SMART INDUSTRIES

WiPeR

Wireless, Pervasive & Reliable Monitoring of Industrial Internet of Things Systems

In many industrial settings, sensors in combination with data processing are used to continuously monitor equipment and processes. Called condition-based monitoring (CBM), the sensors provide real-time data to determine the actual status of an asset. This allows for increased automation, enhanced product quality oversight, prevention of unplanned downtime, improved security, and optimization of maintenance costs.

However, installing and maintaining the network and power cabling for CBM can cost up to half of an installation. A wireless solution for CBM would therefore have many advantages. Primarily, it would reduce the installation time and costs, and allow for a better flexibility and scalability. Additionally, as it eliminates the need for cumbersome and vulnerable wiring, wireless CBM could prove especially suitable for monitoring assets in remote, hazardous, or challenging environments.

However, the operation of sensors without network and power cables poses significant challenges in terms of computation and energy management. Overcoming these challenges is crucial to achieving the expected data quality and operational reliability that is required by the industry.

FRAMING THE RESEARCH OBJECTIVE

The WiPeR project was set up to develop an innovative solution for wireless CBM, a solution that eliminates sensor cables without compromising data quality or reliability.

The three main challenges to overcome were:

- **Energy management:** the energy available through energy harvesting is limited and constantly changing, and the backup battery must survive stand-alone operation for up to 15 years to avoid costly on-site maintenance.
- **Data quality:** low-power wireless networks cannot transmit all the data that are collected by a sensor. The required signal processing involves intensive computation and thus much energy.
- **Resilience:** the wireless network conditions inside a machine are harsh due to magnetic interference, packet reflections, vibrations and extreme temperatures.

THREE MAIN OUTCOMES

The WiPeR project has resulted in a number of prototype cable-free IoT sensor solutions for use in machinery of the industrial partners: bogie monitoring at Televic Rail, smelter monitoring at Umicore, and buncher monitoring at Bekaert. The prototypes are meant as a demonstrator for a wireless sensor to be used to monitor the behavior and operational conditions of industrial systems (e.g., machines, robots, pipelines) and their internal parts (e.g., wheels, spindles or motors).

The demonstrators feature an intelligent hardware and software platform for energy management that can guarantee a long functional lifespan for the sensors. When applied on rotating equipment (e.g., the buncher demonstrator at Bekaert), the WiPeR

solution runs solely on harvested inductive energy generated by the rotating buncher. In this case, there is no need for a battery, which eliminates any battery lifetime limitation. When using a battery and without energy harvesting, the WiPeR demonstrator was validated to collect, process and transfer vibration data for at least 10 years.

All signal processing that is computationally demanding has been optimized to weigh as little as possible on the available energy and transmission bandwidth. This solution will reduce the necessary network bandwidth and tailor it to the varying data quality needs of the CBM application. The demonstrator was shown to guarantee 2kb/s communication using a maximum of 200uW.

The hardware/software combination has been modeled for reliable fault prediction, providing assurance for its robustness. It has been designed to reliably operate in harsh operational environments (e.g., vibrations and shocks, magnetic fields, heat, moisture and dust). It is also remotely reconfigurable, as would be required by realistic working conditions. As proof of its robust operation, the WiPeR demonstrator was validated for operation inside a buncher machine at Bekaert and inside a smelter at Umicore.

The demonstrator sensors were dimensioned to work inside the demo locations. The dimensions of the WiPeR demonstrator for the buncher at Bekaert were approximately 5x5x6cm, small enough to fit inside the buncher. The dimensions of the WiPeR demonstrator for train bogie and track monitoring with Televic Rail were 6x4x3.5cm. Although these demonstrators were suited for their purpose, a more general-purpose wireless sensor would have to be scaled down to 3x3x3cm.

NEXT STEPS

The design and validation of the core research results was refined and driven by the three business cases (at Televic Rail, Bekaert and Umicore). There are no plans for a collective valorization, but the three industrial partners have gained the insights and expertise necessary to further pursue the prototype towards real applications sensors.

MM-WAVES project partners:

The WiPeR project was co-funded by imec, with project support from Agentschap Innoveren & Ondernemen.

FACTS

NAME	**WIPER**
OBJECTIVE	The WiPeR project was set up to develop an innovative solution for condition-based monitoring that eliminates sensor cables without compromising data quality or reliability.
TECHNOLOGIES USED	Low-power electronics, low-power signal processing, low power signal transmission
TYPE	imec.icon project
DURATION	01/10/2020 - 31/12/2022
PROJECT LEAD	Steven Lauwereins, Televic Rail
RESEARCH LEAD	Danny Hughes, KUL – Distrinet
BUDGET	1,926,448.62 euro
PROJECT PARTNERS	Televic Rail, Bekaert, VersaSense, Umicore Hoboken
RESEARCH PARTNERS	KUL – DistriNet
RESEARCH GROUPS	imec – Solutions

WHAT IS AN

IMEC.ICON PROJECT?

The imec.icon research program equals demand-driven, cooperative research. The driving force behind imec.icon projects are multidisciplinary teams of imec researchers, industry partners and/or social-profit organizations. Together, they lay the foundation of digital solutions which find their way into the product portfolios of the participating partners.

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