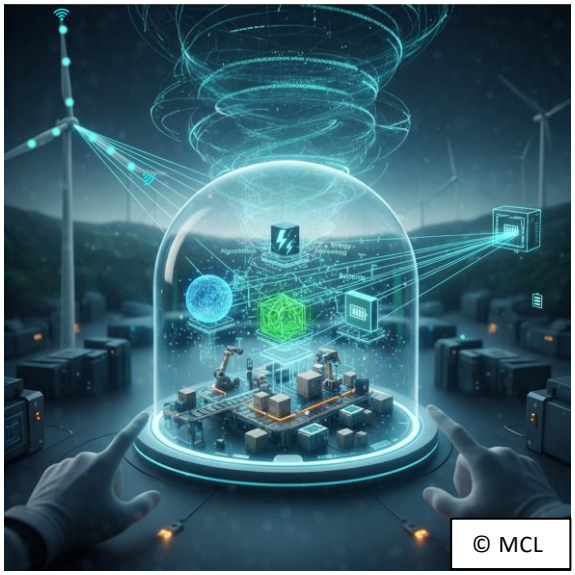
SUCCESS STORY

IC-MPPE
Integrated Computational Materials Process and Product Engineering.

IC-MPPE Project Hybrid20, 2022 – 2026, strateg.

Programme: FFG AI for Green

Project: BladeWatch, 2023-2025, single-firm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USING ARTIFICIAL INTELLIGENCE IN SENSOR NODES – ALSO FOR SMALL BUSINESSES

AUTOMATED ASSESSMENT OF THE FEASIBILITY AND ENERGY CONSUMPTION OF AI ON MICROCONTROLLERS ENABLES AN EFFICIENT DESIGN PROCESS, EVEN FOR SMALL COMPANIES

Artificial intelligence (AI) is revolutionizing our daily lives, yet it is still primarily executed in data centers. Gradually, execution is shifting to personal end devices such as smartphones or televisions, offering major advantages in terms of response time, energy consumption, and security. The next step will be the routine use of AI on wireless sensor nodes (WSNs), which monitor our technical infrastructure, such as wind turbines or bridges.

In condition monitoring, intelligent algorithms detect deviations from the normal state long before they become externally visible. The central challenge is minimizing the energy consumption of the sensor nodes so that they can operate for long periods, even in inaccessible locations. However, machine learning algorithms are mainly developed on and for powerful computers. Estimating the execution time and energy consumption of a single algorithm on a microcontroller is usually a time-consuming task.

Developers of condition monitoring systems must test many different algorithm variants on various computing platforms. As a result, smaller companies in particular are often deterred by the technical effort and risk, and such products remain primarily the domain of large companies with substantial development budgets. This situation disadvantages Austria's SME-driven economy, as well as emerging technologies that do not yet have established markets.

Bundesministerium Innovation, Mobilität und Infrastruktur
Bundesministerium Wirtschaft, Energie und Tourismus

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The Solution

Materials Center Leoben Forschung GmbH has created a fully automated development environment that automatically translates AI models in a standardized format (ONNX) into optimized programs for selected microcontrollers, or tests whether such translation can be carried out successfully. If successful, the algorithm is automatically executed on a test system and its energy consumption is measured.

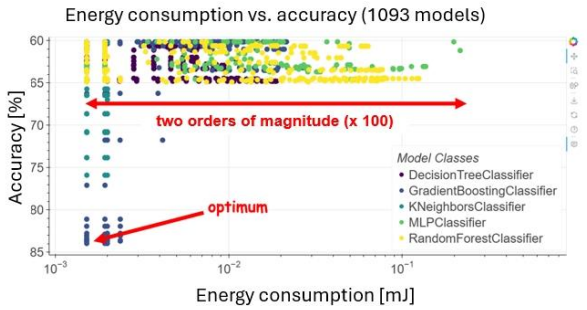
MCL's solution is based on three fundamental components: an intelligent translator (compiler) that autonomously optimizes AI models for microcontrollers; automatic evaluation of all possible partitions of the algorithm between sensor nodes and base stations; and finally, the determination of the actual power consumption of different algorithms on an energy measurement system without manual intervention. This makes it possible to efficiently compare and evaluate hundreds of AI algorithms, including many variants. Technically, the solution uses modern compiler technology (MLIR) and supports common development tools and boards.

A particularly innovative aspect: the system can break algorithms down into individual parts and intelligently distribute them between sensor nodes and base stations, similar to a logistics system that distributes packages across different trucks to minimize transport costs.

Impacts and Effects

The solution makes the evaluation of AI on very small processors economically feasible. The ecological impact is considerable: intelligent sensor nodes enable predictive maintenance of industrial systems and infrastructure. Faults are detected before they lead to failures, resources are conserved, and the service life of systems is extended.

Developers of condition monitoring systems can thus actively maintain and expand their position in a global market with expected growth rates of 10%.



Energy consumption vs. accuracy: The evaluation of over 1,000 AI models for a specific platform shows that their energy consumption varies by two orders of magnitude. The most efficient variants for this application can be found in the lower-left part of the diagram. ©MCL

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