White paper

Efficient image processing systems featuring a camera-integrated image pre-processing function

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Zero-error quality control remains the primary goal. That is why every image processing system must be capable of making clear and precise decisions during the machine cycle. The ability to evaluate image data in real-time and accurately poses major challenges to an image processing system. The object to be inspected and the image processing systems are often located far apart, the latency periods of each interface cannot be precisely determined, the real-time image processing is technically difficult and expensive. In addition, complex inspections produce a high volume of data and increase the system loading, which brings an image processing system to its limits very quickly.

Data-intensive image processing in real-time through the resource-saving partitioning of tasks between camera and computer

Today, the Industry 4.0 concept and the progressive decentralization of manufacturing processes demand increasingly intelligent image pre-processing right where the work is done. Where high-performance and cost-sensitive image inspection is concerned, there is always the question of how to strike an economic balance between the data-intensive image processing tasks to be performed by camera and the host PC. The key to significantly increasing the process speed is the “Field Programmable Gate Array” (FPGA): With its ability to perform all image processing functions in real-time and with low deterministic processing delays, the FPGA has the most effective influence on the quality and velocity of the entire range of image processing and evaluation tasks.

Advantages of a camera-integrated real-time image pre-processing function

High-performance image processing therefore relies increasingly on the partitioning of tasks between pre-processing systems and the actual host PC. Cameras, where the FPGAs are capable of carrying out a large share of the image pre-processing tasks and make decisions in real-time take a considerable load off the image processing system. NET’s GigEPRO camera series was developed precisely for this partitioning of tasks. Customized image pre-processing functions are performed by the camera, preventing a so-called ‘bottle-neck’ in connection with the transmission of data to and from downstream (and less resource-intensive) image processing systems. In addition, GigEPRO makes the respective image processing system unique as it enables companies to develop tailored image processing solutions and protect the application know-how on the camera from third-party access.

Image analysis in standard image processing tasks, such as detecting and measuring objects, usually does not require any complicated evaluation and can be carried out directly by the host PC without any great effort. Where more sophisticated functions are required for the analysis of image data, the use of cameras with an integrated image pre-processing function is one option to improve the quality of the entire image processing and minimize the costs at the same time.

Real-time, when it really matters: Industrial approaches

Controlling image sequences and flash lighting in the FPGA

Printing In most cases, it is only possible to capture a sequence of images of an object with four different colors and different exposures by means of external trigger signals. If the images also need to be buffered before being transmitted, the decisive pre-processing stages can be performed reliably by GigEPRO: Controlled via an external trigger signal, GigEPRO captures the images in sequence, selects the appropriate lighting for the desired color via digital outputs, stores the images in the internal memory and

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sends the image data, ready for analysis, to the host PC via the rapid GigE Vision interface. Thanks to the on-board FPGA and the programmable functions, GigEPRO controls all of the lighting and captures images significantly faster than would be possible using only a host PC.

Continuous image sequence acquisition already on-board

Traffic In specific applications which require a quick sequence of images to be recorded before or after the event, a defined number of images must be captured using a trigger, synchronously at the specified times. In traffic control, pre-trigger functions are therefore necessary to be able to analyze the incident clearly and unambiguously, i.e. running a red light. Here, GigEPRO also performs all of the image pre-processing tasks directly in the camera: A predefined image sequence, activated via freely programmable pre-triggers, can be captured continuously and stored in the memory. The required images are captured much faster than would be possible by direct transmission to the host system via the interface.

Image analysis using the light-section method

Production Automated quality control during production should, where possible, be carried out quickly, effectively and at the production station. For example, it should be possible to inspect the quality of a joint welded by a robot immediately and without delay. In the decentralized inspection of welded joints or glue beads, cameras featuring an on-board image pre-processing function can independently detect any abnormalities in the joint or bead row during a quality inspection running a 3D triangulation and light-section routine to alert the machine.
GigEPRO cameras with an on-board FPGA image pre-processing function can scan and calculate the elevation data in an image analysis using the light-section method significantly faster than would be possible using only a host PC. This enables fast, effective quality control right at the production station.

Data encryption directly in the camera

Security Data is first encrypted to actively protect against attacks by data hackers, e.g. when capturing and transmitting sensitive image data at ATMs. GigEPRO offers the possibility of encrypting data directly in the camera using the customer’s own algorithm, which can be individually programmed. Unlike ready-to-use encryption hardware, only the company operating the hardware knows the encryption method used - the FPGA is protected against its contents being read, and data hacking using reverse engineering is practically impossible.

Open Camera concept: customized image pre-processing for “unique cameras”

Off-the-shelf image processing solutions are a thing of the past. In other cameras, the hardware characteristic of an FPGA is extremely limited and does not allow options for the camera to directly run individual applications itself. The Open Camera concept of NET’s GigEPRO, on the other hand, makes it possible to create a “unique camera” with completely individual algorithms.

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The implementation of sophisticated applications in the Industry 4.0 era is no longer mere fiction - with GigEPRO, it has become a reality:

GigEPRO - GigE Vision camera featuring an integrated image pre-processing function for real-time applications

- GigEPRO offers system integrators a camera for the development of application specific image processing solutions
- Companies are able to protect their competitive advantage as it is impossible to apply their know-how
- GigEPRO is able to encrypt sensitive image data using personalized algorithms that only you, the customer knows
- Compared to standard vision cameras, the GigEPRO Open Camera concept offers more built-in options as it is not only possible to program specific functions, but in addition a wide variety of library-based functions can also be added and combined with each other
- As a complete all-rounder with image pre-processing functions, GigEPRO reduces the load on the host PC’s computing capacity and significantly reduces the infrastructure costs
- GigEPRO is compliant with the industry standards - the extended functions can be easily integrated into a GenICam-based environment

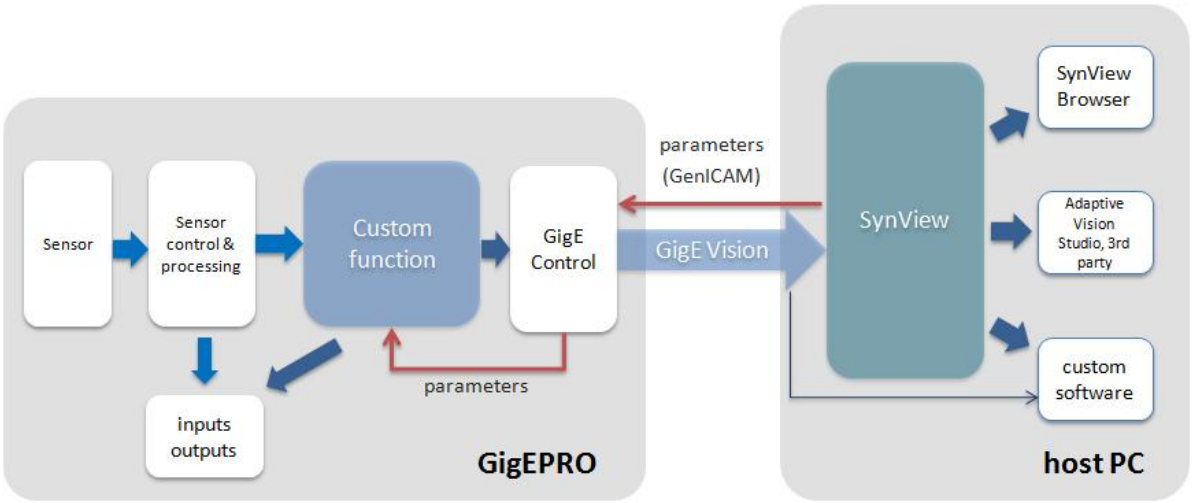

Fig.: Implementation of the Open Camera concept in the GenIcam structure

GigEPRO is developer-friendly

- Image pre-processing functions can be implemented in the camera simply and easily with the free and easy-to-use SynView SDK. This does not affect the GigE Vision environment and the host system does not need to be adapted in any way
- The extended functionality of the FPGA is based on the popular and widely-used XILINX SPARTAN hardware and software environment
- GigEPRO already has an integrated debugging function for the inspection and correction of program codes. Specific developments simply follow a predefined functional flow
- Customer-programmed functions cannot be read externally - this prevents undesired reverse engineering
- Getting started is easy: NET offers training courses for developers to familiarize themselves with the programming of independent functions in GigEPRO in just one day

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- GigEPRO comes with an extensive range of sample codes such as Flat Field Correction (FFC) calibration, Geometry Correction (GeoC) and color correction.

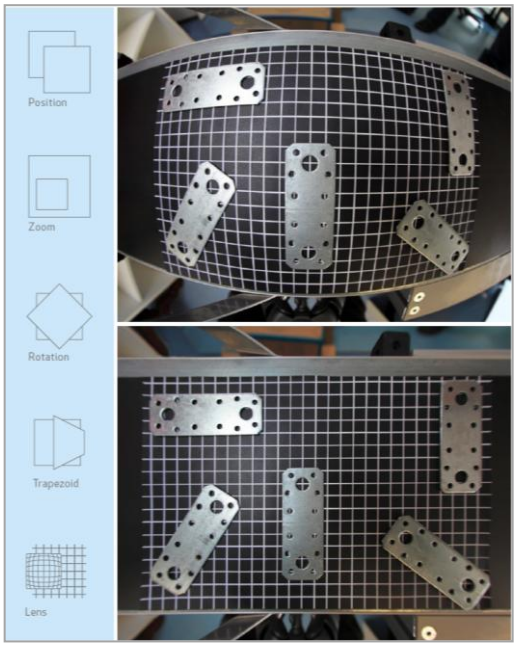

Fig.: Sample code - geometrical image correction in real-time with GigEPRO

SynView makes it very easy to integrate your own applications into existing applications

SynView, the free, integrated software interface developed by NET, offers intuitive operability, flexible adaptability to the software already in use within the company, and low maintenance, enabling the quick and easy use of GigEPRO. SynView offers all the tools necessary to program, set up and parametrize the camera and the operating equipment for the image pre-processing functions provided by NET.
SynView is based on the current GenIcam, GenTL and GigE Vision industrial standards and is a solution developed for cameras and tools that can serve these interfaces. Users can therefore integrate GigEPRO into their existing environment without further ado. A new application developed by the customer on the basis of SynView generally works not only with any other camera that complies with these standards, but also with cameras for which a unique SynView software interface has been developed. This makes it a common, standardized interface for this category of cameras.

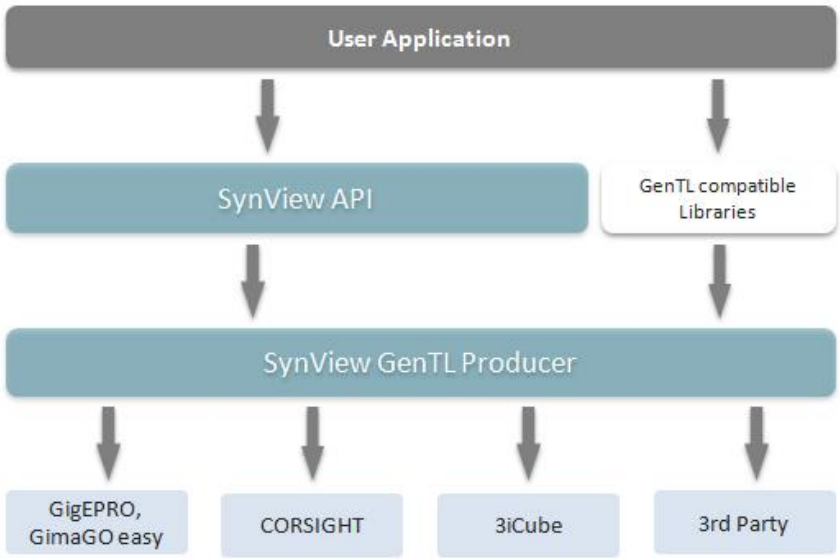

Fig.: Application diagram

The code generator of the SynView browser reduces the development time and configures the integration into the application software: The features of the camera can be set in the Explorer in such a way that the desired image appears in the preview and a source code that is ready for use or a project that can be directly used in MS Visual Studio can be generated with a single click.

The “SynView API” generalizes the GenTL standard even further and creates an interface that is completely object-oriented and very simple to operate. A complete list of object-oriented languages such as “C”, “C++”,

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“C#” and “Visual Basic.NET” are supported. SynView runs under Windows™ and Linux in 32 and 64 bit architectures.

Conclusion

The GigEPRO camera series by NET consisting of 12 models are already prepared to meet the requirements of Industry 4.0 image processing. Image pre-processing functions, which reduce the load on the host PC’s computing capacity and significantly reduce the infrastructure costs, can be executed in real-time with the camera’s programmable FPGA. The Open Camera concept enables the customer to program their own sophisticated applications offering a considerably wider range of functions compared to other GigE Vision cameras.
The GigEPRO camera series is also ideal for fields of application where embedded or mobile systems are used. The camera’s ability to perform specific image pre-processing tasks such as a combination of line scan, optical triggers, sequence storage, direct machine control, data encryption, and much more, can help companies gain a competitive advantage in many cases.
Individual image processing functions can be easily developed and extended with minimum effort by means of the free software interface SynView and an extensive library of standard applications.
The open interfaces, compatible with the current standards, and the network capability with the option of extending the functions make the entire system fit for future applications.

NET New Electronic Technology has been developing and manufacturing cameras for industry and medicine since 1996. NET’s products and innovative concepts increase the efficiency of industrial processes and, in the field of medicine, improve the patient’s chance of recovery. Throughout the globe, the employees and partners of NET contribute towards achieving customers’ application goals with its goal-oriented product and solution consultancy. NET’s portfolio includes compact cameras in industrial and board-level versions, customized camera modules and control units, Smart Vision systems, medical imaging devices, lenses and lighting, image processing algorithms and Machine Vision software.

Find out more about NET >>>

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