NEXCOM
The Intelligent Systems

White Paper

New Eyes for Precision Machining

Making Factories Agile and Efficient with Vision-Equipped IoT Controllers

Industry 4.0 is connecting the Internet of Things (IoT) and cyber-physical systems, giving rise to the smart factory and a new generation of industrial machinery.

The convergence of physical and digital worlds is giving rise to the smart factory and a new generation of industrial machinery. Known as Industry 4.0, this new era is connecting the Internet of Things (IoT) and cyber-physical systems to streamline manufacturing and business processes, improve versatility and precision, and reduce lead times and waste.

Turning a traditional factory into a smart factory to achieve these advantages, however, presents multiple challenges. These include:

- Accommodating the sheer variety and size of the machinery involved
- Managing the complexity of distributed control systems that can include hundreds of control nodes
- Connecting and integrating the multitude of sensors and legacy devices on isolated factory networks

This article describes a PC-based IoT controller that runs on-machine vision solutions and performs IoT gateway services. We look at how this controller delivers new levels of performance and agility to machine vision. We explain the role of real-time industrial Ethernet technologies in ensuring the smooth coordination of multiple control nodes. We discuss how open standards and pre-integrated CODESYS SoftMotion CNC RTE and NEXCOM nexECM software accelerate the development and deployment of multi-function machinery. And we investigate how the performance capabilities of the 6th generation Intel® Core™ processor product family enable a single IoT controller to perform so many tasks.

The Demand for More Versatile Machine Vision

Machine vision systems identify faulty incoming work pieces, guide the positioning of work pieces, and inspect finished parts for quality control. Isolated from the chain of automated control, older, traditional purpose-built machine vision systems lack motion control APIs. They can deliver little more than pass/fail determinations and require programmable logic controllers (PLCs) to handle control functions (Figure 1). Because data often goes uncollected in these systems, correlating variables, spotting trends, and implementing predictive maintenance is difficult, if not impossible.

A New Generation of Machine Eye

Modern pressures to increase efficiency, yield rate, and capacity have created

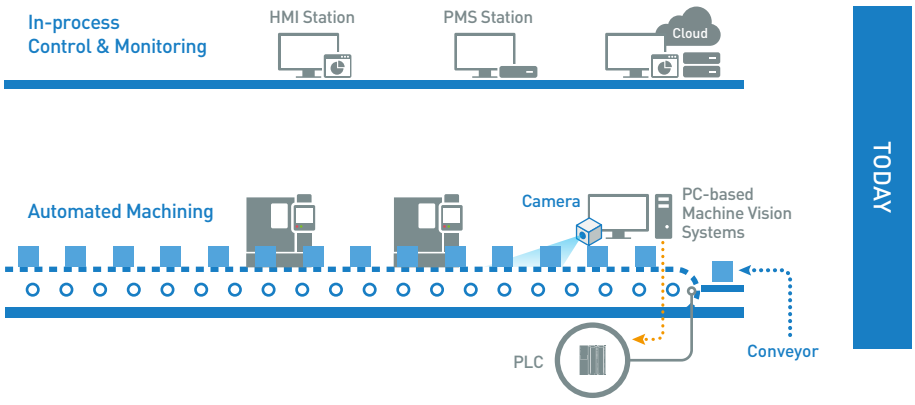

Figure 1. Many of today's machine vision systems work in isolation from the automated control chain.

New machines offer IoT connectivity, increases in computing and image processing, and on-machine vision.

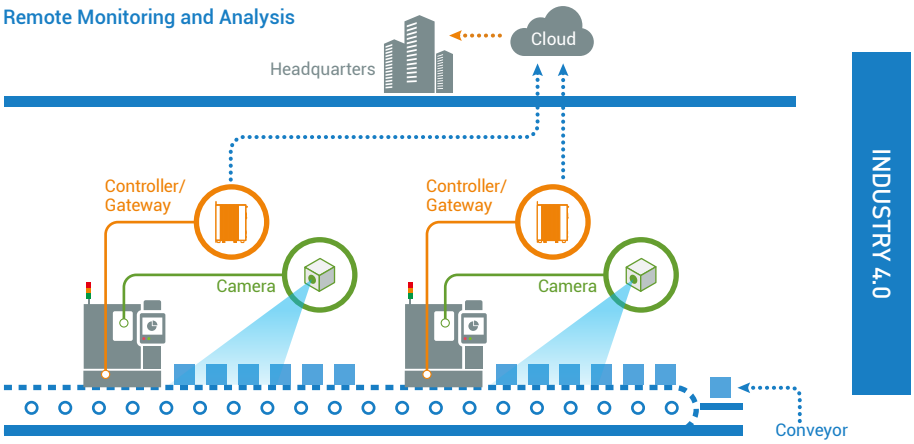

Figure 2. Industry 4.0 modernizes operations with solutions such as IoT industrial controllers that integrate machine vision and cloud connectivity.

demand for a new generation of machine vision systems. IoT industrial controllers that incorporate machine vision are now coming online – literally. These sophisticated and versatile systems offer IoT connectivity and massive increases in compute and image processing, as well as data storage (Figure 2). Their on-machine vision enables greater precision and coordination.

Modern web services and dashboards allow factory management personnel to remotely view machine vision data from these integrated machine vision/IoT controller systems. Sharing this data with supply chain partners makes it easier to identify issues and comply with reporting requirements for customers. Images can be streamed to cloud services for analysis with other manufacturing data to help find root causes of lower-than-expected quality or yield rate. Image data also enables closer monitoring of machining processes so that more timely adjustments can be made to maintain quality.

Recipe for Precision and Capacity

A modern IoT controller providing on-machine vision needs to deliver three capabilities: 1) high-speed imaging and analysis, 2) control and monitoring, and 3) IoT gateway functionality (Figure 3).

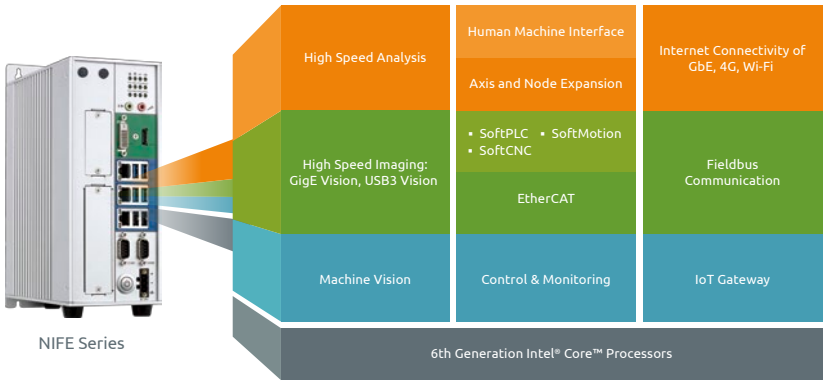

Figure 3. Integrated IoT controller and on-machine vision systems like the NEXCOM NIFE 300 combine high-speed analysis, highly synchronized control and monitoring, and IoT gateway functionality.

A modern IoT controller needs to deliver three capabilities: 1) high-speed imaging and analysis, 2) control and monitoring, and 3) IoT gateway functionality.

High-speed imaging and analysis is critical to production time. The shorter the time period there is between image capture and analysis, the shorter the cycle time.

Control and monitoring ensures quality output production quickly and repeatedly. Based on complex calculations, modern industrial controllers must coordinate control nodes and data exchange in near-real time for in-process modification and correction. To be versatile, these controllers must also support the high-mix, low-volume production required to meet modern demands for mass customization. They should be agile enough to quickly switch from performing one machining process on a material to performing a different machining process on something else. At the same time, they must readily accept auxiliary functions and enable remote management to avoid costly manual interventions, particularly in clean rooms or dangerous environments. Finally, to support human-machine interfaces (HMIs), these controllers must include graphics capabilities.

IoT gateway capabilities are important for greater transparency in factory operations. To provide the necessary IoT connectivity, industrial controllers must provide all the necessary protocols and operations for the connection of legacy devices to the cloud.

A Smart Factory, PC-based Machine Vision IoT Controller and Gateway

To accelerate the rollout of Industry 4.0, NEXCOM developed the NIFE 300, an on-machine vision IoT controller solution that bolts onto industrial machinery. Its open architecture delivers the high interoperability necessary to enable the consolidated functionality of Industry 4.0 systems (Figure 4).

Intended for large machinery and distributed control systems with hundreds of control nodes, the NIFE 300's PC-based open architecture and EtherCAT I/O enable

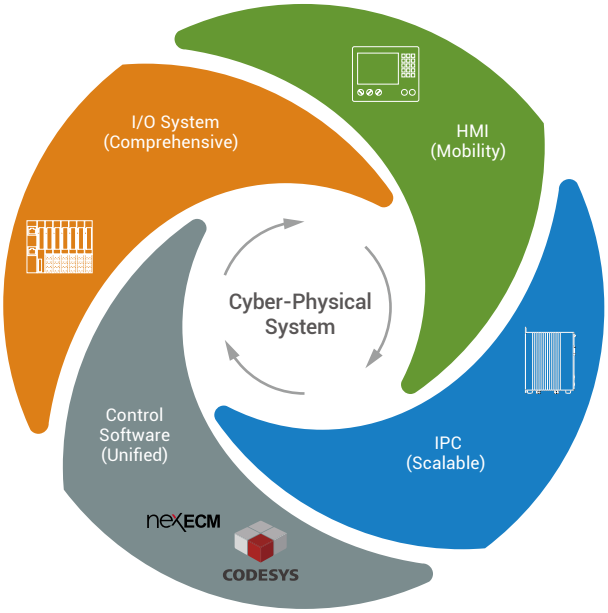

Figure 4. The NEXCOM NIFE 300 provides the consolidated functionality required for an Industry 4.0 IoT controller.

NEXCOM NIFE 300's PC-based open architecture enables extensive expandability and flexibility compared to PLCs.

extensive expandability and flexibility compared to PLCs. Equally important, its support for real-time industrial Ethernet makes the NIFE 300 an ideal fieldbus for providing:

- High-speed transmission and high synchronization for control nodes via a distributed clock approach
- Synchronization latency to within a tenth of millisecond
- Easy addition of extra function and control nodes

To address high-mix, low-volume production needs, the NIFE 300 meets PLCopen* specifications. For industrial machine manufacturers who adhere to IEC 61131-3 standards, the NIFE 300 facilitates control programming via CODESYS SoftMotion CNC RTE software. Using libraries of reusable logic and motion functionality, developers can more easily create control schemes for fast design of SoftPLC, SoftMotion, and SoftCNC functions.

For machine manufacturers that program with C/C++ languages, NEXCOM offers its nexECM software pack. This pack lets industrial machine manufacturers reuse assets, adapting existing motion-control functions onto IoT controllers to save development time and cost. NexCAT's EtherCAT configurator allows developers to employ real-time industrial Ethernet motion control without extensive knowledge of EtherCAT.

To facilitate management, the NIFE 300's HMI software, JMobile Suite, provides a graphical overview of machining processes and system status. Factory operators can access this view through a local HMI station or remotely through mobile devices and a web-based HMI. They can check settings, operations, and progress nearly anywhere at any time (Figure 5).

Powerful, Flexible Machine Vision Platform

Intel's newest wave of 14 nm processors, the 6th generation Intel Core processor family, makes the PC-based NIFE 300 a powerful machine vision platform. The built-in Intel® HD Graphics 530 deliver up to 30 percent better graphics performance over previous-generation graphics. These integrated graphics free up CPU resources while executing machine vision tasks so the NIFE 300 can perform high-resolution image analysis with extreme precision.

Figure 5. The NIFE 300's JMobile Suite is an HMI solution enabling local control and remote monitoring.

The combination of EtherCAT technology and multicore Intel® processors significantly reduces the number of controllers required.

The NIFE 300 supports both the GigE Vision and USB3 Vision interfaces commonly used for the connection of high-performance industrial cameras. Front PCI and PCIe interfaces make adding and connecting cameras to frame grabber cards easy for the acquisition of uncompressed images and lossless image compression.

A Versatile IoT Gateway

To bridge the gap between physical systems and the enterprise, the NIFE 300 functions as an IoT gateway providing fieldbus, Gigabit Ethernet (GbE), and 4G/ Wi-Fi connections. These connections support two-way communications between the factory floor, manufacturing execution systems (MESs), and enterprise resource planning (ERP) systems, giving "make to order" manufacturers greater agility. Manufacturers can also use the gateway functions to collect manufacturing statistics and other data for process optimization and predictive maintenance.

An Industrial-Strength Processor Family

The NIFE 300 IoT controller offers a choice of the Intel® Core™ i7-6700TE, i5-6500TE, and i3-6100TE processors. These 6th generation Intel Core processors deliver a leap in performance, power efficiency, and image processing. What's more, their faster DDR4 memory support and the additional high-speed I/Os enable next-generation industrial applications.

Intel® Core™ processors offer the multicore architecture required to consolidate systems and deliver real-time, deterministic performance. They enable the NIFE 300 to handle complex integration logic and motion-and- kinetics control tasks in parallel, commanding hundreds of axes or processing hundreds of thousands of I/O tag data. Further increasing multitasking responsiveness, the processors' Intel® Hyper-Threading Technology enables two processing threads per physical core.

The combination of EtherCAT technology and the ability of multicore Intel® processors to support higher channel density and greater multitasking significantly reduces the number of controllers required. The NIFE 300 makes full use of the processors' support of fast DDR4 2133 DRAM and high-speed interfaces. Machine manufacturers can order the controller with up to 16 GB DRAM. PCIe 3.0, USB 3.0, and SATA 3.0 ensure smooth performance of complex control schemes and image capture.

The processors' high-powered graphics engine brings dynamic real-time 3D simulation of machining paths – as well as Ultra HD 4K graphical display capabilities – to machining information and HMI applications. Intel® HD Graphics 530 supports the latest graphics APIs, including DirectX 12 and OpenGL 4.5, for energy-efficient rendering of 2D and 3D vector graphics. Hardware-accelerated video codecs enable fast transcoding.

Intel® Advanced Vector Extensions 2 (Intel® AVX 2) ensures efficient processing of image data. With newly optimized 256-bit integer instructions and new fused multiply-add (FMA) instructions for floating-point computations, Intel AVX 2 doubles the number of double-precision floating point operations per second (FLOPS) per clock cycle. This performance boost improves performance on robot guidance, positions and measurements of work pieces, and surface inspection.

Industrial machinery must be more intelligent, more agile, and more flexible to help manufacturers face mounting pressure to optimize operations and address new opportunities.

Making Today's Factory Smarter with Vision-Equipped IoT Controllers

In a global economy of fast-shifting markets and price competition, manufacturers face mounting pressure to optimize operations and address new opportunities. To help businesses attain these goals, the next generation of industrial machinery must be smarter, more agile, and more flexible. As a combined IoT controller and machine vision system, the NEXCOM NIFE 300 provides a true Industry 4.0 solution. Tapping the performance of the latest Intel Core processors, the NIFE 300 can help increase manufacturing quality and capacity, accommodate mass customization, and catalyze the fusion of physical factories and business systems for greater insight and process optimization.

Founded in 1992, NEXCOM integrates its capabilities and operates six global businesses, which are IoT Automation Solutions, Intelligent Digital Security, Internet of Things, Interactive Signage Platform, Mobile Computing Solutions, and Network and Communication Solutions. NEXCOM serves its customers worldwide through its subsidiaries in five major industrial countries. Under the IoT megatrend, NEXCOM expands its offerings with solutions in emerging applications including IoT, robot, connected cars, Industry 4.0, and industrial security.

www.nexcom.com

NEXCOM is an Associate member of the Intel® Internet of Things Solutions Alliance. From modular components to market-ready systems, Intel and the 400+ global member companies of the Intel® Internet of Things Solutions Alliance provide scalable, interoperable solutions that accelerate deployment of intelligent devices and end-to-end analytics. Close collaboration with Intel and each other enables Alliance members to innovate with the latest technologies, helping developers deliver first-in-market solutions.

Learn more at: intel.com/iotsolutionsalliance