Continuous fitness check predicts potential machine faults

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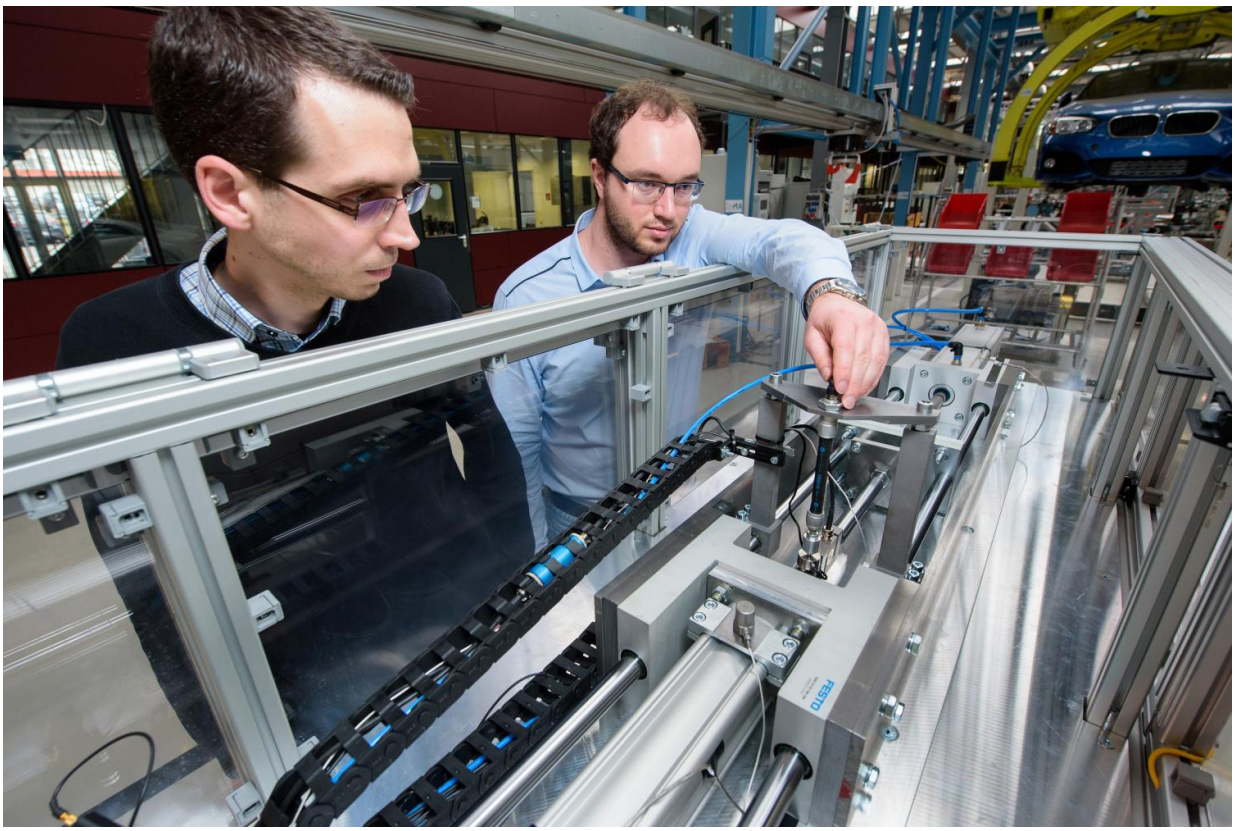

It keeps a constant eye on the condition of the machine, it carries out diagnostic analyses and it notifies the operator when a part needs to be replaced. The research team led by Andreas Schuetze at Saarland University has developed an early warning system for industrial assembly, handling and packaging processes. Nikolai Helwig (left) and Tizian Schneider, research assistants in the group, are pictured testing the smart condition monitoring system on an electromechanical cylinder. The research team will be exhibiting their technology at the Saarland Research and Innovation Stand (Hall 2, Stand B46) at Hannover Messe, which

runs from April 24th to April 28th. Credit: Oliver Dietze

It keeps a constant eye on the condition of the machine, it carries out diagnostic analyses and it notifies the operator when a part needs to be replaced. The research team led by Andreas Schütze at Saarland University has developed an early warning system for industrial assembly, handling and packaging processes. Intelligent sensors continuously collect a wide array of measurement data from inside plant machinery and compare the signal patterns against those for normal operating conditions. If the system detects a difference in the patterns that indicates a potential fault, it immediately notifies the equipment operator about what remedial measures should be taken. This helps engineers to plan maintenance more effectively and protects them from unpleasant surprises and unexpected production losses.

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Robots in production lines work tirelessly and with micrometre precision—unless of course a component fails. If, for example, the linear actuator used to precisely position a car body in front of an assembly robot is damaged, the robotic arm will no longer be able to position the car door as exactly as it normally does. The result is a door that is misaligned. Or, to take another example, the sudden failure of a machine component due to material fatigue could well result in the complete shutdown of a production line. A team of engineers led by Andreas Schütze, an expert in sensor systems from Saarland University and the Center for Mechatronics and Automation Technology, is working with a group of academic and industrial partners to prevent this sort of situation from arising.

Their system subjects machines to what is effectively a continuous medical check-up. The human equivalent would be equipping a person with an activity tracker, a continuous digital ECG and blood pressure monitor so that their state of health could be analysed at any time. 'Our system makes it possible to continuously visualize the current condition of plant machinery and provide advance warning of potential damage. To do this we fit sensors inside the machines and these sensors are able to interact with each other and with existing process sensors. This enables us to register even the smallest of changes,' explains Andreas Schütze. The researchers make use of the phenomenon that technical equipment will begin to make a different noise, or will vibrate or overheat long before it actually fails. The trick here is that the characteristic manner in which a machine hums or vibrates during normal operation is different to that observed when something has changed within the machine, though these differences can be very subtle and undetectable to normal senses.

This is where the system developed by the Saarbrücken mechatronics specialists comes into play. The sensors are able to detect these slight changes and can assign them automatically to specific fault profiles. 'We have studied how signal patterns, such as the frequency of vibrations, alter during common damage or fault states,' explains Professor Schütze. To do this the research team examined the patterns in thousands of measurement data sets and identified those associated with particular types of damage or mechanical wear. 'We feed this information to the sensors, transforming them into smart devices that are able to detect these signal differences on their own,' explains Nikolai Helwig from Schütze's team. This essentially eliminates the need for an external analyser, as the system is able to perform the analysis itself.

The goal of the research team is to develop a set of sensors and modules that will allow companies that operate plant machinery to put together a fitness check specifically tailored to the needs of their plant or

equipment. 'The customized sensors can either be integrated into the machinery when it is being made or can be retrofitted. Initially the sensors spend their time collecting baseline data, that is data that reflects the normal operating state of the machine,' says Helwig. Once that has been done, the system is ready to continuously compare the current operational data with those typical sensor signal patterns associated with incipient equipment failure or damage. 'Our method also opens up opportunities for other Industry 4.0 applications. For example, the system can also be used for quality control purposes by analysing whether production machinery was operating properly during a manufacturing process.

The system under development is currently entering its test phase during which the experts in sensor and measuring technology will be working with the companies Bosch Rexroth and Festo. The sensors will be used at Bosch-Rexroth to monitor the condition of machine tools, while at Festo their job will be to check the linear actuators mentioned above, specifically Festo's spindle axes and electromechanical cylinders.

Provided by Saarland University

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