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Case Study

Artificial Intelligence for Better Diagnosis

New AMD Embedded processor technology for medical systems

Artificial Intelligence for Better Diagnosis

Medical imaging is constantly looking for more computing power to render higher quality visual information to clinicians, enabling faster and more accurate diagnosis and more gentle surgery. By leveraging Artificial Intelligence, support can be significantly enhanced in the future. What role does embedded computer technology play in this context today?

Medical imaging has made immense progress in recent years. This is primarily due to the digitization of diagnostic imaging and the associated improvements in data and image quality as well as the faster availability of images. With the widespread introduction of artificial intelligence (AI) with deep learning, we are now entering the next evolutionary stage. Compared to traditional computer-aided diagnostic systems, AI offers greater autonomy, making diagnosis faster, safer and more reliable, because self-learning systems capture new situations better than static systems.

What benefits does AI bring?

Research results from various fields illustrate how accurate and fast AI-based medical imaging systems are already succeeding today. For example, researchers from the Department of Systems Medicine and Bioengineering at Houston Methodist Research Institute have developed an AI software that detected breast cancer 30 times faster than doctors in a field trial of 500 mammograms. The accuracy was 99%. Such a system would not only make breast cancer easier to recognize; it would also be better at detecting false positives, thereby avoiding unnecessary biopsies to the benefit of the patients.[i] Another AI research team focused on skin cancer diagnosis. Based on photos, the system was able to identify skin cancer just as reliably as dermatologists.[ii] A third project from the Icahn School of Medicine at Mount Sinai Hospital, New York City, proved to predict liver cancer with the same accuracy as specialist oncologists. During the course of their research, the scientists found that the system could also be used in the future to tell if a patient is prone to schizophrenia or other mental illnesses. [iii]

Mass adoption needed

AI and deep learning have already proven to be extremely valuable tools to improve the early detection, diagnosis and treatment of many serious illnesses. If this intelligence were directly available to all doctors through medical imaging, not only could many lives be saved, but wrong treatment and unnecessary surgery avoided. Doctors would then have an unprecedented amount of information at their disposal to automatically support them with the highest level of expertise in diagnosis and treatment. This way, even the smallest and rarest indicators – which a doctor may never experience during several decades of professional practice – could be identified reliably. This would benefit all stakeholders: the patients, the doctors and the health system. A study by business consultancy PWC finds that the widespread use of artificial intelligence across Europe alone would reduce the forecast health and aftercare costs by almost €

Migrating to AI is a simple task when using the AMD-based COM Express Computer-on-Modules from congatec, as existing COM Express designs with other processor technology can be easily modified.

200 billion within ten years. [iv] This raises the question: Which technology platforms will enable mass adoption?

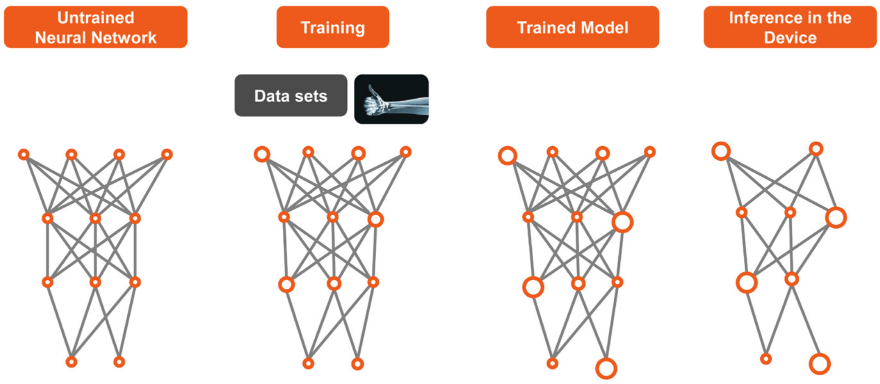
Ready for AI

Let's start with the good news: The latest embedded platforms offer all necessary requirements in terms of computing power, energy efficiency and programmability to integrate high-performance artificial intelligence into every ultrasound device, every diagnostic radiology station, and every medical PC in doctors' offices. Now, you may well wonder how the artificial intelligence of entire data centers fits into low-power embedded platforms. The truth is: It doesn't. Neither does it have to; because deep learning – a resource-intensive type of machine learning – still takes place on servers, at least for the time being. The medical devices simply use the intelligence garnered in the data centers. This process is called inference.

Deep learning in the data center

The process is almost always the same for all types of different tasks. A net comprising many computing units – mostly General Purpose Graphics Units (GPGPUs) – is combined into a deep neural network (DNN). This deep learning network must then be trained. As far as diagnostic imaging is concerned, this may include radiology images for the early detection of breast or liver cancer, or even ordinary photos of the skin to train the system for the recognition of skin cancer. The amount of image data required for this is immense. Real-life research projects speak of 130,000 to 700,000 images of positive and negative diagnoses. Armed with this information, the neural networks develop parameters and routines based on case-specific algorithms with an accuracy that is in no way inferior to that of experienced specialists.

InIntegrating intelligence into embedded computers



Schema illustrating deep learning in the data center / intelligence in the local medical device.

However, this intelligence now resides in the cloud or in a central data center, and not yet in the medical device. This is where inference comes into play. It is the process used to integrate what has been learned into the local device. For the neural network intelligence stored in the data center to fit on just one processor, the software must be smaller. Therefore, any parts of the neural network that are no longer required after successful training are usually omitted. Since they are not active in the decision making process, they can be safely left out. In addition, several decision layers of the original neural network can now be combined in a single operation. Again, this has no disadvantages, since the local system doesn't have to self-learn, even if that is quite possible. It is clearly more efficient to continue to train the large system with all new data and then bring the local devices up to the current level of knowledge via regular software updates. This is exactly why medical IoT interfaces for connecting devices to the clouds and servers of the technology providers are crucial for the further development of these technologies.

The right processor technology

While this significantly lowers the computing performance required locally in the medical device, the needed processing power is still very high for a single processor. In addition, the local computing architecture and that of the data center should be comparable to reduce the overhead for porting the software and algorithms. The latest embedded accelerated processing units offer exactly the right measure of flexible computing power with classic x86 processors and powerful GPGPUs for AI and machine learning. The energy requirements are so low that these features can already be integrated into almost all image processing application areas today – from mobile fanless X-ray machines to edge storage devices for RIS (Radiology Information Systems) and PACS (Picture Archiving and Communication Systems).

AMD Ryzen Embedded V1000 for medical devices

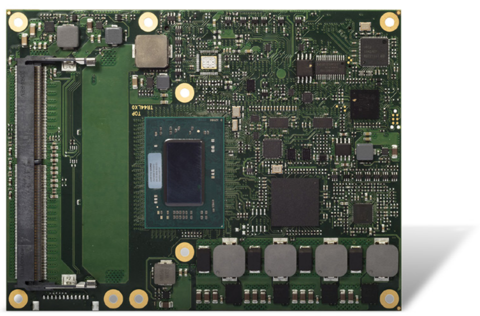
Thanks to its significantly increased computing and graphics performance, the new AMD Ryzen Embedded V-Series is particularly fit for this purpose. With a total of 3.6 TFLOPs from the multi-purpose CPU and the powerful GPGPU, it offers flexible computing performance that until a few years ago was only achievable with systems consuming several hundred watts. Today, this computing power is available from 15 watts upwards. This makes it possible to integrate it into fanless, hermetically sealed and hence highly hygienic and robust medical devices for patient-centered and mobile care.

Deep learning and AI are not witchcraft

These AMD embedded processors also provide comprehensive software support for tools and frameworks such as TensorFlow, Caffe and Keras that are required for the rapid and full-scale introduction of AI and deep learning. At https://gpuopen.com/professional-compute/, developers can also find a wide range of software tools and programming environments for deep learning and AI applications, such as the popular open source ROCm platform for GPGPU applications. The open source concept is key for ensuring that OEMs are not dependent on a proprietary solution. This includes the HIPfy tool, which allows proprietary CUDA-based applications to be converted into portable HIP C++ applications, making them hardware-independent. With access to such an ecosystem, deep learning and AI are comparatively easy to implement and not just the reserve of IT giants such as Google, Apple, Microsoft and Facebook. Even mobile app developers have started to implement deep learning and local inference into real applications, such as the Not Hotdog app which recognizes different hot dogs in mobile phone photos with high reliability – a clear example that AI has arrived in the private sector.

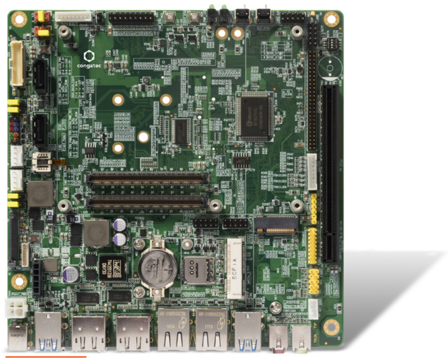
Fast design-in with Computer-on-Modules

Now, the only remaining question is how medical device manufacturers can design these AI enablers into their medical imaging devices as quickly and efficiently as possible. One of the most effective ways is to use standardized Computer-on-Modules. The modular approach decouples the medical device from the processor technology, providing manufacturers with a stable roadmap for their products, ensuring high long-term availability and efficient re-use of own development efforts. By simply swapping modules,



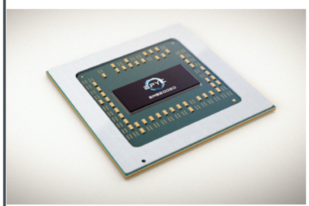
The latest COM Express Type 6 benchmark module for local medical AI: conga-TR4 with AMD Embedded Ryzen processor.

new performance classes can be integrated into existing designs, enabling OEMs to easily extend the functionality of their designs with these innovative features. The leading module form factor COM Express is already used in many medical devices today. This allows OEMs a plug and play approach to making their medical hardware AI-compatible, whereby they simply exchange the modules. congatec has already tested how quickly this job can be done in several system designs using the new conga-TR4 module with AMD Ryzen Embedded V1000 processors. To migrate the module to an existing system based on another COM Express Type 6 module, developers at a partner company needed the same amount of time as equipping the system with hardware that had already been evaluated. Software set up also required only the usual installation routines. Thanks to the standardized API, which is identical for all congatec modules, no additional hardware programming effort was needed. One consequence of this is that GPIO control is the same for each module. System designers need this, for example, to measure ambient brightness levels in order to automatically adjust the brightness of the display. Migrating to AMD processor technology is not a challenge with congatec modules, but a big bonus for systems that will implement AI in the future.



Standard module on standard board: The conga-IT6 mini-ITX motherboard from congatec can be equipped with the new module and then plugged into any medical device that uses the ATX standard.

Embedded high-end server design options



Migration to the AI is an easy task with AMD-based COM Express Computer-on-Modules as they can replace existing COM Express designs with other processor technology.

High-end systems, such as medical backend servers that require even more power than AMD Ryzen Embedded V1000 processors offer, can alternatively evaluate the new AMD EPYC™ Embedded 3000 processors. Providing a long-term availability of up to 10 years, up to 16 cores, 10 Gigabit Ethernet, and up to 64 PCIe lanes for many additional parallel processing and machine learning image processing units, they are an ideal and reliable platform for use in the medical environment. Depending on customer demand, congatec plans to provide these processors on COM Express modules as well, with the ultimate goal of developing a new high-end embedded server pinout for COM Express. Fully customized embedded boards will be an alternative option.

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i https://www.sciencedaily.com/releases/2016/08/160829122106.htm
ii https://news.stanford.edu/2017/01/25/artificial-intelligence-used-identify-skin-cancer/
iii https://www.mountsinai.org/about/newsroom/2017/university-herald-deep-learning-the-most-advanced-artificial-intelligence-chris-brandt
iv https://www.pwc.de/de/gesundheitswesen-und-pharma/studie-sherlock-in-health.pdf

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About congatec AG

congatec is a leading supplier of industrial computer modules using the standard form factors COM Express, Qseven and SMARC as well as single board computers and customizing services. congatec's products can be used in a variety of industries and applications, such as industrial automation, medical, entertainment, transportation, telecommunication, test & measurement and point-of-sale. Core knowledge and technical know-how includes unique extended BIOS features as well as comprehensive driver and board support packages. Following the design-in phase, customers are given support via extensive product lifecycle management. The company's products are manufactured by specialist service providers in accordance with modern quality standards. Headquartered in Deggendorf, Germany, congatec currently has entities in USA, Taiwan, China, Japan and Australia as well as United Kingdom, France, and the Czech Republic. More information is available on our website at www.congatec.com or via Twitter, LinkedIn, and YouTube.

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