Popular science summary of the PhD thesis

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Title of the PhD thesis	From Models to Microcontrollers: Tools, Techniques, and Deployment Frameworks
PhD school/Department	Department of Applied Mathematics and Computer Science

Science summary

Today, many everyday devices, from household appliances to industrial machines, are becoming smarter by using artificial intelligence (AI). But while powerful AI models usually run on large computers or in the cloud, many useful applications require them to run directly on small, low-power chips inside machines and sensors. This field is known as Tiny Machine Learning (TinyML). Running AI locally can make systems faster, more energy-efficient, more secure, and better suited for places with poor internet connectivity. Despite all advantages, it is technically challenging, because these tiny devices have very limited memory and computing power.

This PhD thesis investigates how AI models can be made efficient enough to run on such small embedded devices, and how engineers can choose the right tools and techniques when deploying them in real industrial systems. The work combines practical experiments, software development, and technology analysis.

First, the thesis studies the detection of cavitation, a damaging phenomenon in water pumps, using vibration data and machine learning. The results show that, in some cases, simpler and smaller models can perform just as well as deep learning, especially when carefully engineered and tested directly on real hardware.

Second, the thesis introduces EdgeMark, a modular framework that automates the process of converting, deploying, and benchmarking AI models across different TinyML platforms. This helps researchers and companies compare tools fairly and understand real-world performance trade-offs.

Finally, the thesis surveys how modern TinyML toolchains use techniques such as quantization to reduce model size and energy usage, and it summarizes their strengths and limitations.

Together, these contributions provide practical guidance for engineers and researchers working with AI on small devices, and they help pave the way for more reliable, efficient, and widely adopted embedded intelligence in future industrial and everyday technologies.

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