Deep Learning Technology at VISION 2018 in Stuttgart

"Deep learning offers an edge whenever you have test objects with large variations that make them difficult to model mathematically"

VISION

Dr. Klaus-Henning Noffz, CEO of Silicon Software/ Source: Silicon Software GmbH

VISION: How does the deep learning approach differ from conventional image processing systems? What makes deep learning so special?

Dr. Klaus-Henning Noffz (KHN): In the past, complex image processing tasks, such as object identification and classification, were cumbersome in terms of development time and image processing effort. With deep learning, a neural network is trained and constructed in a much quicker time and with less investment. Traditional methods are still suitable when dealing with exact object position determination, dimensional inspection, or code reading, to name a few examples. In contrast, deep learning is better suited when test objects demonstrate great variation and are mathematically difficult to model. It really stands out with very high reliability in identification rates, and it will improve the quality of current image processing systems as well as open up new applications.

VISION: What is the difference between the concepts "deep learning" and "machine learning"?

KHN: Deep learning is the technology used to implement machine learning, which is an approach for achieving artificial intelligence.
Deep learning is part of machine learning in which neural networks are implemented. The concept relates to the unusually high number of hidden layers in the neural network. Using the multiple methodological breakthroughs in recent years

and the rapid technological advances in the area of distributed computing and GPU computing, deep learning delivers models primarily in the fields of image, sequence and language recognition, and it successfully implements applications in diverse areas such as automotive manufacturing (self-driving automobiles), financial (stock price prediction, risk prognosis, automatic trading systems), medical (computerized image recognition of carcinomas), biological (genomics), eCommerce (recommendation systems) and web environments (anomaly identification).

VISION: Which technological trends and developments are you seeing currently in deep learning?

KHN: Deep learning is developing at a breakneck speed. Driven by large companies such as Google, Microsoft, Facebook and Intel, as well as in specific fields such as autonomous driving, language recognition and facial recognition, companies are colliding and cooperating with one another in a very agile way. With deep learning in image processing, the popularity and use of Convolutional Neural Networks (CNN) are increasing. CNN is a special type of a neural network that is particularly well suited for spatial arrangement of information. CNNs can be trained to learn criteria for object differentiation. Thus, they are particularly well suited for the most difficult classification tasks in the most diverse application cases.

To cope neural networks are becoming larger, but at the same time, the algorithmic complexity must be radically reduced. Architectures are arising that deliver ever higher identification rates within concurrently more complex tasks. For the implementation and execution of such networks, FPGAs are ideal for many reasons. They demonstrate their excellence with large on-chip memory and high bandwidth, whereby CNNs can now classify high-resolution images in real time. The FPGA enables classification of image data directly in a frame grabber — from image capture to classification result. Currently in the field of machine vision, we are seeing a high demand for inline applications.

VISION: In which image processing/computer vision applications is deep learning already playing a role today? In which applications and markets do you see future application areas?

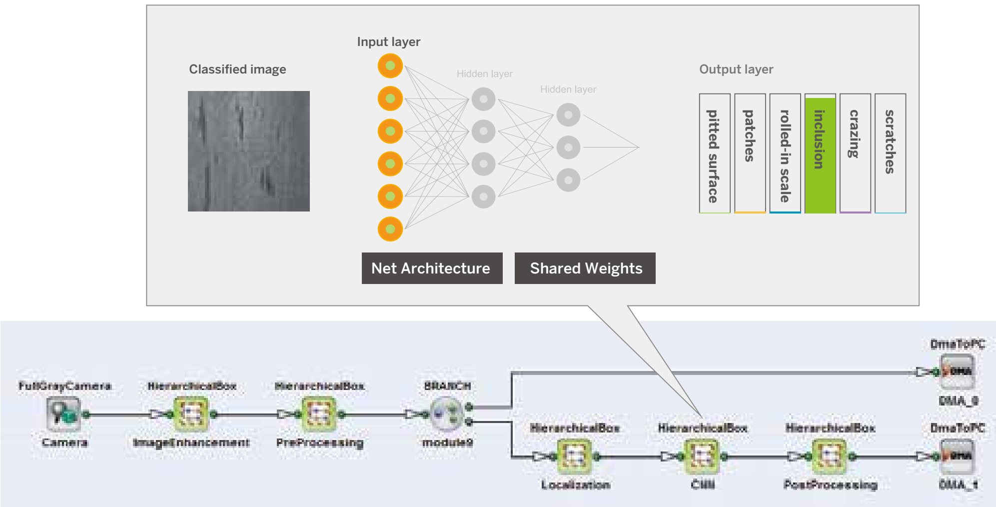
KHN: Google started classifying large image and video collections early. Very quickly, applications were developed without large time requirements. Human recognition in the security field is a typical example. In the industrial field, they tried to apply CNNs to tasks that had always been problematic with classic algorithms before.

Today, deep learning is in use with pattern recognition and object detection. It obtains the best results with varying objects and with identification of defects or anomalies, but also with difficult surfaces that exhibit transparencies and reflections. In the manufacturing process, a machine is now able to handle a variety of variances under changing environmental conditions. Deep learning is being successfully implemented in status monitoring and preventive maintenance. Future application areas encompass autonomous driving and assistance systems, drones, agriculture, inline inspection, cellular research, robotics, and cognitive systems that work together with humans.

VISION: In your view, which are the challenges with which deep learning will establish itself on a broader level in the future?

KHN: The great challenges are to be found in the area of technology and in acceptance of the technology. With the short development cycles in network architectures and development platforms, high pressure comes to bear on companies to be compatible with current software and developments. Moreover, system components must be available that fulfill industrial demands upon release and that offer processor capacity in cameras, frame grabbers or industrial PCs to be able to process more complex networks. On the other hand, resistance to accepting the deep learning "black box" still exists. It exhibits very high identification probabilities, but it is still algorithmically not verifiable.

Silicon Software will offer larger FPGA processors



CNN operator in VisualApplets for various neural networks' architectures and weight/Source: Silicon Software GmbH

in frame grabbers just for high bandwidth deep learning applications. FPGA technology is optimally suited for this and especially for industrial purposes, as FPGAs demonstrate lower thermal output and ensure deterministic latencies. At the software level, more and more companies are offering deep learning solutions.

VISION: To what extent and in which fields will deep learning displace traditional image processing systems based on programmed algorithms?

KHN: Using the "training instead of programming" approach, deep learning can achieve very broad distribution. This is not about simple systems that can be implemented, but rather about complex tasks where traditional programming is markedly more complex with the algorithmic description of all possible variants. Thus, classification tasks are significantly easier to solve than with existing algorithmic methods. For many new tasks, neural networks are highly useful for situations involving reflective surfaces, poorly illuminated environments, moving objects, robotics, and 3D, to name a few where existing methods have clearly meet their limits and can only be realized with great investment and great expertise.

VISION: Deep learning is often mentioned in connection with Embedded Vision. Where are the points of contact here?

KHN: Intel's Movidius models show that deep learning is not just reserved for workstations. Even in the decentralized computing approach of Industry 4.0, there exists a need for embedded Vision with deep learning. Small image processing units or even intelligent cameras can take over demanding partial tasks.
Since most embedded devices are equipped with an FPGA, they have sufficient performance for more complex neural networks. FPGAs are particularly energy efficient in comparison to GPUs and well suited for embedded and industrial applications with tough real-time conditions. Thus numerous applications with very low error rates can be implemented, such as those in the areas of manufacturing, quality assurance, robotics, medical technology, and automotive.

VISION: Are there any exciting applications in which your deep learning solution is already integrated that could be mentioned as an example in a press release? If so, could you briefly describe an application (maximum three sentences)?

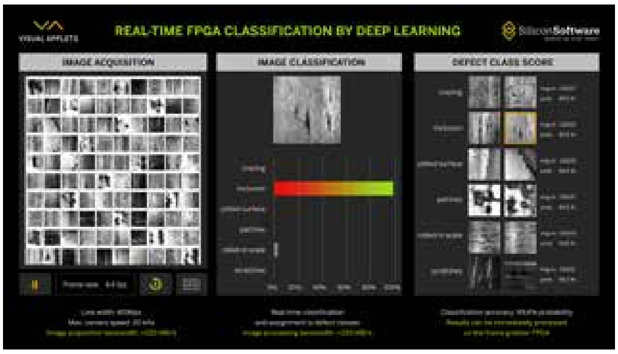
KHN: Inspection tasks which have until now been considered difficult, such as the identification and classification of defects on reflective metallic surfaces, can now be solved using deep learning with neural networks. The application, implemented on a frame grabber's FPGA, attains the highest bandwidths and identification rates in real time. A new

Deep Learning application (error detection on metallic surfaces) running on a FPGA with a high data rate of approx. 200 MByte/s. / Source: SIlicon Software GmbH

CNN operator within a VisualApplets application design serves as the software basis that dispenses a probability distribution of the defect classes for each acquired image.
These applications are currently in the evaluation phase. Users are international clients in the area of metals processing and automotive manufacturing. Due to NDAs, no PR regarding the current status is allowed.

VISION: Which trade fair innovations in deep learning will you be exhibiting at VISION 2018?

KHN: At VISION 2018, we will be presenting our FPGA-based deep learning solution in VisualApplets. It demonstrates how the inference of a pre-trained network runs at high bandwidth in real time as a pure FPGA-based solution. Throughput



rates of 220 MB/sec with a classification accuracy of 99.4% are achieved. The demonstrator on exhibit is of metal surfaces inspection with analysis of six defect classes, where no CPU or GPU processors are necessary. Using the VisualApplets FPGA graphical programming environment, users are able to build inference into a VisualApplets design using the special CNN operator. A very high-performance "CNN-ready" frame grabber could also be used for the inference of very large neural networks.

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