of the machine or system," explains Herbert Graf, Senior Manager Software Controls at the company. "We already benefit from sensors integrated into devices. The resolver or absolute encoder of a motor also positions the generator, for example." If these do not deliver enough precision, a further sensor should take on the precise positioning. After all, in today's environment, Homag needs to constantly improve and optimize the precision and availability of its machines and systems. Sensor technology also enables controller to be expanded to control loops, thus improving systems. "We receive information about changes to the system and can use the sensor values to detect whether and how the machine has changed and whether that will be a problem, or everything is still OK," describes Graf.

Many binary sensors are used in the Homag machines and systems. "They typically report 'damped' or 'not damped', for example. If the sensors have an interface, the diagnosis can be improved," says Graf. "On an open sensor, it would be possible to see whether it is still connected and working." An interface is also useful for exchanging information, so that staff do not have to adjust the sensor's measurement range by teaching. "We have already implemented this function in places. Unfortunately, only the intelligent sensor itself costs around the same as the simple version at the moment. The costs come from the interface with the programmable logic controller," explains Graf. There is no economical alternative in sight, he complains, so that the expense often overrides the benefits - putting the brakes on the implementation of Industrie 4.0.

Wide spectrum of sensors in use

Homag uses a huge range of sensor applications. "We measure, observe, check, compare and count along the horizontal connection, for example," reports Graf. "Our machines have a life span of up to 25 years." The spectrum of workpieces used by customers is very wide and Homag does not know how trends will develop over the next few years, he continues. As a result, the counting contacts have to be very robust, especially for machines with a batch size of one. In addition, the systems often have to analyze multiple sensors in parallel. "We like to use inductive sensors and mechanical switches, known as roller levers, for end limitation. The material analyzed does not change here," explains Graf. Where capacitive sensors are used, however, the analysis may alter when the humidity or surface layer of the workpiece changes. Optical sensors require more setting work, depending on the surface.

So what do sensor technology manufacturers recommend? "In the future, the key will be to analyze the sensor information intelligently," says Dr. Thomas Meißner, Project Manager in Corporate Innovation Management at Balluff GmbH in Neuhausen auf den Fildern. "However, the potential user needs to deal with various issues before establishing the kind of sensor technology network required for this."

Wireless communication via fieldbus

Meißner sees the type of data transmission as a key trend at the moment, with wireless data transmission gaining ground as an alternative to wired communication via fieldbus systems, which are often easier to implement with less technical effort. “But this requires ultra low power sensor technology, as detectors that consume a lot of electricity are not suitable for wireless communication.”

Standardizing interfaces

Another key requirement is the standardization of interfaces. Balluff uses the open communication standard IO-Link for its wired connection and is involved in the further development of a new wireless standard which, it is hoped, will be compatible with the company’s wired communication standard, so that it can be integrated into the existing IO-Link structure. The plan is to create a robust technology that is not disrupted by other wireless connections such as Wi-Fi, because it blocks out occupied frequency bands. In addition, the defined short reaction times mean that the technology is ideal for communication within automated production plants, where commands are often transmitted within fractions of a second.

According to Meißner, for wireless data traffic in general, it is important to pay attention to possible wireless interference - such as from smartphones or other sensors transmitting in the same network - from the start. “Under the tough conditions of production, the use of very reliable and failsafe sensors is vital.”

Better classification of data

Connecting sensor data also plays a crucial role, continues Meißner. The key is not only to forward data to higher-level systems, but for multiple sensors to work together. “Sensor-data fusion centers around the integration of data from different sensors,” explains Meißner. “They then act in a similar way to people, who rely on more than just a single sense.” Sensor-data fusion can mean data collection from identical or different sensors in order to enhance the detection performance or data classification, for example by combining optical and acoustic input.

As part of Industrie 4.0, smart sensors that use integrated intelligence to evaluate and assess data in advance are gaining ground. A special Balluff sensor, for example, can recognize a dirty diode itself and can send a signal: “Clean me!”

Checks using light barriers

Balluff has already implemented a solution like this for an automotive manufacturer, where sensors working incorrectly due to dirty diodes had caused production to halt. The customer now uses a sensor that checks whether light signals can be reliably detected at the right intensity using the principle of a light barrier. If not, they need to be cleaned or replaced.

Sensor technology plays a special role in interlinked production systems. “In an integrated production environment, it is not enough for a single machine to be able to interpret and use the relevant signals for itself,” emphasizes Ralf Pfisterer, Sales Manager at Bosch Connected Devices and Solutions GmbH, Reutlingen. “Instead, existing data needs to be provided to other participants in the value chain.” With sensor technology being introduced into more and more components, however, a huge quantity of information and data is already available in new machines. The size and connection option (interface) play a central role here, making the machinery easier to use.

Avoiding machine shutdowns

The requirement of making as much as possible predictable and plannable is driving the use of sensor technology in every conceivable machine element and component, says Pfisterer. Wherever possible, all signs of attrition should be detected and monitored from the very beginning, in order to prevent possible machine shutdown or to plan accordingly. But manufacturers do not only use new machines that already contain sensors.

Sensor technology needs to be able to bring existing machines up to a similar level. “The data only represents real added value if it can be gathered throughout the entire value chain. That is why sensor technology is so important,” explains Pfisterer. According to him, that is what is behind the growth in sensors that gather measured values that affect the workpiece or machine and have a significant impact on the result. In addition, sensor technology is coming ever closer to the heart of the action. “Given the small size, it is now possible to take measurements ever closer to the process itself and thus to intervene even earlier,” says Pfisterer. “We can record the acceleration and temperature distribution inside a roller, for example, which could damage the end product if the temperature is too high.”

Distributing intelligence

Another trend relates to “distributed intelligence.” This means that sensors should not only detect and record data, but interpret it, too. “When a threshold value is reached, for example, only the notification of this would be transmitted to the controller or gateway, and not the entire data set. This is of interest for measuring acceleration,” explains Pfisterer. In order to achieve this, sensors need to be able to make calculations on site and be configured via software.

Adaptable sensor technology adapts

Adaptable systems are also in demand. The wide range of applications demands sensors that can be adapted to the application concerned. “How the data is interpreted and further processed is crucial. The user has the option of using the exact sensors that perfectly fit his application and delivering useful results,” assesses Pfisterer.

VDMA Guideline

Members can order the VDMA Guideline “Sensors for Industrie 4.0 - Options for cost-efficient sensor systems” from the VDMA Forum Industrie 4.0 or download it as a PDF. ■

Further Information

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Contact

Dr. Christian Mosch, VDMA Industrie 4.0 Forum, E-Mail: christian.mosch@vdma.org

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