Purchasing third-party machine-vision software can make a lot of sense for OEMs who don’t want to maintain their own in-house code library. Heiko Eisele, president of MVTec LLC, the US subsidiary of Germany-based MVTec, commented on recent changes in standard software packages and talked about how vendors are improving their offerings.

**Q:** What’s behind the rise of third-party, hardware-independent machine-vision software?

**A:** As machine-vision hardware has become a commodity, innovation now occurs mostly in software, and there are more vendors offering third-party standard packages. Standard products have been used in tens of thousands of similar installations and are extensively tested and field-proven, so they’re more reliable than a package you create in-house. There are still far more hardware than software manufacturers, but competition among software vendors has increased in terms of the tools, algorithms, and hardware SDK [software development kit] support they provide. For example, although MVTec has offered support for parallel processing since 2000, multiprocessor and multicore support is now also a feature of some other vendors’ software packages.

**Q:** What other improvements are appearing in machine-vision software?

**A:** Support for 3-D vision is improving. In 3-D calibration, for example, you want to be able to precisely measure the image, and that requires an accurate camera model. In our latest software release, Halcon 9.0, we extended the existing model to include higher-order mathematical terms. This gives a more accurate description of the imaging process, so the camera produces more accurate data. We also provided new operators for sheet-of-light measurement and added multigrid stereo capability.

Other changes include increasing the user friendliness of the development environment. For example, ours provides tools that let you develop algorithms much faster, by automatically generating code based on the user’s interaction with the software. Users have access to the entire library so they can write their own code, but certain tasks can be made more intuitive with a graphical user interface. We are providing this combination for more and more tools in our library, so users can quickly fix problems in the applications they develop.

**Q:** How else are vendors improving software?

**A:** In semiconductor and solar-cell inspection, as well as flat-panel displays, you must look at very fine detail in a large area. So, the use of line-scan cameras is increasing because of their higher resolution and their larger field of view. That means bigger images, which is the main reason we have removed the previous image size restriction of 32k x 32k. Larger images also require more memory, driving the trend to packages like Halcon that support 64-bit operating systems. As long as there’s enough memory in the host computer, you can process images of any size.

Another trend is the increased use of infrared imaging in inspection as sensor quality improves, bringing less noise and more accurate response. Infrared cameras used to be big and expensive, because the sensor had to be cooled down considerably to reduce image noise. Now, many infrared cameras operate at room temperature, making them cheaper and easier to use in a manufacturing environment, such as for managing heat dissipation.
Camera Link camera boasts 209 fps
Basler Vision Technologies claims that its A406k is the fastest 4-Mpixel Camera Link camera on the market, capable of operating at 209 fps at full resolution. The A406k achieves this high frame rate using a 10-tap, 85-MHz Camera Link configuration, transferring approximately 800 Mbytes/s, although this bandwidth limits the A406k to a maximum data depth of 8 bits.
Like other members of the A400 family, the A406k employs a CMOS sensor with a rolling shutter and is available in both monochrome and color versions. By using the supplied AOI (area of interest) list editor, users can change the size, position, and exposure time of a series of AOIs. www.baslerweb.com.

PCI Express frame grabber offers PoCL
The PIXCI EB1, a PCI Express x1 frame grabber from Epix, works with all area-scan and line-scan base-configuration Camera Link cameras and can be outfitted with a PoCL (Power over Camera Link) interface. The PIXCI EB1 offers low-latency, 250-Mbyte/s image transfer to a PCI Express bus x1 through x16 slot. The board safely supports PoCL cameras by detecting when a PoCL camera is connected and will disconnect power if it exceeds the specification.
The frame grabber comes with XCAP-Lite software and has camera-specific controls for most Camera Link cameras and generic controls for all other cameras. XCAP-Lite lets you load, view, and save images to and from files when the PIXCI EB1 is present. www.epixinc.com.

Pleora GigE SDK gains Linux option
With Version 3.0.0 of the iPORT Vision Suite for Linux, the iPORT SDK from Pleora Technologies now allows Linux-based GigE imaging programs to run on 64-bit architectures, effectively doubling the level of processing power available to Linux developers. Geoff MacGillivray, product manager at Pleora, explained that the Linux enhancement rounds out the company’s offerings for 64-bit platforms, complementing support for Windows Vista and XP. www.pleora.com.

Sapera Essential gains improved color capability
Dalsa reports that it has improved the color capability of its Sapera Essential machine-vision software. The hardware-independent Sapera Essential combines board-level image acquisition and control with advanced image-processing capabilities; the latest version supports Windows 64-bit and the .Net interface.
With the introduction of the Sapera Essential Color Tool, the software supports RGB, YUV, HSV, and LAB formats for color conversions. Split and merge functions are also available for plane-by-plane processing. The software processes color images through basic operators such as thresholding, histogram, projections, statistics, clustering, and color reduction. A color-correction algorithm can compensate for different lighting conditions, and a color classifier can separate color regions of an image.
Sapera Essential offers features such as Blob analysis, area and shaped-based pattern matching, and optical character recognition. An evaluation copy (32 bit or 64 bit) is available from the company’s Web site. www.dalsa.com.
Power over Camera Link enables smaller systems

By Ann R. Thryft, Contributing Technical Editor

A little more than two years ago, the AIA (Automated Imaging Association) ratified two extensions to the Camera Link standard: the PoCL (Power over Camera Link) interface and the mini-Camera Link connector. Since then, user demand has risen for these interfaces, especially PoCL, in cameras and frame grabbers used in machine vision. Both help facilitate smaller cameras by reducing the size of the camera’s back panel.

PoCL helps reduce the number of necessary cables, and the number of connectors on the back of a camera, by powering a camera directly through the interface. “The interface eliminates the need for a separate power supply,” said Steve Kinney, JAI’s director of technical pre-sales and support, who also chairs the AIA’s Camera Link committee. “It provides a clean, one-cable solution that fits more easily into crowded spaces, saves on cabling costs, and avoids problems caused by cables rubbing together.” This is important in repetitive, space- and weight-critical environments such as semiconductor and electronics inspection, where cameras repeatedly move very quickly over the surface of a board or wafer.

Since PoCL provides only 4 W, users of high-performance cameras will still need external power supplies. But many smaller cameras can be powered with PC-based frame grabbers using PoCL, said Kinney. “In the Camera Link standard, there are four redundant pins assigned to ground, one on each corner of the connector. In Power over Camera Link, two of those pins are reassigned for power.”

The size of the back plate in most frame grabbers accommodates a maximum of two Camera Link connectors, said Kinney. But the mini-Camera Link connector, which is pin-for-pin compatible with the original, is only half the width and half the height of it, so four can fit in that same space.

“We see Camera Link and GigE Vision as the two dominant vision standards in the near future,” said Kinney. Improvements to PoCL are in the works: Although the current implementation only provides for 4 W over a single base Camera Link configuration, in theory it is also possible to provide 8 W over a medium or full configuration. Members of the Camera Link committee are currently working on proposals to do exactly that.

FOR MORE INFORMATION
Frame grabbers thriving in inspection

By Ann R. Thryft, Contributing Technical Editor

If a slew of new frame-grabber products is any indication, these image-acquisition boards are thriving in electronics and semiconductor inspection. Recent product introductions from Adlink, Dalsa, Euresys, Matrox Imaging, National Instruments, and Sensoray, among others, include interfaces such as PoCL (Power over Camera Link) or 1394b (FireWire), take advantage of PCI Express bandwidth, incorporate additional logic for image preprocessing, or take GigE Vision functions onboard. One frame grabber from Imperx resides on an ExpressCard in a notebook computer.

Although users may associate frame grabbers with older analog interfaces, engineers are actually using them widely with digital interfaces. “Most camera manufacturers are moving to standard digital buses like Camera Link, GigE Vision, and IEEE 1394a/b because of their lower implementation cost,” said Matt Slaughter, vision products manager for National Instruments. “With standard interfaces, the ease of combining cameras and frame grabbers from multiple vendors with a minor configuration effort means you can have a system up and running in a very short time.”

In particular, vendors say, frame grabbers are needed where either the combination of resolution and bandwidth or else bandwidth alone is very high. “In terms of imaging needs, the semiconductor/electronics segment can be divided into two major groups,” said Dwayne Crawford, product manager for Matrox Imaging. Wafer, LCD, and PCB (printed-circuit board) inspection constitute the first, high-end group, with similar data rates and image sizes. “The number of pixels you need to inspect an LCD panel or the larger dies is increasing exponentially,” he said. “Fine details are shrinking in semiconductor geometries, as well. In PCBs, geometries are also shrinking, but throughput is more of an issue.” In the second group, wafer bumping and wire-bonding inspection, large images are not a concern: Although frame rates are high, data throughput is not. But in these applications, image acquisition must be synchronized with motion-control I/O.

Because of its very high bandwidth, Camera Link has become the de facto serial digital standard for use with frame grabbers in machine vision, said Inder Kohli, Dalsa’s product manager for frame grabbers and vision processors. “Since FireWire and GigE Vision interfaces are ubiquitous in PCs, you can use them to bring in camera data,” he said. “But Camera Link is driving both the growth of, and many trends in, frame grabbers and vision processors.” In semiconductor and electronics inspection, users want more efficient, less costly production lines, reflected in better resolution and higher frame rates in cameras. GigE and FireWire rates are not high enough for every application in this segment, so frame grabbers are still needed here, he said.

One trend affecting frame grabbers is the evolution of the AIA’s Camera Link standard, as evidenced in the PoCL interface, said Kohli. In some semiconductor and electronics applications, such as wire-bonding inspection, small, lightweight, high-bandwidth cameras use single-cable connections incorporating power and data. He explained that although in-line power is native to FireWire, adding power to GigE lines could add cost and complexity to a vision system. “Power over Camera Link cameras cost-effectively deliver power and higher bandwidth data on the same cable,” he said. Crawford said that Matrox Imaging, like some other frame-grabber manufacturers, has added support for the interface to its newer product families because PoCL helps reduce camera size and simplify cabling.

Manufacturers are also adding onboard logic to handle a variety of processing tasks. As data rates increase, image data must be processed faster, so even more preprocessing tasks must be offloaded onto frame grabbers to
reduce the load on the host computer’s CPU, said Kohli. Dalsa’s Xcelera-CL PX4 SE has a suite of onboard processing functions, such as color space conversion and defect analysis, that users previously performed with custom boards or a vision-processor board. “Combining onboard processing capability with PCI Express’s high transfer bandwidth, as we’ve done with the Xcelera SE, lets the frame grabber provide both raw images and processed data concurrently, making processing more efficient and cost effective,” he said.

Preprocessing functions can help correct optical artifacts such as distortion that are becoming a greater problem as sensors get larger and pixels shrink in geometry, said Crawford. “Preprocessing operations—such as optical and prospective distortion correction, flat-field correction for uniform sensitivity and responsivity across the sensor, and dead pixel replacement—are therefore more relevant,” he said. “Single FPGAs [field-programmable gate arrays] can handle these operations well, and correcting image artifacts must occur before you even begin processing the images, so we’ve put them on our frame grabbers, such as the Matrox Solios family.”

In some of its frame grabbers, National Instruments offers the option of onboard, user-programmable FPGAs for controlling timing, triggering, and I/O. The FPGA can also be used to synchronize multiple cameras and lights, or control hardware like actuators with precise timing, said Slaughter.

All of Imperx’s frame grabbers are made for notebook computers, said company sales manager Nathan Cohen. “Notebooks are entering machine-vision applications more and more as they come equipped with dual-core and quad-core processors, huge amounts of memory, and higher bus speeds” he said. “You can use...

---

10 GigE may be coming to machine vision

At the high end of electronics inspection, bandwidth needs surpass what’s available in FireWire and GigE, said Dwayne Crawford, product manager for Matrox Imaging. “They even surpass what’s available in Camera Link, pushing the envelope beyond 1 Gbyte/s to as high as 5 to 6 Gbytes/s. No standard interfaces handle data rates that high, not even 10 GigE.”

For this reason, the AIA’s (Automated Imaging Association’s) GigE Vision committee has started the High-Speed Transmission Subcommittee to investigate technologies with speeds faster than Camera Link, said Crawford, a member of the subcommittee. “These include aggregating multiple 10-GigE links to apply networking techniques to high-end machine vision. In a system that uses Ethernet, managing determinism becomes a major issue, much more so than it is in networking applications such as VoIP.”

To bring a 10-GigE layer onto GigE Vision, a frame grabber is needed to convert packet data into an image format, offloading that function from the host, said Eric Carey, director of R&D for Dalsa and chair of the AIA’s GigE Vision committee. “Although GigE cameras use the host to de-packitize images, at much higher 10-GigE data rates, this would prevent the host from accomplishing other tasks,” he said.

Frame-grabber-like products in high-end applications enable the packets for deterministic events, such as triggers and exposures, to be manipulated at a very low level in the protocol by hardware, before the operating system can introduce latency and jitter, Crawford explained.—Ann R. Thryft
them for a small production run, [for] simpler systems that do not need many I/O controls, or for more complex systems that sit on the production line but need to be contained in a compact space. We’re seeing a rise in inquiries for electronics applications because people are shrinking their systems.” Notebooks equipped with frame grabbers make machine vision portable, and they are becoming popular in situations where a full desktop computer is not needed, he said.

The company’s newest model, FrameLink Express, was originally designed for military applications. A Camera Link model for newer, faster ExpressCard laptops, it can simultaneously acquire images from two Camera Link cameras. Because it’s compliant with ExpressCard, it provides up to 235 Mbytes/s of bandwidth, which is fast enough to work with line-scan cameras on an electronics production line, Cohen said. The FrameLink Express can do histograms, look-up tables, and hex pixel dumps, and it also integrates a timing generator. “With two inputs on the frame grabber, you can designate one camera as a primary and one as a slave and synchronize imagery very precisely for 3-D inspection, or use multiple cameras at different points on a production line,” he said. “Multiple inputs in a laptop also let you overlay images for multispectral inspection such as IR, UV, and visible light.”

More trends in machine vision will affect frame grabbers in the near future. One of the most important is dealing with the high bandwidth and huge images resulting from the use of Camera Link, said Slaughter. “In PCB and component inspection, you might want a really high-resolution image of a board or wafer, but what do you do with it? Do you stream it to a RAID array, or try to do some kind of in-line processing? If you are doing in-line processing, you won’t be able to do it very fast, so do you do post-processing?”

PCs equipped with multicore processors may be one solution, according to Slaughter. “One machine with a multicore processor can chop up the image into smaller data sets that can be processed in parallel,” he said. “Our software makes this easy by automatically splitting up the images into the right number of pieces based on how many cores your PC has.”

Some frame grabber manufacturers are adding support for Power over Camera Link because it helps reduce camera size and simplify cabling. Courtesy of Matrox Imaging.

55th Annual Technical Meeting of IEST
May 4–7, 2009
New Monday–Thursday Timetable!
Chicago Marriott Schaumburg (Northwest Suburban Chicago)

Understanding the Revisions: MIL-STD-810 Town Hall Forum

Learn about the mechanical and climatic test method changes in the recently issued MIL-STD-810G, and take the opportunity to voice your opinion! This in-depth review and open discussion, led by experts who wrote the revision, will address new freeze/thaw, time waveform replication, and multi-exciter testing.

Register online at www.iest.org.
Thermal imaging finds faults quickly

By Ann R. Thryft, Contributing Technical Editor

As chip sizes continue to get smaller, the ability to detect uneven heat generation and thermal dissipation on a chip’s surface becomes increasingly difficult but also increasingly important. Engineers in failure-analysis labs and design labs need thermal-imaging tools that can measure temperature distribution over chip surfaces and quickly detect hot spots, which decrease efficiency and frequently lead to early failure.

“Hot spots reduce chip performance, because current and speed decrease exponentially with temperature,” said Richard Barton, technical director for OptoTherm. “An increase of only 10 to 15°C can decrease chip life by 50%. And large thermal gradients can cause signal-integrity and timing problems, such as when a hot processor circuit is located next to relatively cold RAM.”

Other causes of hot spots on chips are incorrect wiring patterns, shorts or breaks in wiring, incorrect deposition of insulating films, increased transistor leakage, and improper die bonding. If the thermal-imaging system shows that there is indeed a hot spot or spike in temperature on a packaged chip, the system user may need to decapsulate the device in order to look at the bare die and try to isolate the hot spot, said Barton.

Thermal imaging can also make it easier for engineers to locate short circuits. For example, OptoTherm’s Micro thermal-imaging microscope system includes a Find Shorts software tool that quickly detects very small increases in temperature as a chip or board is powered. “Using this tool, we’ve found temperature increases as small as 0.03°C, which translates into an increase of only a few hundred microwatts,” said Barton.

Although thermal imaging is typically used in failure-analysis labs, engineers can also use it to verify new designs. At the design stage, engineers can check for problems like thermal runaway, which is caused by transistor current leakage, which in turn increases as temperature increases.

Failure analysis of small boards, such as identifying defective and marginal components, is also made easier with thermal-microscope systems. Another OptoTherm software tool, called Model Board Comparison, detects very small temperature differences between properly functioning components and defective components on small circuit boards. It captures a sequence of thermal images during functional or diagnostic tests of one or more known-good boards that have an established, correct thermal performance. Those images are then used to create a software model of the board, which is compared with a defective board.

“If you are running a functional test where different areas or components are powering up at different times, it’s important to know where hot or cold spots occur, or to identify an area of a module that’s not receiving power, or a component that’s activating when it shouldn’t be,” said Barton.