New Smart Cameras Help Drive Industry 4.0

By Fulvio Pozzalini, Technical Product Manager with Tattile

Industry 4.0, whether it is referred to as the “Smart Factory” or the “Industrial IoT,” has long offered more conceptual ideas than realizable solutions, at least from the perspective of outside observers. Yet for those involved in advanced automation, where factories are becoming smarter, more connected, and autonomous, Industry 4.0 is an everyday reality. A new breed of smart cameras is acting as the “eyes” of these factories, and helping to turn far-fetched Industry 4.0 concepts into practical solutions with tangible improvements in the monitoring, analyzing and controlling of data from anywhere on the globe.

First introduced in the 1980’s, smart cameras combine lenses, sensors, processors, interfaces and software together into small, all-in-one vision systems. Besides being inexpensive, their primary advantage is having the on-board computational ability to solve a vision task independently without connection to a host PC. A compact form factor also makes smart cameras easy to fit in tight spaces or to retrofit into an existing process. Since they have few moving parts and do not generate high temperatures, maintenance costs are kept low. Smart camera systems are also typically provided with GUIs for developing a machine-vision inspection program with little or no programming. Smart cameras that integrate fast CPUs may even allow the use of familiar off-the-shelf software packages designed for PC-based systems.

Until the late 2000’s, smart cameras featured mainly low-end processors and were deployed for single-purpose applications, such as bar code reading, go/no go decision making, OCR or counting. Difficulty managing sophisticated algorithms meant that complex images or operations requiring rapid analysis were well outside their scope. As processing improved, however, smart cameras began to compete with PC-based systems in applications including assembly verification, 1D and 2D barcode inspection, and robotic guidance.

Processing power has long been a problem for smart cameras, prompting many customers to ask “why not incorporate larger processors?” Simply put, a larger processor and FPGA means a much larger camera. The same goes for a larger sensor to increase image resolution. Both defeat one of the main benefits of the smart camera: compact size. Also, a larger processor requires additional power consumption resulting in higher heat dissipation. Using a fan isn’t an answer since it introduces the potential for mechanical failure. Fans also cause vibrations that could influence measurements. As a result, system integrators have continued to rely upon traditional PC-based cameras for high-speed, complex applications and smart cameras for low-end, single-purpose applications, or they’ve simply added more smart cameras to gain more power — not an efficient solution.

A MORE INTELLIGENT SMART CAMERA

Meeting the needs of Industry 4.0 required a new breed of smart camera, one that combined multi-megapixel resolution and speeds comparable to a PC-based system, but without the size, heat and power drawbacks associated with bulky processors or sensors. Easy-to-use, open source software was a must for rapid and successful development. In addition, since network connectivity is the key factor defining a successful Industry 4.0 program, the camera had to be built around a proven machine vision standard such as Camera Link, GigE Vision, CoaXPress or USB3. Finally, an industrial-grade IP67 housing was essential to survive the harsh chemicals, vibration, moisture, extreme temperatures, dust, and other contaminants found in an industrial environment. All this... and the new smart cameras had to cost less to buy and maintain than their PC-based counterparts.

Thankfully, this new breed of smart cameras is available from Tattile (www.tattile.com). The company found inspiration in the wave of miniature, low power technologies that were a byproduct of Industrial products. Tattile has transferred components typically used in Industrial product, such as ARM processors and CMOS sensors, and developed a line of smart cameras that meet the demanding reliability and reproducibility requirements specific to machine vision. Tattile smart cameras have gotten faster, smaller and more affordable every year, which is leading to higher adoption rates in Industry 4.0 projects for its customers, as well as in traditional PC-based machine vision applications that can now use a Tattile smart camera.

At the forefront of Tattile's smart camera line is the new S12MP. It delivers lightning-fast speeds up to 300 frames-per-second at full 12 megapixel resolution in 10-bit mode or 140fps in 12-bit mode, a capability that was unheard of a few short years ago. Speed can be further increased by reducing the acquisition ROI, therefore reducing the amount of data per image. Image processing architecture consists of a Xilinx 7030 class SoC dual-core ARM Cortex A9 processor and a Xilinx Kintex 125K FPGA that handles image preprocessing and communication interfaces to ensure real time management and zero latency. The S12MP has more than twice the resolution of 5MP smart cameras currently on the market that are touted as "high resolution". Its 12MP resolution helps system integrators do more with fewer cameras and cables, saving money on their designs. Moreover, by swapping PC-based cameras for a smart camera, the integrator eliminates the need for frame grabbers and the time-consuming set-ups of each individual camera.

Like all Tattile smart cameras, the S12MP is based on the Linux OS. Open source lets customers develop custom applications employing their own code or third-party libraries such as OpenCV, ready to use and free of charge. Recently, Tattile formed a partnership with MVTec in order to have a special version of Halcon vision library created that runs on its smart cameras, a move that ensures easier application development. Applications can be built and tested on any computer without the need of a custom cross-compiler or a board support package.

Typically, smart cameras use closed systems, meaning you can only deploy software from the same supplier. This approach is in direct contrast with the ideal of the Smart Factory which calls for customization, flexibility and scalability. When a programmer can't do anything more than what the software installed on a camera lets them do, they are operating with your hands tied. By deploying Tattile cameras with Linux OS, however, the programmer can maximize the productivity of a vision system at a lower price.

Tattile smart cameras are equipped with FPGAs that can be tailored for specialized target applications, and are compelling alternatives to x86 processors. The FPGAs manage the image sensor and I/O, a configuration that translates into vastly improved acquisition management and a reduced working load for the CPU. Unlike complex FPGAs found on legacy smart cameras, the Tattile FPGA can be easily programmed through the VHDL language or with VisualApplets by Silicon Software. The user has the option to directly implement its proprietary algorithms into the FPGA to decrease the load of the CPU that in turn only has the task of analyzing the data being extrapolated by the FPGA.

BETTER, FASTER, STRONGER

In Industry 4.0 settings, Tattile smart cameras can be connected with most components and systems involved in the industrial value creation process as well as to the factory's networks and the Internet. Ethernet networking connects Tattile smart cameras to automated devices that act on provided information, instantly leading to desired actions without any human intervention. Instead of being a reactive tool to detect defects, Tattile smart cameras have become extraction tools that employ Big Data-style statistical and data science techniques to draw insights from images and apply them throughout the enterprise.

For example, with the use of data analytics and Tattile smart cameras, a plant manager is able to determine when a piece of equipment will fail before the maintenance crew notices there is a problem. The systems sense warning signs, use data to create maintenance timelines, and preemptively service equipment before trouble starts. Or consider the use of smart cameras to acquire images of molded plastic parts at every stage of the production process, starting at the locations of suppliers. Images recorded of parts can be compared with thousands of others stored in the cloud to identify correlations and trends. Or they can be combined with data from sensors from other connected devices to gain insights into how each step and variable impacts the final product.

Going forward, an increase in processing power, together with software advances, will help overcome one perceived disadvantage of smart cameras – flexibility — and expand the scope of smart camera applications. Healthcare, pharmaceutical, food & beverages, military, surveillance, and industrial are all anticipated to offer smart cameras a healthy growth rate.

Specifically for Industry 4.0, smart camera manufacturers like Tattile are working to accommodate the range of industrial networking standards used in automation so that their cameras are able to communicate across all industrial protocols and with standard discrete I/O. Factory protocols can be directly integrated on some cameras today, but emerging protocols like Ethernet/IP and PROFINET may require third-party converters.

While current points of view differ over meeting the challenges presented by Industry 4.0, one thing everyone can agree on is that smart cameras will play a game-changing role in its development and adoption. No other component on a production line captures more information than a smart camera — assessing products, flagging defects, and collecting data that is transformed into actionable information and insights that can drive measurable performance improvements.

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