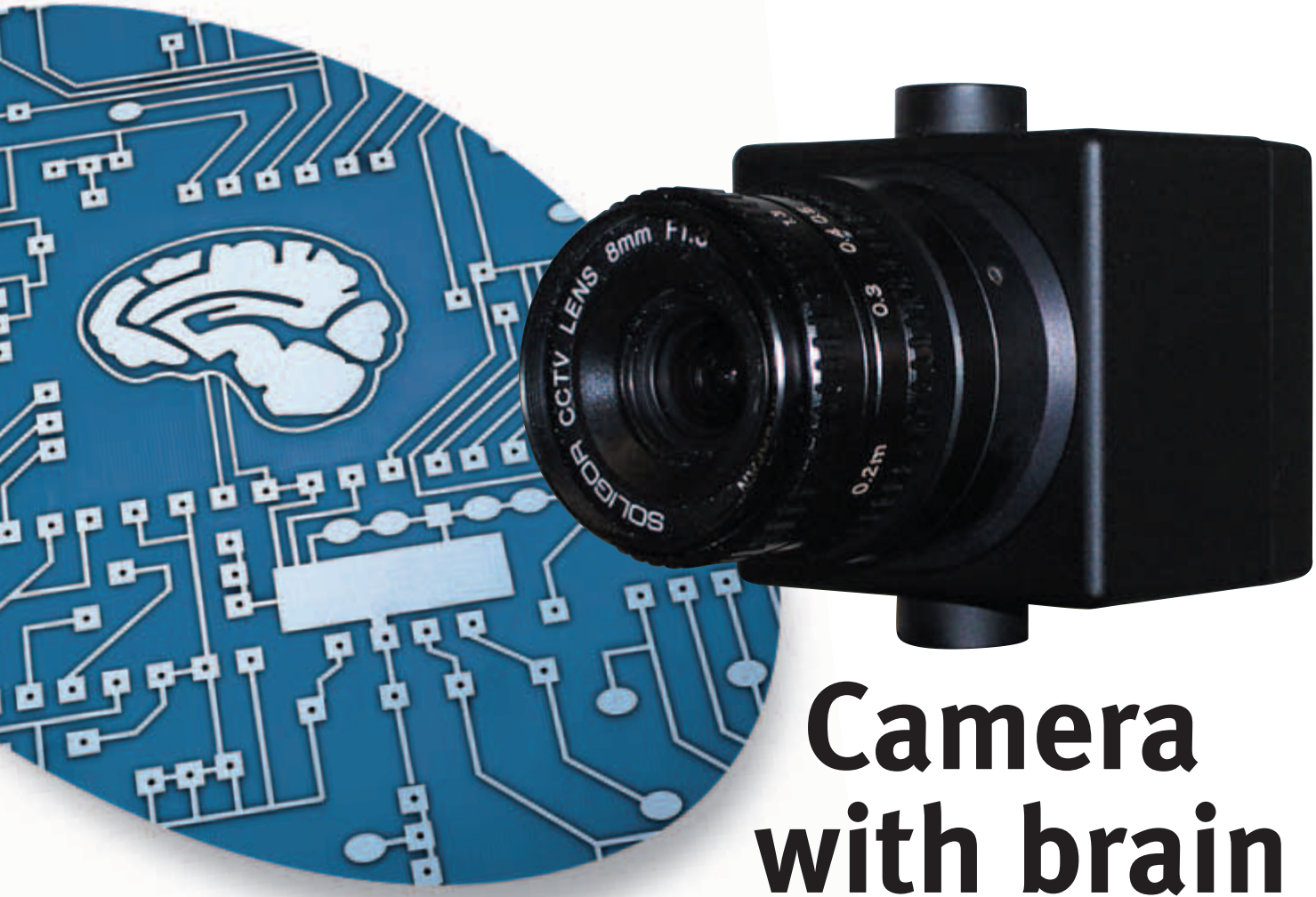

Camera with brain

Intelligent Cameras and compact Vision Systems – Possibilities & Limitations

In addition to PC-based imaging solutions, intelligent cameras and compact vision-systems became significantly more important in the last years.

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A current study prognosticates these small image processing systems a growth of 20% for the next years, with a general growth of about 10% for the whole branch of industrial image processing. In order to decide, which system is the better one, possibilities and limitations of intelligent cameras and stand-alone vision-systems should be discussed.

The idea is inviting

The idea is inviting: instead of a conventional PC with built-in frame-grabber and connected vision sensor, a small intelligent camera is used, which takes over all imaging tasks, in the best case with the same performance and flexibility, but at a lower price as a vision workstation. Can this work? It could , if some basic concepts and limiting conditions are considered.

First of all it is very important that the responsible person for the vision-system, or the consulting partner exactly knows the application and its needs. Questions concerning the system choice that have to be answered here, are:

- How many black-white/colour cameras are needed?
- Are these cameras running free or is a synchronisation between the sensors necessary?
- Which machine interfaces are needed?
- What about image processing?
- Which and how many operations have to be done in a certain time?
- How CPU-intensive is the image processing job?
- Which additional services have to run? How much CPU time will they need?

The answers to these questions result in a profile for the needs and in corner marks of the performance data for the necessary vision components. On the basis of the following criteria, it should be easier to decide what system is suitable for the application.

In general the mentioned vision-systems can be classified as shown in the graphic opposite.

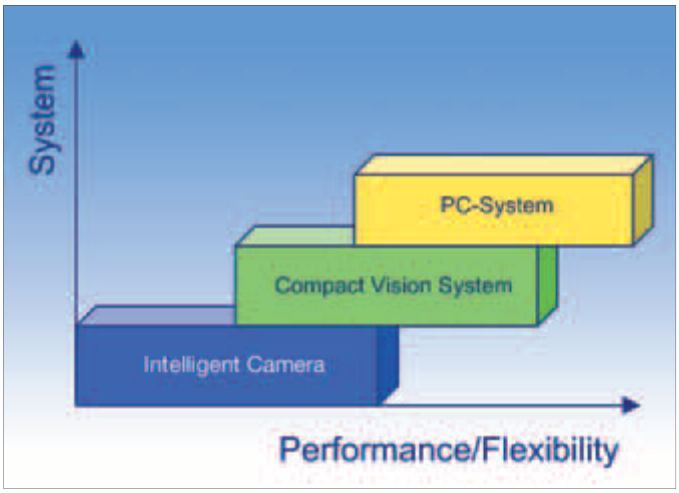
Things are in motion

Intelligent camera systems normally work with microcontrollers or signal processors, optimized for embedded devices due to the limitations of space and of the possibilities of leading away the waste heat. So they often do not have the computing power like a processor used in PCs and workstations. Compact vision-systems can be positioned in the midrange area. They dispose of significantly more computing power, than intelligent cameras. The upper end of performance is still occupied by PC-based systems with its gigahertz processors and slots for several even large PCI-cards. But there is no clear-cut dividing line for using and things are in motion.

Consequently CPU-power is one of the most important reasons for using PC-based image processing computers. But the question is how much CPU-performance is effectively used and really necessary? During many applications vision PCs are bored, so that just here intelligent, compact systems have a number of advantages.

According to their type compact systems are extremely small and therefore space saving. The configuration and programming tasks can be done with a temporary connected terminal or remote from a workstation for centralized administration. In the case of intelligent cameras and small fan-less compact systems, the manufacturer has to see to a power consumption as low as possible to limit the temperature of the inner room of the mostly closed chassis. This becomes very important, in case the ambient temperature grows to a high level. A failure of a fan in workstation systems could quickly lead to a breakdown of the processor and other important electronic components. Here fan-less embedded systems are much more robust.

When comparing different vision-systems, it is not only the technical possibilities and features that are important, but also the costs of a system. Apart from the initial price for a system the operating costs are a significant factor in the calculation of the total costs. These costs for the running system consist of the outlay for energy, room and particularly for maintenance. And right at this last point compact systems have a further great advantage over PC-based vision systems. Intelligent cameras and stand-alone vision systems are closed systems in comparison to a PC. It may sound trivial, but an Office-suite, a service pack, a new Internet Explorer patch or a device driver for a printer or something like that, is installed quickly on a system. Unfortunately there is no guarantee that the system will work properly and stable after the installation process. There arise conflicts between different software packages over and over again. Some malfunctions may appear with a time delay or only under certain circumstances, aggravating troubleshooting and leading to high hidden costs. With hard discipline and strict approval criteria not applied, you run a big risk!



Positioning of Vision Systems

Embedded devices however usually run special fitting operating systems, which are not changed any more during operations. These operating systems can be proprietary developments from the system's manufacturer or independently buyable software like embedded Linux or also Microsoft WinCE or XP embedded. This heightens the hurdles of having a try at the software configuration. But if the necessary knowledge and tools are available (appropriate training should be offered by the manufacturer or distributor of the device), embedded operating systems provide the chance of building a bespoke operating system particularly for OEMs, which offers many services, but not more than the required ones. For this of course a test environment is needed, to avoid the mentioned disadvantages and risks.

Embedded operating systems

As an example two embedded operating system are named, µCLinux and Microsoft Windows XP embedded. Both operating systems are there divided in components, from which the executable runtime image has to be built. As a result the system builder has the entire control over the system and its components. He decides which services are allowed to run on it and which not. Of course own components for custom drivers or applications can be integrated as well. Operating systems reduced in such a way thus have significantly lower requirement in free hard disc space (footprint), but the reliability is increased because of the reduced number of services and applications running on the system. In addition to that Linux-based operating systems have the advantage that no licence-fees are claimed. However this does not mean that Linux is cost-free! XP embedded however can be integrated more easily in existing Windows-based networks, especially if Linux know-how would have to be built up for such a system.

An example for a system with embedded Linux is the intelligent camera CANCam of the company Feith Sensor to Image. Although the camera is extremely small, it provides a complete computer with great flexibility and performance. Further information can be found under www.feith.de.

Intelligent camera systems reach their limits, if the application needs high computing power and/or it is necessary to have synchronized image processing of different cameras. Here compact vision-systems, which have more computing power and several video-ins, can offer something more performance. The upper end is still being covered by image processing workstations with partly several powerful framegrabbers. Anyway, it is possible to move the limits, if the camera or compact vision-system owns capabilities for image pre-processing, which work independently from the host's CPU. This could be realized e.g. in a fitting hardware design within a FPGA.

Alternativ for PC systems

The most detailed offerings for libraries and programming tools designed for vision applications exist for x86 based systems and therefore also for compact vision systems, which are x86-based too, and fulfil the other system requirements. For intelligent cameras such a variety of different software tools does not exist. Only a few vendors offer a library, which can be used both on a PC and the camera system. But such a combination makes the application development job significantly easier and more quickly. In most cases special camera-specific libraries and development tools are provided. Whether such a solution is sufficient, can not be answered generally. This must be decided in the context of the application and its needs.

Summarizing, one can say that in many fields of image processing application intelligent cameras and compact vision systems are a real alternative solution to PC-systems, especially when the applications are not extremely time critical.