Computer-on-Modules for Robotics & Industry 4.0 Automation

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Industry 4.0 and the availability of technologies for collaborative robotics continuously increase the intelligence requirements in automation and robotics. Computer-on-Modules enable system engineers to adapt the computing cores to these evergrowing needs most efficiently by offering flexible scalability off-the-shelf.

Collaboration is a major trend in automation today: Industry 4.0 systems require the controls of all the various machines and robots to collaborate with each other. On top of this demand for fully meshed control logic there is also a transition happening where collaboration is not only based on the exchange of digital information in real-time, but also on artificial intelligence and situational awareness empowered by deep learning technologies and powerful smart environmental sensors such as intelligent cameras.

With all these new elements of collaboration, vendors of traditional robotics and machine controls are facing significant changes; and those changes are happening fast. The collaborative robots market is forecast to grow at a high CAGR of 56.94% between 2017 and 2023 and is expected to be worth USD 4.28 Billion by 2023. This steep growth is attributed to high ROI rates and low prices, making collaborative robots more attractive for SMEs, as well as increasing industry investment in automation to support the Industry 4.0 evolution.

Engineers who want to be part of this innovation wave are facing manifold challenges. One major engineering task is the adoption of Industrial Internet technologies to enable the collaboration between the different systems. Here, the engineer task is to enable their systems to communicate in real-time with other systems; and with communication demands increasing as more and more controls need to coordinate with each other, bandwidth demands are now rising from traditional 100 Mbit or 1 Gbit Ethernet performance to 10 GbE offered by new fog servers. Those servers fulfill major higher-level analytics, decision, communication, and control tasks in Industry 4.0 environments. Protocol implementations for real-time communication such as a decentralized data distribution service (DDS) need to be managed here as well.

On top of this Industry 4.0 interaction between the machine and robot controls, the intelligence of each device needs to be ramped up to enable real collaborative devices. Artificial Intelligence (AI) technology is one of the drivers of the Industry 4.0 trend that is expected to grow at the highest rates. AI means dealing with simulation and implementation of human intelligence on a computer. For this intelligence, self-learning algorithms need to be implemented alongside all the supporting sensor technologies that deliver the relevant situational information that needs to be analyzed for making decisions. The critical challenge for manufacturers is turning legacy machines and robotic arms that are traditionally programmed to execute 100% predefined movements into such intelligent machines and robots. Drastically increased computing performance is required to support all the computing, measurement, motion control and machine vision capabilities that will ultimately enable customization of products and flexible mass production on the factory floor through collaborative intelligence. And looking ahead, this computing performance needs to be highly scalable to be able to fulfill future demands.

There is clearly a massive amount of work involved in implementing all these functionalities – not to speak of the additional IoT gateway requirements for OEMs to improve field deployment, maintenance services and on the fly deployment of new machine and robotic functionalities. So how can engineers fulfill all these new tasks under the high pressures from market dynamics where first to market is a major determining factor for gaining market share?

One lever is to utilize existing ecosystems and standards to streamline the engineering process by using off-the-shelf available frameworks and open source software such as real-time Linux or hypervisor technologies so that engineers can concentrate on the application development. Another lever lies in changing the way of designing the dedicated

Figure 1. The rugged starter kits are tailored for Industry 4.0 and collaborative robotic applications and come complete with reference designs for various purposes

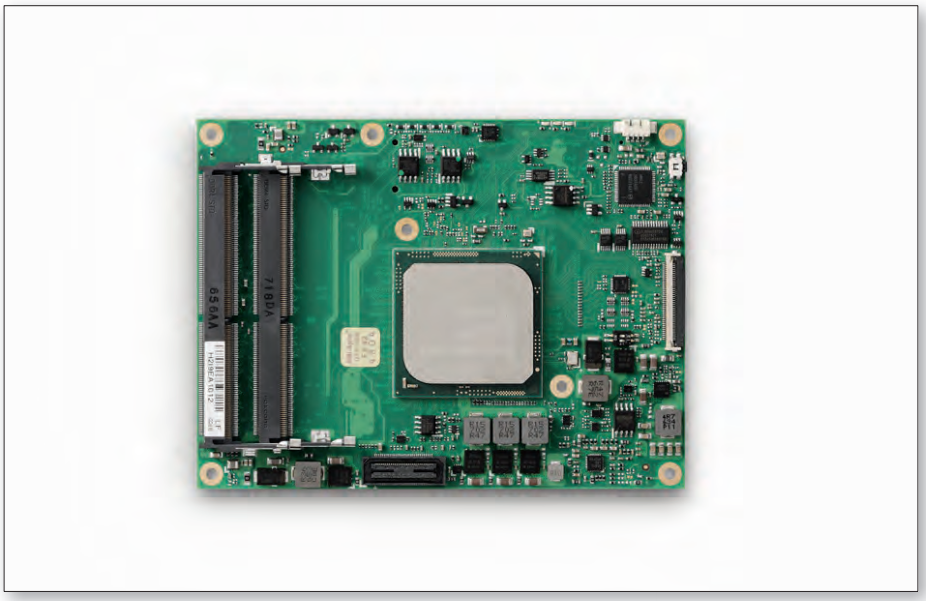

Figure 2. Thanks to their 10 GbE interfaces and massive PCIe support, the brand-new COM Express Type 7 Computer-on-Modules from ADLINK Technology are tailored for Industry 4.0 server and collaborative robotic applications

hardware. Traditionally, leading machine and robot manufacturers used to develop their own controller boards. However, with new generations of CPUs being launched at accelerated speeds and machine equipment needing to incorporate the latest functions to meet Industry 4.0 demands, manufacturers are forced to change their controller board designs more frequently. This requires time and leads to delays in passing certifications so ultimately results in increased time-to-market. To circumvent these problems, manufacturers need to start to evaluate the use of embedded Computer-on-Modules (COMs) for customizing their control boards. With these off-the-shelf available COMs, machine performance can be upgraded to the latest CPU with a simple module replacement. There is no need to redesign the entire control board, which helps to significantly accelerate the product development cycle.

The COM design model, which combines the core module and a customized carrier board, has the advantage of boosting flexibility. Yet there are further challenges to overcome. First of all, a COM is not a complete single board computer; it is the system core and controls peripheral applications via interfaces and specialized functionality on the carrier board. In the case of equipment malfunction, the added complexity may make it more difficult to identify whether the source of the problem lies in the carrier board, COM or peripheral cards. Therefore, without help from a team of experts, locating the root cause can be time consuming. In addition, manufacturers with ambitions to develop intelligent machine or robotics solutions tend to engage in projects that are diverse and often involve complex requirements such as firmware changes and BIOS customizations. Support for multiple operating systems including Windows, Linux, RTOS and virtualization is also required so specific development kits are needed to ensure smooth development of both the carrier board and software. However, as many suppliers are outsourcing a large part of their development work to third-party vendors and have no plan to train their own software engineers, they lack the ability to solve problems independently and to promptly provide the necessary technical support.

A leading international robotic arm manufacturer faced the challenges described during its transition from internally designed controller boards to the adoption of the COM concept. ADLINK Technology comprehensive COM starter kits – specifically tailored to fulfill not only individual but all requirements for industrial automation and robotic applications, complete with reference designs – were able to eliminate most of the challenges of the customer. When the customer encountered difficulties during development, the technical team responded quickly and effectively to assist in addressing system integration issues, whether or not they were directly related to the COM. When necessary, highly trained ADLINK staff visited the customer location to find the root cause of the problem as it is the company goal always to provide professional support to customers during the entire development process. If module vendors have their own signal measurement laboratories, they can help customers also in measuring all computer input and output signal waveforms to ensure that COM design and manufacturing comply with all the required standards. Yet helping customers during the design-in process of a module is not the only service COM vendors can offer. They can support them even more comprehensively by publishing complete design for manufacturing (DFM) verification principles for the product design-in stage. All those efforts aim to guarantee highest product compatibility and reliability as well as fastest time-to-market. Close collaboration with Intel is helping firms such as ADLINK to launch new COM products the day new processors for the embedded markets become available, so that OEM engineers can instantly upgrade their control systems with the very latest Intel processor technology, allowing really fast and also highly reliable time-to-market strategies. ■