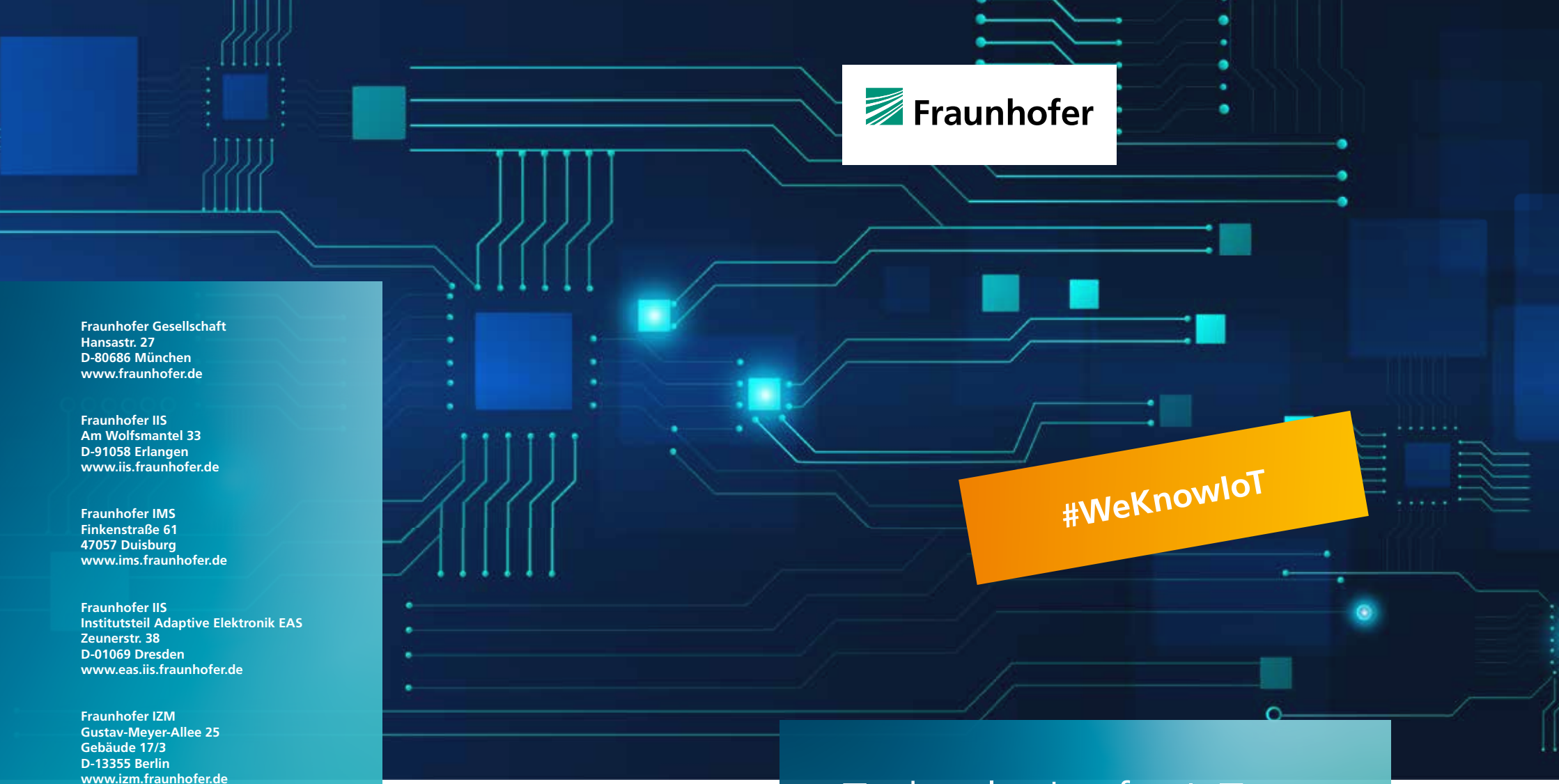

Fraunhofer

#WeKnowIoT

Technologies for IoT

smart.efficient.application-oriented.

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Contactless Vital Parameter Monitoring

Measurement of the respiratory rate is important in particular for the detection and monitoring of respiratory diseases. Thereby, our contactless method enables comfortable long-term monitoring for patients and increase hygiene significantly. Automated measurement of respiratory rate (and other vital signs) at entrances to clinics, practices and nursing homes helps to isolate potentially infected persons at an early stage, or can be applied for evaluating a driver's state and level of attention.

The contactless respiration rate measurement is based on the movement of the chest and only requires an RGB-camera. Image processing and machine learning techniques are used to track feature points on the torso and analyze the frequency spectrum of the chest movement.

Fraunhofer IMS develops methods for contactless measurement of vital parameters such as heart rate, heart rate variability, respiratory volumes, oxygen saturation and blood pressure. Most vital parameter measurements are based on intensity changes of the skin caused by blood volume changes in hypodermic tissue, and can be measured in the visible light as well as in the NIR spectrum for applications in the dark.

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Photo: Adobe Stock

Customizable Gesture Recognition for Embedded Systems

Intuitive methods are increasingly preferred instead of using computer keyboards or touchscreens to control machines or computers in real-life situations. Applications can be as simple as a remote control or as complex as augmented reality scenarios.

Fraunhofer IMS presents a customizable AI based gesture recognition that exploits the motions of e. g. your head, hand or foot. It can be trained directly in the local embedded system without any cloud connection. Choose natural gestures that suit to your application, teach your gestures and connect your application to each of the trained gestures. You are free to use any 2-D or 3-D gestures.

This way, applications can be controlled intuitively with gestures that the user personally prefers.

The number of gestures depends only on the available resources of the microcontroller. The gesture extraction algorithm was developed using the Fraunhofer software AI framework "AIfES" which supports highly efficient implementation of neural networks on embedded systems. The recognition of a gesture needs about 20-100 ms on the used hardware.

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Photo: Fraunhofer IMS

AI Hardware Acceleration for AIRISC Processor

It is beneficial for Machine Learning (ML) to run local on edge IoT devices to improve security, power consumption and to reduce latency for real-time processing. While ML algorithms are computationally intensive and embedded systems have limited resources, custom microprocessors are needed to deliver sufficient performance.

Fraunhofer IMS has developed a package of accelerators for efficient neural network execution. With these accelerators, modern AI algorithms work on energy-critical hardware, such as energy-autonomous sensor systems. We have ported our optimized software framework "Artificial Intelligence for Embedded Systems – AIfES" to the AIRISC core allowing benchmarking with Tensor Flow Lite.

Our RISC-V based 32-bit processor "AIRISC" features instruction set extensions and coprocessors for efficient neural network computation. The additionally implemented SIMD (Single Instruction Multiple Data) instructions are compatible with the P-Extension of the RISC-V specification for DSP applications.

For a medical application realized to detect atrial fibrillation in ECG data, we achieved a speed advantage of factor 7 in evaluation with only 10% higher area and power requirements.

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Photo: Fraunhofer IIS

mioty®-
The All-around Talent for IoT

Robust transmission of sensor data for condition monitoring and smart metering – this is what recommends the wireless and standardized transmission technology mioty® for applications in the Industrial Internet of Things (IIoT). It enables hundreds of thousands of sensors to be connected via just one base station. This is a huge advantage, especially in the smart city and smart building sectors with many end devices.
mioty® is a standardized technology of the European Telecommunication Standards Institute ETSI. A telegram splitting method, developed by Fraunhofer scientists, ensure complete, reliable data transmission even if up to half the telegrams fail or are transmitted incorrectly. This is achieved by splitting the overall data into small data packets/telegrams and transmitting them redundantly over several frequencies in the band. The mioty transmission method uses less energy than conventional methods.

Maintenance-free mioty®-LPWAN with Energy Harvesting

In addition, energy autarkic power supply for the sensors is possible using energy harvesting technologies. We developed solutions that use minimal vibrations or temperature differences to generate power. This is possible by highly efficient voltage regulators and energy-management systems that make even the smallest currents and voltages usable.

Integration in your products

We provide reference designs for component developers (software and front-end designs for the base station, firmware for end-points), software and hardware design and we support prototyping and product development (including integration on new platforms).

Integration into your application

We offer workshops for the introduction and integration of mioty®, support during (test) installations, through measurement campaigns and their evaluations, as well as during rollout with partners. If you like to test it directly in your applications, you can also get an evaluation kit to do so.

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Photo: Fraunhofer IIS

Embedded AI: Artificial Intelligence in Edge Applications

Smart industrial applications require intelligent systems that can independently evaluate and interpret data and translate it into decisions and actions. Neural networks are ideally suited to solve these tasks. They work particularly quickly, efficiently and reliably if the data is processed right in the place where it is generated: directly in the device and with the help of embedded artificial intelligence (“embedded AI”).

This data processing on the edge reduces delay times and complexity, but also brings decisive advantages in terms of data protection, because less data needs to be transmitted and stored. Sensitive handling of data is particularly important in object recognition based on image and video material.

For this purpose, we are developing edge AI solutions for object recognition in offline mode, where the image and video material is analyzed locally on an embedded platform. The results of the object recognition can be presented in anonymized form in accordance with data privacy requirements or used directly for applications with gesture control. In addition, we are working on further edge AI solutions, for example for the recognition of patterns and anomalies through the analysis of time series data.

The core of this development work is the optimization of neural networks towards energy-efficient and low-latency data processing algorithms, which are then integrated on suitable embedded platforms.

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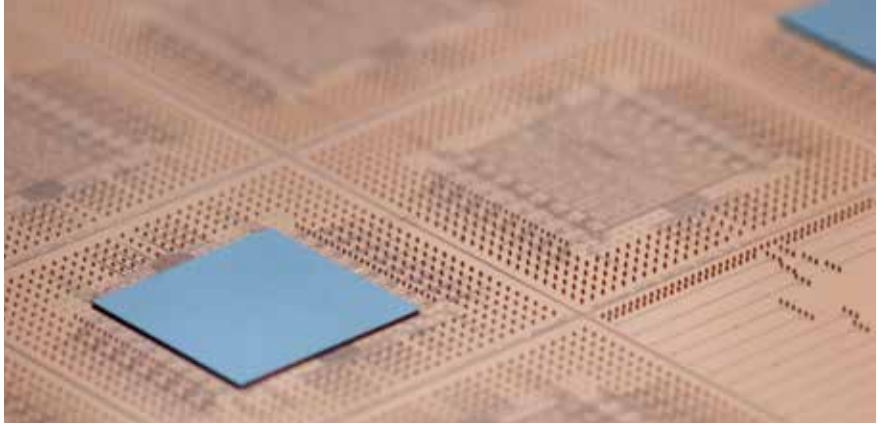

Photo: Fraunhofer EAS

Modern System Packaging and Implementation

Motivated by advances in microelectronics and a holistic approach, we at Fraunhofer IIS/EAS are dedicated to developing new electronics design concepts and closing gaps in the design flow.

The increasing miniaturization of electronics, new manufacturing technologies and the increasing range of functions place special demands on their performance and the design process. Our work is therefore focused on meeting the growing complexity of circuits with new design concepts. Our goal is a fast, resource-saving, error-free and safe development of electronic systems. But also new technologies like chiplets are in our focus under the aspect “More than Moore”.

Support in the design process is also provided by “Intelligent IP” – the automation solution for analog and mixed analog/digital chip design. Systematic structuring and cross-technology automation significantly accelerate the development process. Reusability is improved and resources are conserved.

Testing complex systems entirely without the use of hardware resources can be implemented with an individual Deep SiL methodology. In this process, the behavior of the hardware is mapped as accurately as required in an absolutely virtual manner. This increases the test coverage and improves the robustness of the system. At the same time, agile development processes are created and the economic risk is significantly reduced.

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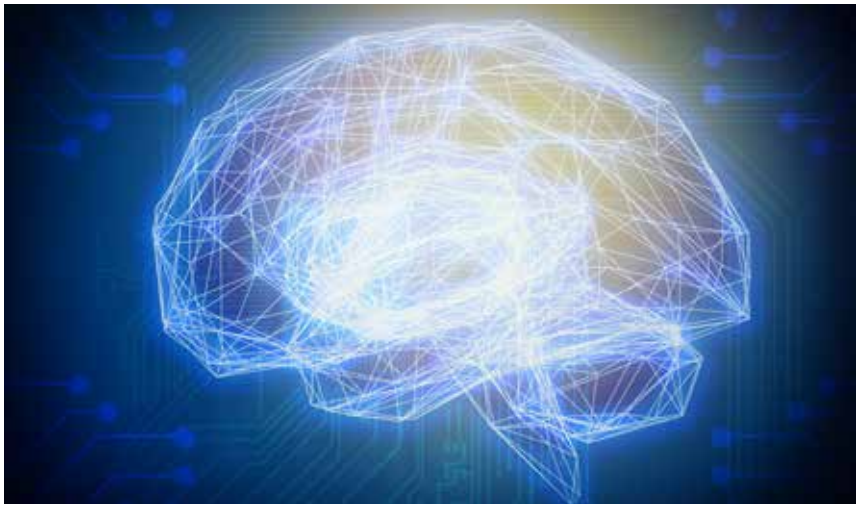

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Highly Efficient and Application-specific Neuromorphic Hardware for Edge AI Solutions

In general terms, neuromorphic hardware refers to a hardware design with efficiently running “deep neural networks” inspired by the human brain. Embedding AI directly on edge devices and processing the data locally offers advantages over conventional computing architectures, among them lower latency, higher energy efficiency and better data protection. By using neuromorphic hardware, many calculations can be carried out in parallel, such that the hardware can work more efficiently and deliver faster results.

We are developing highly efficient and customized integrated circuits for AI accelerator IPs, which permit challenging and difficult applications. Our co-design framework lets customers benefit from optimized development times. In this way, we offer a solution to bring AI energy efficiently to edge devices with secure and rapid data processing. There are possible use cases in domains such as audio technology, Industry 4.0, wearables and autonomous driving.

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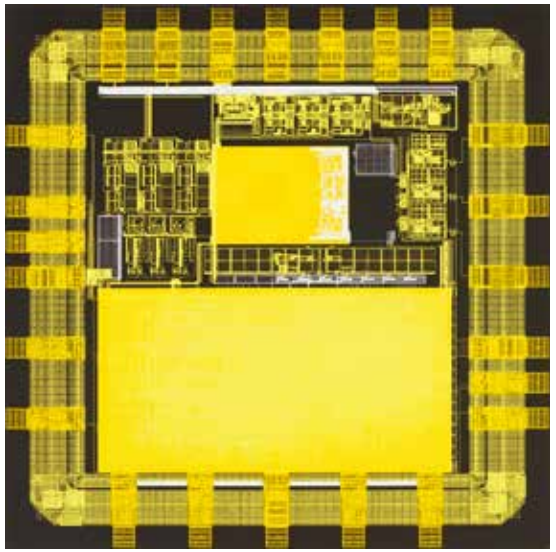

Photo: Fraunhofer IIS, Fred Ziegler

RFicient Chips for a Sustainable Internet of Things

The number of wirelessly networked devices is growing rapidly, both among private consumers and in industry. For devices to be available at all times, however, their wireless receiver needs to be permanently switched on, which limits the battery life of small, battery-powered IoT nodes to just a few weeks. The RFicient® chip, developed by the Fraunhofer Institute for Integrated Circuits IIS, represents a huge leap forward.

Our chip enables us to save up to 99 % of power – so a battery that would have managed just over a month with conventional technology can now last ten years. The appeal of this product lies in the fact that, even with the extended battery life, the sensor node is still ready to receive signals at any time: it needs just 30 milliseconds to respond by performing an action. While other wake-up receivers are often switched off for minutes at a time and can sometimes take too long to respond, the RFicient® chip guarantees an immediate response. This is important not only in time-critical applications, but also in situations where there are many services running simultaneously or many different nodes being queried – such as at airports, train stations or football stadiums.

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Hybrid Radio: Three Become One

Modern hybrid radios switch automatically back and forth between analog VHF, digital DAB+ and Internet streaming. By always looking for the best way to receive a radio program, they allow passengers to enjoy uninterrupted listening as they travel. The technology also provides users with an easy way to enjoy their favorite local shows outside of the respective broadcast areas.

Hybrid infotainment-system functionality of this kind is possible through the integration of Fraunhofer software components. The software solution for hybrid car radios includes data decoders that deliver images, text messages, and other information in addition to the audio content. For that purpose, Fraunhofer IIS provides a full-stack solution that incorporates everything from baseband decoding to audio playback, and a web-based user interface.

Whether used individually or in combination, Fraunhofer's software components for hybrid radios ensure uncompromising sound quality. Once configured, radio or automotive manufacturers receive a flexible software defined radio solution that can be easily ported to a wide variety of hardware platforms.

The look and feel of the radio always remain the same, regardless of which processor the software is running on. This platform independence makes it possible to address different markets or vehicle categories with just one software solution. At the same time, manufacturers can cleverly counteract currently prevailing component shortages. Depending on current availability, it is possible to switch to alternative hardware quickly and with little implementation effort.

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Photo: Fraunhofer IIS

5G Bavaria Open RAN Test Bed Industry 4.0 in Nürnberg

The 5G Industry 4.0 test bed at Fraunhofer IIS is an open environment for testing specific customer use cases in industry and logistics. It employs the latest mobile technology under real-life conditions in a stand-alone 5G campus network.

5G can considerably boost the performance of wireless connections in an industrial. Testing applications with 5G early on accelerates the move toward fully connected, flexibly customizable production, assembly and logistics processes. A realistic setting for the 5G Industry 4.0 test bed is provided by the interior and exterior facilities of the Test and Application Center L.I.N.K. at Fraunhofer IIS in Nürnberg, Germany. All outdoor, indoor and transition areas of the testing area are equipped with interlocking communication and positioning solutions. These make it possible to test a wide range of industrial applications in practical implementation scenarios.

Sponsored by
Bavarian Ministry of Economic Affairs, Regional Development and Energy

Faster to market with the Industry 4.0 test bed

Companies, research institutions and universities can use the 5G Bavaria Industry 4.0 test bed to investigate how 5G can meet various industrial application requirements in real life. Those who stand to gain the most are manufacturing companies, positioning system providers, system integrators and telecommunications companies that need easy access to a 5G test infrastructure in order to put their solutions through their paces and ready them for market.
The time between the standardization of new 5G functionalities and their availability as commercial components can be used on the test bed to test new applications and prototypes.

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