

Forschungsfabrik Mikroelektronik Deutschland

**Fraunhofer Group for Microelectronics in Cooperation with Leibniz
Institutes FBH and IHP**



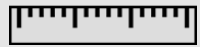
Challenges and Trends in Neuromorphic Hardware

Why Neuromorphic Hardware?



- Power

- Dedicated ASICs accelerate inference of DNNs in comparison to CPU/GPUs by factors of 29 to 200
- Cause: “von Neumann-bottleneck” of traditional computer architectures



- Form factor

- Some applications demand very small form factors or e.g. bendable/printed electronics
- 3D-integration and integration into sensor design are a means to reduce form factor and power



- Latency

- High data-throughput from sensors (high resolution, high rates) needs to be managed locally
- Industrial and automotive applications require latency of around and below 1 ms

Use case 1: Hearing Aids



Smart
Health

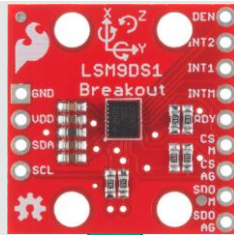


- Audio source separation requires complex signal processing and AI to isolate one talker from background noise in different scenarios
- Form factor and power consumption are major challenge incl. wireless communication
- Fraunhofer FMD has 250+ engineers working on audio technology in Erlangen, Germany
- Home of mp3, AAC and mobile audio codec development
- Technology built into 10+ billion devices

Use Case 2: Ultra-low-power Sensor Node



Smart
Industry



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- Example: **Anomaly detection** for a motor for predictive maintenance
- Measure vibrations and check, whether they are “normal”
- When strange vibrations occur, notify maintenance
- Communication by e.g. Fraunhofer MIOTY™ Technology
- Transmission of raw data exceeds power budget by far
- → AI-based signal processing has to be inside the node

Use case 3: AI Processing in Wearables



Smart
Health



- Example: **Detection of Atrial Fibrillation in ECG signals**
- Integrated into Fraunhofer FitnessSHIRT
- Ultra-low power AI-based processing of ECG signals due to limited batteries
- On-line analysis to inform the consumer immediately and without delay about any potentially dangerous condition

FMD Expertise and Impact

- European consortium for Next Generation Computing is addressing the challenges on the algorithmic, design and technology side, e.g.
 - analog cross-bar designs using memristors and in memory computing,
 - mixed analog-digital spiking neural network architectures for ultra-low-power
 - FeFET, OxRAM, RRAM
- FMD areas of expertise
 - Signal processing, codecs and AI, e.g. 10+ billion devices equipped with FMD technology
 - Software and hardware IP design, e.g. millions of radio receivers are equipped with FMD technology
 - Semiconductor technology and (3D-)integration, e.g. 10+ million wafer moves per year in FMD facilities
- FMD and CEA-Leti are building a strong European supply and value chain for Next Generation Computing

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