APPLICATION NOTE

INDUSTRIAL VISION

Optimize your applications with image pre-processing - know-how for users

Ideal machine vision results are achieved when images can be clearly interpreted by either humans or computers. Only then can image processing be considered a success. The key success factor is the ability to highlight the useful information contained in the image. Image ***pre***-processing plays a major role when it comes to making the relevant information usable for the user. In this context, image normalization refers to the stage of the image enhancement process in which results can be made comparable by standardizing specific features (e.g. by restricting the brightness or grayscale range). This process greatly enhances the ability to clearly establish whether something is “good” or “bad”, conforms to the specified dimensions or is in the right position. Below, we would like to show users of digital image processing just how much additional potential can be created for their applications through image pre-processing.

1. Image pre-processing provides always an advantage as no optical image is perfect.

Information that is not contained in the image cannot be made visible and “read out” later. Inhibitors in such cases include the ambient lighting conditions, discoloration and optical distortions caused by the combined effects of lighting, optics and camera. However, digital image pre-processing can always be used to successfully enhance the image content or to extract specific features from relevant image regions.

Image pre-processing identifies image imperfections and provides the ability to “edit out” these defects whereby enabling reliable decisions to be made and important information to be “made visible”, ultimately enhancing the image content.

2. Image pre-processing in the camera conserves resources and provides increased efficiency.

Real-time image processing is a prerequisite to achieve the shortest possible production and inspection cycles. The length of time available for image processing is directly limited by the machine cycle time, requiring high computational demands on existing systems. Even powerful computers can reach their limits very quickly when dealing with complicated applications. By using low-cost FPGAs (Field Programmable Gate Array) in the camera, even complex algorithms can be processed in real-time. Thereby, the camera produces the optimized result.

Costly computing resources can be avoided completely or freed up for other purposes by shifting the image processing task from the computer to the camera. At the same time, the fastest tasks can now be completed in real- time.

3. Industry 4.0 users benefit from image pre-processing in the camera.

The shift from centralized/non-interlinked system architectures to industry 4.0 underlines the necessity for innovative ideas in industrial image processing. The goal is to create decentralized, interlinked application architectures that have a high level of standardized hardware and software. The seamless integration of cameras via the GigE Vision and USB3 Vision interface, and the stable acquisition and enhancement of reproducible image sequences onboard, make it possible to develop image processing systems that are ideal for the future.

Compact, GentTL/GenIcam-compatible cameras can be easily integrated into interlinked system architectures. Camera-integrated image pre-processing enables individual image processing solutions that are continuously extendable and can be easily integrated with no additional effort.

4. The Open Camera concept enables the system integrator to provide the best possible application solutions.

Specific tasks require customized image processing solutions. NET’s Open Camera concept now enables system integrators and machine builders to individually configure cameras themselves. So-called IP Cores can be protected directly in the camera and sensitive image data can be encrypted using proprietary algorithms created by the system manufacturer.

Camera-integrated image pre-processing supported by the Open Camera concept provides a competitive advantage for users who want to be sure that their know-how is successfully implemented but protected as well.

Onboard image pre-processing_an_en_rev_1.0 | 11/2015

Onboard image pre-processing – concept and implementation

Conventional image processing

Image processing consists of image acquisition, analysis and the communication of decisions through digital inputs and outputs in order to complete tasks. In this context, image acquisition involves localizing, counting, detecting and measuring objects within the visual range of the image sensor. Common compute-intensive applications such as OCR, pattern recognition, feature extraction, presence/absence of objects and the scanning of codes require several image analysis functions to be executed successively. Image segmentation, feature extraction and color analysis are carried out before the final decision is made on the central processor (CPU). If, however, more complex analysis of the image is required, the image processing functions can become extremely complicated and a costly processor unit may be necessary.

Onboard image pre-processing

Using high-speed microelectronics, applications can be run more efficiently - and at lower cost - than is the case where tasks are shared between camera and computer in the conventional way. A camera-integrated Field Programmable Gate Array (FPGA) is used in such cases. FPGAs can execute image processing functions in real-time with a minimal deterministic delay.
As FPGAs are particularly suitable for computations that are typically required by image pre-processing functions, they are also used exactly for this purpose at NET. The image data is still sent from the camera to the computer, where the decision is ultimately made on the basis of this image data. However, the image data is restricted to only the relevant information after onboard image pre-processing has been completed. Therefore decisions can be made in real-time producing the shortest possible machine cycle times.

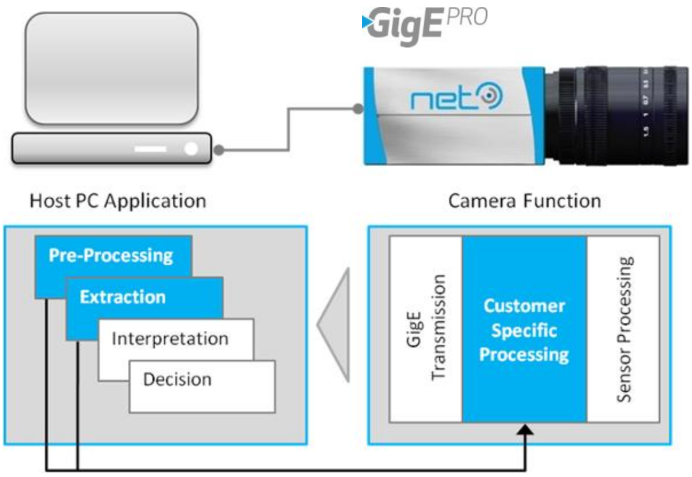

Fig.: Breakdown of image processing tasks in onboard image pre-processing

Application example "Quality control": Maximum requirements in terms of color accuracy and speed

Reproducible color results in real-time are crucial for reliable quality control in the food sector in order to be able to make correct decisions in the on-going production process. These color measurements can be particularly problematic where only minor color deviations appear in the camera's field of vision and the color changes have to be detected at high-speed. Disruptive factors such as inhomogeneous lighting conditions or inconsistent color temperature make quality control more difficult.
NET has taken on this challenge and, together with a well-known customer from the food industry, has developed a system that delivers true-color results in real-time every time. The system has only to be calibrated and synchronized once with no further intervention required by the user. The pre-calibrated and synchronized GigEPRO cameras achieve the required degree of other things, the color temperature of the LED lighting that changes during the aging process is factored in.

Fig.: Reference chart for color calibration in the camera

It is crucial that the colors of the food items are comparable and reproducible from measurement to measurement as they are optimally compared with every image captured such that the slightest nuances in color can be detected in real-time. Food items with color deviations that lie outside the defined spectrum are rejected within the shortest possible inspection cycles.
In addition, image information can also be used for continuous monitoring and documentation, for example, in addition to calculating the number of aberrations, the system can measure and classify the incident or determine when it occurred. This way, time-consuming lab measurements performed at a later stage can be reduced to a minimum.