Engineers develop networked self-analyzing electric motors

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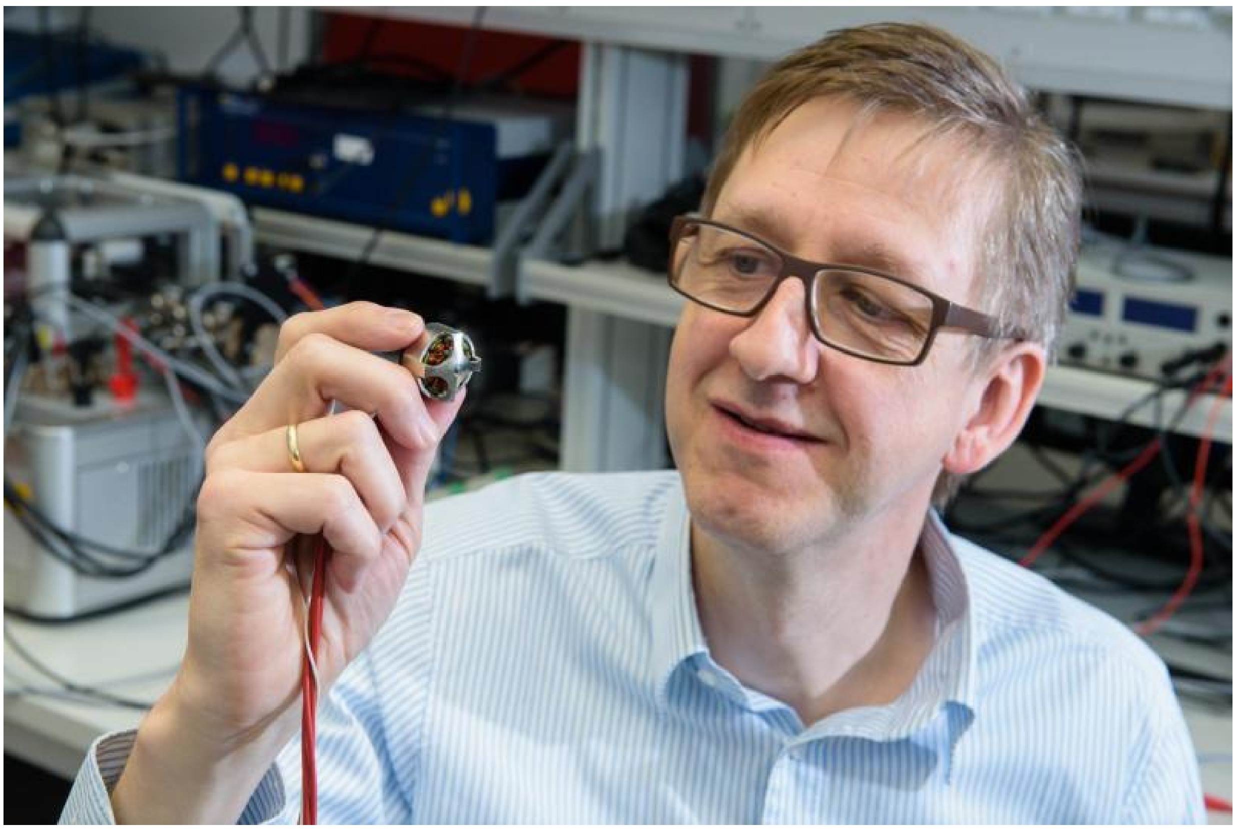

By transforming the motor itself into a sensor, the team led by Professor Matthias Nienhaus are creating smart motors. Credit: Oliver Dietze

A team of engineers from Saarland University are developing intelligent motor systems that function without the need for additional sensors. By essentially transforming the motor itself into a sensor, the team led by Professor Matthias Nienhaus are creating smart motors that can tell whether they are still running smoothly, can communicate and interact with other motors and can be efficiently controlled.

Simply using data collected from the motor while it is operating, the researchers are able to calculate quantities that in other systems would need to be measured by additional sensors. And they are teaching the drive how to make use of this knowledge. They are currently working with project partners to study and test a number of different procedural methods. The ultimate goal is to make manufacturing processes more cost-effective and flexible and to enable machinery and equipment to be continuously monitored for faults or signs of wear.

The project will be on show at HANNOVER MESSE from April 25th to April 29th, where the team will be exhibiting at the Saarland Research and Innovation Stand in Hall 2, Stand B46.

Sensors are all around us in today's world. Cars, for example, contain dozens of these tiny artificial sentient devices that warn us when, for instance, something gets too close to the vehicle, when the coolant gets too hot or when there is too little fuel in the tank. But these small sensitive detectors can sometimes fail and stop working, with the result that the vehicle is left standing at the side of the road. And what can happen to a car can also happen to other machines or pieces of plant equipment: a faulty sensor can lead to production downtimes and financial losses.

The drive systems specialist Professor Matthias Nienhaus from Saarland University is working on developing a new kind of self-monitoring motor - one that doesn't need sensors. 'We're developing an important new type of sensor: the motor itself,' says Nienhaus. The advantage of this new approach is that the engineers simply collect data that is available from the normal operation of the motor. 'That makes our approach very cost-effective as there's no need to install any additional sensors. We're looking at elegant ways of extracting data from the motor and of using this data for motor control and for monitoring and managing processes. We are also working with project partners on improving the design and construction of miniature motors so that they yield the greatest possible quantity of operational information,' explains Nienhaus. His own particular specialist area of research concerns electromagnetic miniature and microdrive systems with power ratings ranging from a tenth of a watt to several hundred watts.

Just like a doctor uses blood test data to draw conclusions about the health patient, Nienhaus and his team use motor data to determine the health of a drive system. 'We examine how our measured data correlates with specific motor states and how specific measured quantities change when the motor is not operating as it should,' says Nienhaus. Gathering data from the motor while it is operating normally is particularly valuable for the research team; the more motor data they have, the more efficiently they can control the motor. The engineers analyse the huge amount of motor data in order to identify those signal patterns that can be used to infer something about the current status of the motor or to flag up changes arising from a malfunction or from wear. The team is developing mathematical models that simulate the various motor states, fault levels and degrees of wear.

The results are fed into a microcontroller, the brain of the system in which the data are processed. If a certain signal changes, the controller can identify the underlying fault or error and respond accordingly. These 'sentient' motors can be linked together via a network operating system to form an integrated complex that open up numerous opportunities in the fields of maintenance, quality assurance and production. It is also conceivable that a system could be designed in which one motor automatically takes over if one of the other motors fails.

In order to gather data from the motor, Nienhaus and his team carefully monitor the precise distribution of the magnetic field strength in the motor. An electromagnetic field is generated when electric current flows through the coils located within the outer ring of rotating permanent magnets. The researchers record how this magnetic field changes when the motor rotates. This data can then be used to compute the position of the rotor and to draw other inferences about the status of the motor, which allows the motor to be controlled efficiently and error states to be detected reliably.

Nienhaus is currently testing a number of different methodologies to determine those best suited to acquiring data from the motor. This work is being carried out as part of the project 'Modular sensor systems for real-time process control and smart state monitoring' (MoSeS-Pro: see below for more information), whose members include companies such as Bosch, Festo, Sensitec, Pollmeier, CANWAY and Lenord, Bauer & Co. The research team is looking to identify which motor speed range generates the best data and which type of motor is best suited for this type of application. The MoSe-Pro project is being funded by the Federal Ministry of Education and Research (BMBF).

Provided by Saarland University