Neuromorphic Computing: When Technology Understands our Heart

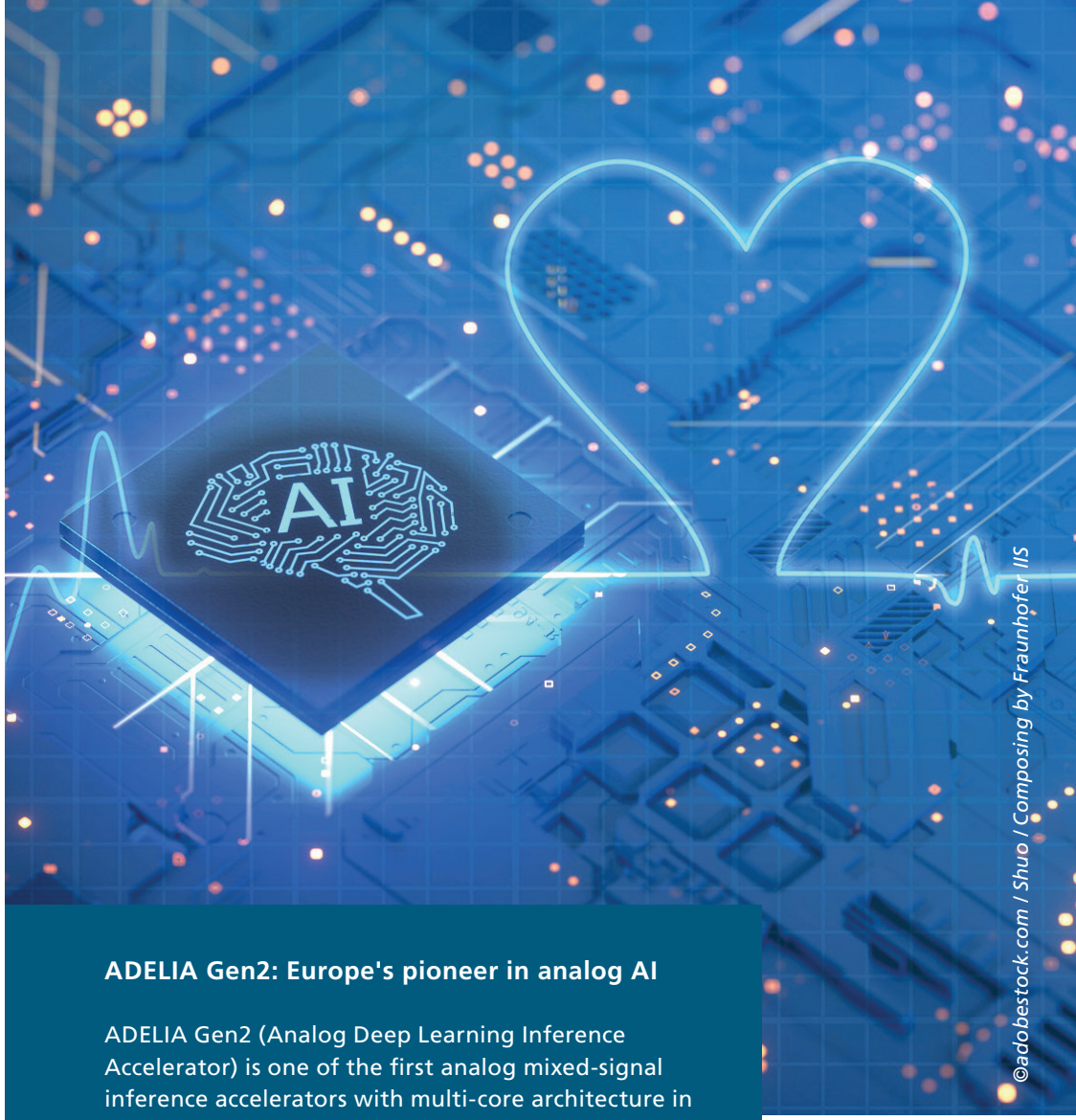
The combination of artificial intelligence and innovative hardware promises solutions that go far beyond conventional approaches. One exciting example of this is the use of neuromorphic computing for the energy-efficient analysis of electrocardiogram (ECG) data, which can provide valuable information about the general health of the heart in real time. This technology can be integrated into tight-fitting functional clothing or chest straps already established for pulse monitoring in sports to bring fitness and physical as well as mental health monitoring to the next level.

The heart is the motor of our lives – an organ that works in time with the sinus node, which emits electrical impulses and controls the contraction of the heart muscle. It is precisely this electrical activity that an ECG measures and that makes it possible to monitor the condition of the heart by electrodes. However, analyzing this data requires computing power that is limited, e.g. in wearable applications.

This is where neuromorphic computing comes into play: Inspired by the human brain, an artificial neural network running on highly efficient accelerators is trained to recognize various heart conditions. With the help of this specially developed neural network, the technology recognizes heart problems such as atrial fibrillation or other arrhythmias with unprecedented efficiency – even in real time.

Difference to conventional solutions

The technology is based on an electrical ECG sensor that requires direct skin contact and can be integrated into chest straps or textile wearables, for example.
This approach differs fundamentally from smartwatches, which measure the pulse optically and are usually based on long-term analyses to calculate a general risk of atrial fibrillation. The neuromorphic system, on the other hand, works with pinpoint accuracy and in real time: even during physical exertion, such as during sports, it can detect atrial fibrillation with high accuracy so that those affected can be informed immediately of potential cardiac arrhythmia to act in adequate time. In telemedicine, patients in rural areas could transmit their health data directly to medical professionals, leading to rapid diagnosis and treatment.



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Neuromorphic computing as the interface between technology, data, and human health.

ADELIA Gen2: Europe's pioneer in analog AI

ADELIA Gen2 (Analog Deep Learning Inference Accelerator) is one of the first analog mixed-signal inference accelerators with multi-core architecture in Europe. The ASIC was developed by Fraunhofer EMFT and Fraunhofer IIS as part of the ECSEL JU project ANDANTE, which incorporates a total of ten partners and has a funding volume of 40.58 million euros.

ADELIA: Analog meets digital for improved AI performance

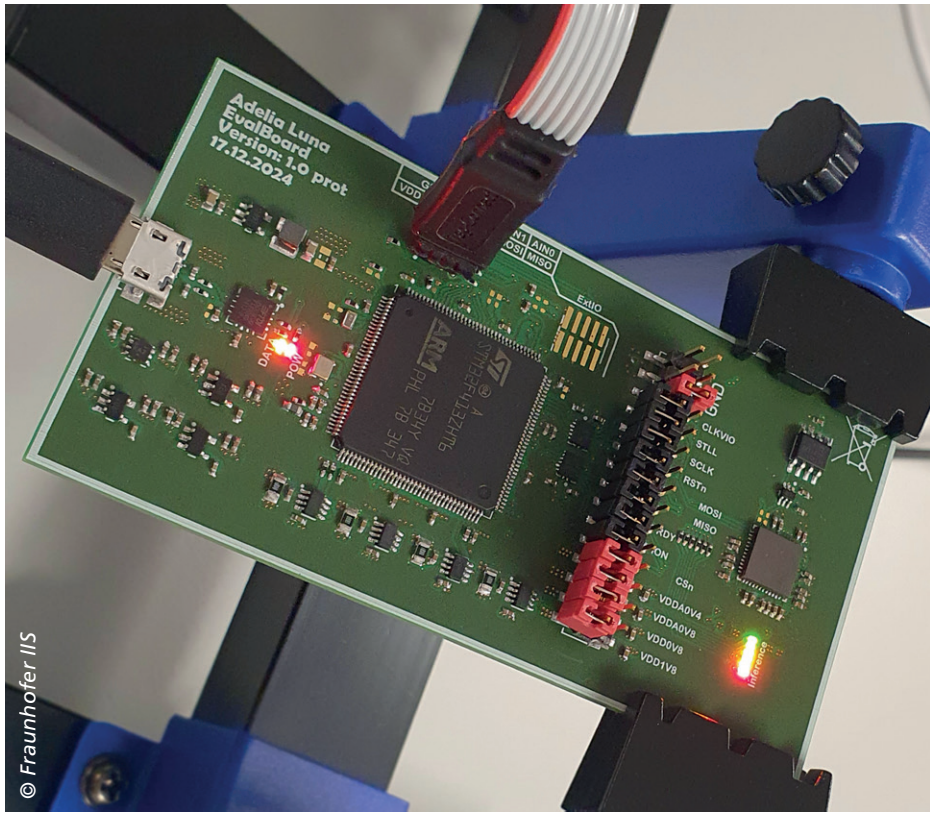
The core of the solution is ADELIA, the »Analog Deep Learning Inference Accelerator«. This scalable analog AI accelerator enables the extremely energy-efficient calculation of deep neural networks. Data processing takes place directly on the chip – an approach that not only saves energy, but also increases data security, as sensitive raw data does not even have to leave the sensor node. The use of analog computing improves performance by a factor of 10 compared to purely digital accelerators. The first applications already show the potential of ADELIA. In voice activity recognition, the chip with a power consumption of less than 200 µW achieved an accuracy that is in no way inferior to that of a fully digital solution – but with a fraction of the energy consumption. The researchers have already won an award for the evaluation of ECG signals using a digital AI accelerator in medicine.

Flexible eval kit for the practical test

An evaluation kit is available for the proof of concept, which can be used to demonstrate the performance of the technology, using Fraunhofer's sensor interface technology maphera®. It enables, for example, a free selection from many available ECG sensors, which can be connected to the microcontroller unit via Bluetooth. Here, the AI model takes over the analysis of the digitized sensor data and recognizes heart rhythms with impressive latency and power consumption. Additional neural networks can be seamlessly executed on the accelerator using an existing software ecosystem.

Pioneering for diagnostics and everyday life

ADELIA redefines precision, speed and energy efficiency. The intelligent combination of neuromorphic computing and modern sensor technology has the potential to fundamentally transform the healthcare market. Life-saving diagnoses could become directly available in everyday life – exactly where they are most urgently needed.



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ADELIA evaluation kit

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