NEXCOM
The Intelligent Systems

White Paper

Precision Machining for Industry 4.0

Industry 4.0 expedites the convergence of physical and cyber worlds, giving rise to a new generation of industrial machinery. The new generation of industrial machinery is closely intertwined with the Internet of Things (IoT) and emerges as a cyber-physical system which can streamline manufacturing and business processes, improve versatility and precision, and boost quality and capacity.

To achieve these advantages, this article considers a PC-based IoT controller designed to consolidate machine vision and precise control into one solution while connecting physical manufacturing systems to factory and enterprise networks. We look at this controller's ability to deliver new levels of performance, precision, and agility to machine vision and motion control. We explain the role of real-time industrial Ethernet technologies such as EtherCAT in ensuring the fast, smooth coordination of multiple control nodes. We discuss how multi-function machinery can be developed and accelerated to the market by using pre-integrated CODESYS SoftMotion CNC RTE and NEXCOM NexECM software. And we discuss how the controller also yields visuals of machining processes and provides the extensive support for industrial communication standards and internet connectivity suited to IoT gateway services. All delivered in one compact robust controller.

Furthermore, we look at how the compute performance of 6th generation Intel® Core™ processors contributes to the overall solution. We also consider their importance in enabling system consolidation and ensuring real-time, deterministic performance.

The Growing Demand for Machine Vision

Modern pressures to improve competitiveness in precision machining are spurring demand for a new generation of industrial machinery. To increase yield rate and capacity, this new machinery is capable of incorporating machine vision, enabling greater precision and coordination in quality inspection, complex machining, and analysis of complex processes.

The new machinery replaces traditional purpose-built, machine-specific systems, in which case machine vision was accomplished by one system lacking motion control APIs and enabling little more than pass/fail determinations, work pieces were machined by purpose-built computer numerical control (CNC) machinery, and conveyors were controlled by programmable logic controllers (PLC). Most of the data available from these systems went wasted, making it hard to correlate variables, spot trends, and implement predictive maintenance (Figure 1).

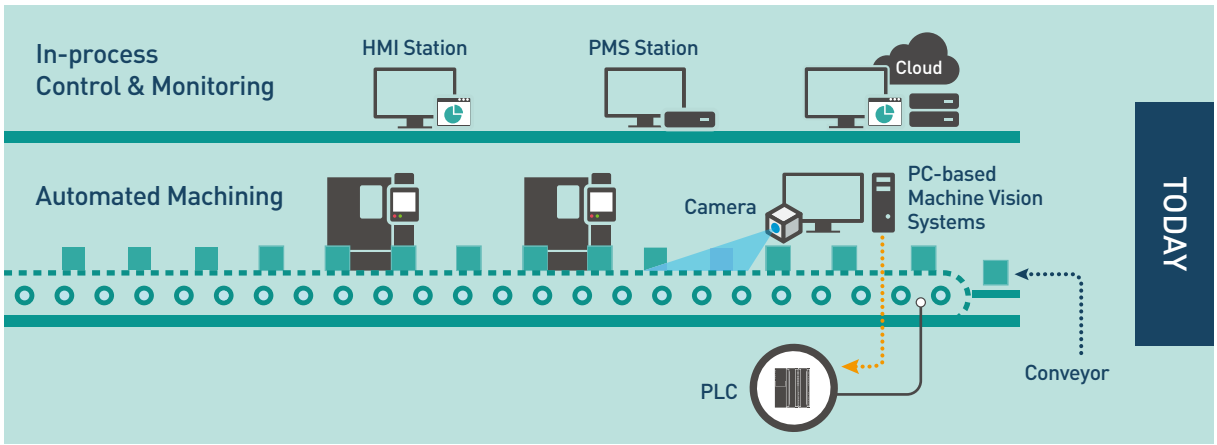

Figure 1. Many of today's machines work in isolation, making it hard to correlate variables, spot trends, and implement predictive maintenance.

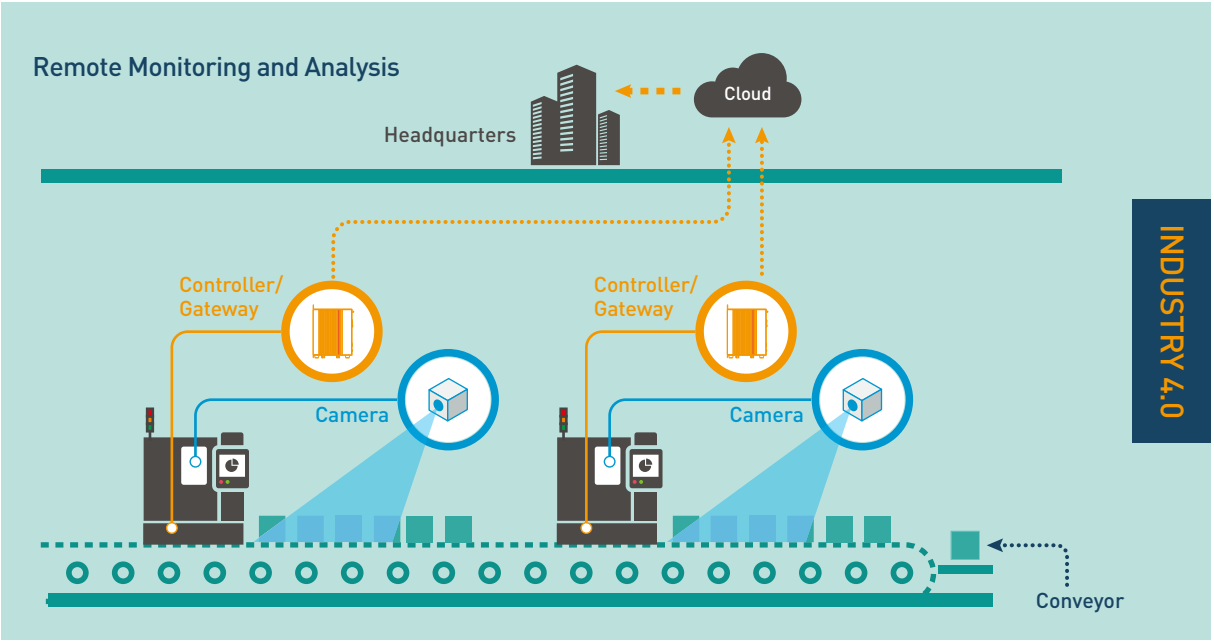

Figure 2. Industry 4.0 modernizes operations with solutions such as IoT industrial controllers that can perform multiple applications.

A New Industrial Controller

With the advance of new machinery comes a new generation of industrial controller. More sophisticated, versatile, and flexible, these new industrial controllers combine machine vision, control and monitoring, and IoT gateway on one unified platform (Figure 2).

Their on-machine vision guides the positioning of work pieces and enables in-line inspection for quality control. They spot faulty incoming work pieces to avoid wasting machine time and then inspect finished pieces to ensure quality output. With web services, machine vision data can be streamed to cloud services for analysis with other manufacturing data to help manufacturers find root causes of lower-than-expected quality or yield rate. Image data can also enable manufacturers to monitor machining processes to perform fine, timely adjustments.

Control and monitoring are essential for producing quality output quickly and repetitively. Industrial controllers must constantly exchange data among all control nodes and be able to coordinate these nodes based on the results of complex calculations in near real time for in-process modification and correction. They must also provide graphics capabilities for human machine interfaces (HMIs).

In addition, to meet modern demands for rapid production cycles and mass customization, IoT controllers must support high-mix, low-volume production needs. As opposed to traditional purpose-built CNC machinery, IoT controllers must be agile and flexible to perform different processes, readily accept auxiliary functions, and enable remote adjustments of functions. All of these attributes together provide a future-proof advantage for a lower total cost of ownership (TCO).

By functioning as an IoT gateway, IoT controllers increase the overall transparency of factory operations by connecting nodes on the factory floor to the intra-plant network and all the way to the cloud.

A Successful Formula

Openness for Value-added PC Applications

To accelerate the roll out of Industry 4.0, NEXCOM offers an IoT controller solution that supports PC applications such as on-machine vision and bolts onto industrial machines to convert them into cyber-physical systems. Based on 6th generation Intel® Core™ processors, the NIFE 300's open architecture provides a unified infrastructure for the consolidated functionality required of Industry 4.0 machinery (Figure 3).

For machine vision, the PC-based NIFE 300 makes a powerful platform for high-resolution image analysis and extreme precision. Intel's newest 14nm processors, the 6th generation Intel Core processor product family, delivers up to 30 percent graphics performance over the previous generation graphics. The integrated graphics free up processor resources while performing machine vision tasks.

Processing of image data is efficiently handled by Intel® Advanced Vector Extensions 2 (Intel® AVX 2). Intel AVX 2 gives a performance boost to floating point-intensive machine vision applications, hastening the outcome of robot guidance, positioning and measurements of work pieces, and surface inspection. Delivering imaging and analysis at a faster speed can translate into a shorter machine cycle time and higher capacity.

As to connection of high-performance industrial cameras, the NIFE 300 supports both GigE Vision and USB3 Vision interfaces; its 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. The PC-based open architecture enables the NIFE 300 to avoid the limited expandability and poor flexibility that is characteristic of PLCs. Design and programming software traditionally running on separate PCs is also supported on the NIFE 300.

Precise and Flexible Control Functions

Intended for large-size machinery and distributed control systems with hundreds of control nodes, the NIFE 300 simplifies node expansion and coordinated control with EtherCAT I/O. As a real-time industrial Ethernet,

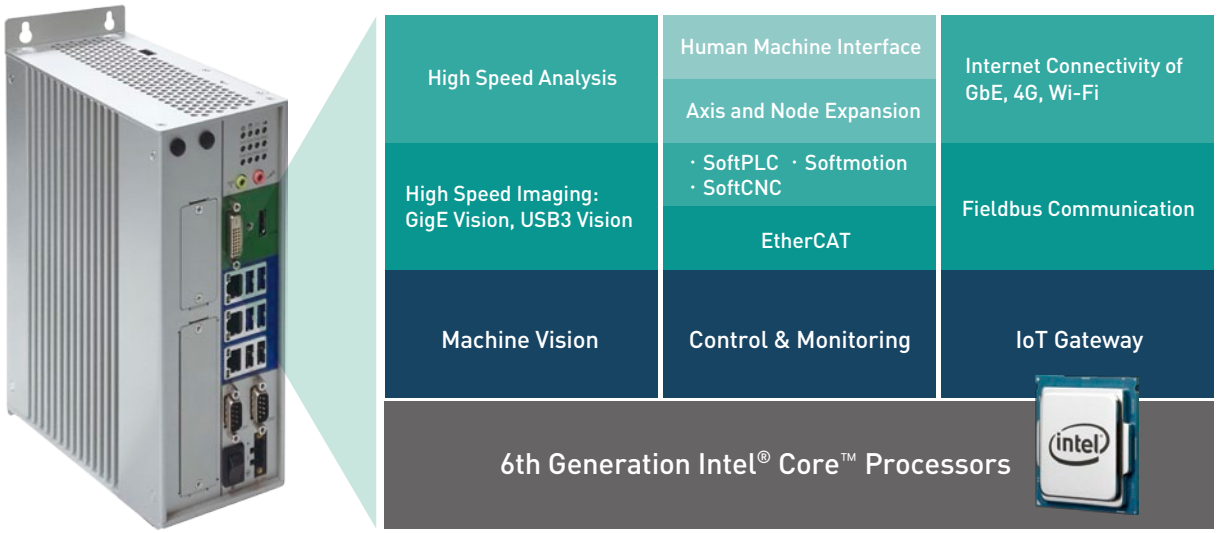

Figure 3. NEXCOM IoT controller provides a unified infrastructure for the consolidated functionality required of Industry 4.0 machinery.

EtherCAT makes an ideal communication protocol for control for several key reasons. First, it delivers high-speed transmission and high synchronization through a distributed clock approach for control nodes (subsystem devices). Secondly, it can control synchronization latency to within a tenth of millisecond. Thirdly, it simplifies the addition of extra function and control nodes.

To address high-mix, low-volume production needs, the NIFE 300 supports two programming languages—IEC 61131-3 and C/C++—for fast design of SoftPLC, Softmotion, and SoftCNC functions. The pre-integrated CODESYS SoftMotion CNC RTE software based on IEC 61131-3 offers libraries of reusable logic and motion functionality so that ladder logic diagrams can be created with less effort. For more complex control schemes, NEXCOM offers its C/C++-based NexECM software pack with NIFE 300-ECM, a variant of NIFE 300. Using it, industrial machine manufacturers can implement functions such as kinetics control or adapt existing control functions onto IoT controllers without starting from scratch- saving valuable development time and cost.

To facilitate manufacturing management, the NIFE 300's HMI software, JMobile Suite, provides an overview of machining processes and system status (Figure 4). 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 4. The NIFE 300's JMobile Suite is an HMI solution enabling local control and remote monitoring.

A Versatile IoT Gateway

To bridge the gap between physical systems and the cyber world, the NIFE 300 functions as an IoT gateway providing fieldbus, Gigabit Ethernet, and 4G/Wi-Fi connections. Like EtherCAT, PROFIBUS, PROFINET, DeviceNet, and EtherNet/IP are some of commonly used industrial communication standards in the industrial automation and control sector and are supported by the NIFE 300.

These connections seamlessly link the factory floor and manufacturing execution systems (MES) 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 everything from process optimization to predictive maintenance.

An Industrial-Strength Processor Family

The NIFE 300 offers a choice of the Intel® Core™ i7-6700TE, i5-6500TE, and i3-6100TE processors, all of which use the Intel® Q170 Chipset and support DDR4 2133 memory. These 6th generation Intel Core processors deliver a leap in performance and image processing. Their multi-core architecture helps the NIFE 300 consolidate systems and deliver real-time, deterministic performance. They enable the NIFE 300 to handle complex integration logic, motion, and kinetics control tasks in parallel, commanding hundreds of axes or processing hundreds of thousands of I/O tag data.

The processors' high-powered graphics engine brings dynamic real-time 3D simulation of machining paths as well as Ultra HD 4k graphical display of all sorts of machining information to HMI applications. The built-in Intel® HD Graphics 530 supports Direct X 12 and Open GL 4.5 for energy-efficient rendering of 2D and 3D vector graphics. It also provides hardware-accelerated video codecs for fast transcodin g. The support of higher channel density and greater multitasking enables significant reductions in the number of controllers needed on the factory floor. With the NIFE 300, you can do more with less.

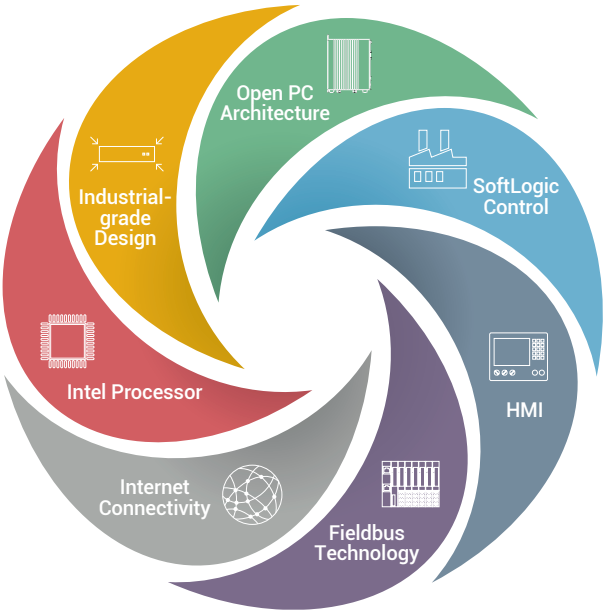

Figure 5. The NEXCOM NIFE 300 integrates feature-rich functionality in a compact yet robust design.

A Compact yet Robust Design

The manufacturing environment is rife with risk factors like electrostatic discharge and sudden spikes in the power supply which may cause machinery malfunction and even shutdown. To avoid potential production interruption, NEXCOM has built electrostatic discharge immunity into the NIFE 300 by following the stringent international standard IEC 61000-4-2; the NIFE 300's COM ports also carry isolation grounds for enhanced protection.

These are a plethora of features inside the compact NIFE 300 measuring 90 mm wide, 185 mm deep, and 254mm high (Figure 5).

Conclusion

In a global economy of fast-shifting markets and price competition, manufacturers face mounting pressure to optimize operations and address new opportunities. To help them, the next generation of industrial machinery must be more intelligent, more agile, and more flexible. Tapping the performance of the latest Intel Core processors, NEXCOM IoT controller NIFE 300 combines motion control, cloud connectivity, and PC openness. The NIFE 300 can help increase manufacturing quality and capacity and catalyze the fusion of physical factories and enterprise offices for providing true Industry 4.0 solutions.

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.

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