



FRAUNHOFER IMS

INNOVATION ON SILICON

Work procedures have become more complex and challenging, there is little time and workforce is expensive or hard to get. Electronic Assistance Systems are able to assist and contribute to a user friendly, time and resource-efficient interaction with complex tasks. While vehicles are expected to be equipped with electronic assistance systems, it is not that widespread in other fields yet. Electronic Assistance System Solutions by Fraunhofer IMS bring that added value of these systems into work and living environments as well as into other areas of application, e.g. medicine and leisure.

From novel assistance systems for more efficiency in the nursing and hospital sector, for more efficiency and transparency in industry, trade and private households, for the area of facility management up to solutions for the next generation office – the Fraunhofer IMS business unit “Electronic Assistance Systems” offers electronic system solutions for the benefit of manufacturers, operators and end users.

Sensors play a key role in this context, but they generate large unmanageable amounts of data that need to be evaluated. Artificial intelligence is a suitable technology to meet this challenge. For this purpose, Fraunhofer IMS has developed suitable machine learning methods that enable use on embedded systems.

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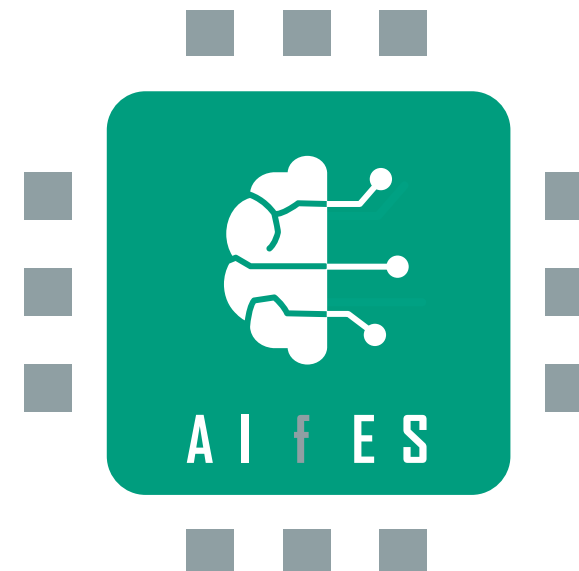
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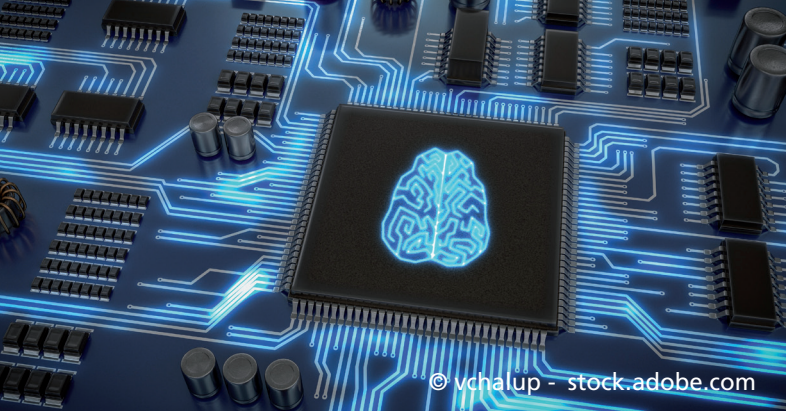


FRAUNHOFER INSTITUTE FOR
MICROELECTRONIC CIRCUITS
AND SYSTEMS IMS

MICRO INTELLIGENCE

ARTIFICIAL NEURAL NETWORK (ANN)
FOR MICROCONTROLLERS AND
EMBEDDED SYSTEMS





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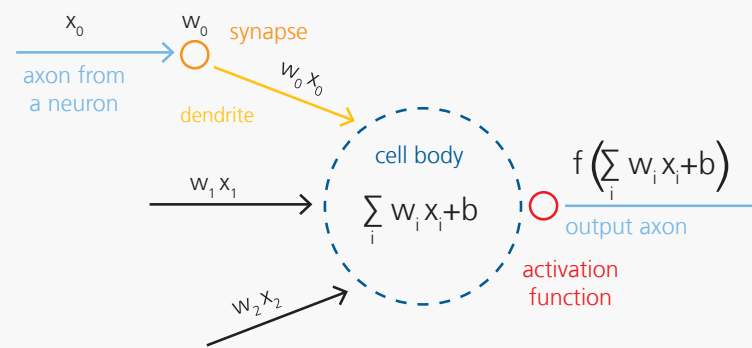
AI fES – ARTIFICIAL INTELLIGENCE FOR EMBEDDED SYSTEMS

Fraunhofer IMS has developed a feedforward artificial neural network (ANN) in the programming language C which can be used platform-independently. By using standard libraries based on the GNU Compiler Collection (GCC) and a source code reduced to a minimum, even integration including learning algorithms on a microcontroller is possible. The ANN is superficially not focused towards big-data processing, but should offer the possibility of implementing self-learning microelectronics that do not require a connection to a cloud or more powerful computers.

Fraunhofer IMS offers individual and customer-specific solution possibilities besides from common image recognition. This includes the feature extraction and preprocessing of the relevant sensor signals as well as the development of the optimal network structure and network configuration.

IMPLEMENTATION TOOLBOX

The neural network was built on a modular principle in order to realize individual solution strategies for various tasks. All parameters from the normalization of the sensor data, the structure of ANN, the most appropriate activation function as well as the learning algorithm are configurable. As a learning algorithm, an online

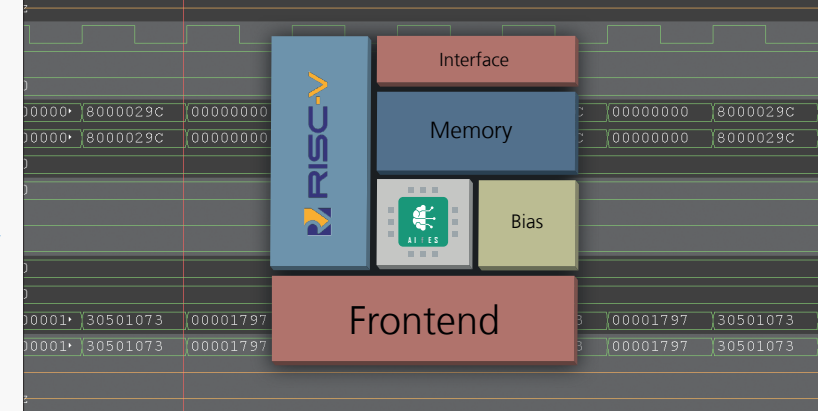


backpropagation algorithm with many setting options has been implemented. The implementation of an evolutionary learning strategy for the ANN is currently in development.

Programming with the GCC allows porting to almost all platforms. This enables fully self-contained integration including a learning algorithm on an embedded system. The classic variant, in which the learning phase is performed on a more efficient unit, is possible as well. The advantage in this case is that the same source code can be used for different processors – it only has to be compiled for the respective hardware.

DEVELOPMENT PLATFORM

When using Windows, for example, the source code is compiled as a “dynamic link library” (DLL) to be able to integrate it into software tools like LabVIEW or MATLAB. Also the integration into various software development environments as Visual Studio is possible. For the first development of the individual ANN, the PC is a particularly suitable platform for the performance of fast calculations. Once the correct configuration has been done, you can proceed with the implementation into the embedded system. The integration on a Raspberry Pi with Raspbian or an ATmega32U4 microcontroller has already been successfully implemented.



DEVELOPMENT ROADMAP

In addition to the development of further learning algorithms and the implementation of a deep ANN for higher-performance embedded systems like the Raspberry Pi, there is also a particularly energy-efficient hardware accelerator for the ANN on the roadmap.

FIELDS OF APPLICATION

- Internet of Things / Smart Sensors
- Medical Devices / Wearables
- Smart Home / Smart City
- Smart Factory / Condition Monitoring