

High-performance design brings robot technology to cost-sensitive applications

DeltaBot: PC-based pick-and-place robot

Much like the historical progression of computer technology, more cost-effective robot technology is steadily advancing into areas that were previously too cost-sensitive to apply it. Food manufacturing, packaging and warehousing are prime areas to experience the next wave of robotics with high-performance, low cost robots entering the marketplace from leading suppliers such as AEMK Systems. In order to boost control performance while reducing cost, AEMK's DeltaBot line has been recently upgraded with a control system from Beckhoff.

Based in Waterloo, Ontario, Canada, AEMK is an innovative provider of high-speed robotics systems for a wide range of applications. The company was established to commercialize the results of five years of research at the University of Waterloo involving ultra high-speed robots. "We strive to provide customers with the most cost-effective robots possible with simple integration, low maintenance cost and outstanding customer service," Amir Khajepour, AEMK President and University of Waterloo Professor, said.

The AEMK robots use tensioned cables instead of rigid links to reduce moving inertia and mechanical equipment cost compared to conventional pick-and-place robots. It also means that very little maintenance is required to ensure high repeatability. Due to their cost-effectiveness, AEMK robots are used in many labor-intensive applications such as the food and packaging industry or automated warehousing with high capital cost barriers to incorporating automation equipment.

DeltaBot: the PC-based pick-and-place robot

The three- and four-axis models of these ultra high-speed robots are dubbed DeltaBot. They are capable of over 120 pick-and-place cycles per minute and have proven to be highly effective for high-speed assembly, automatic inspection and packaging applications. The DeltaBot uses passive cables to control the movement of end effectors. This design permits the robot's workspace to be easily scaled to adapt to any application. In addition, their straight-line design makes the robots ideally suited for use in the food industry with its strict hygiene regulations.

PC platform with scalable performance

In order to boost control performance while reducing cost, the DeltaBot line is equipped with a Beckhoff control platform consisting of a CX1010 Embedded PC, TwinCAT PLC automation software, EtherCAT I/O terminals as well as AX5000 Servo Drives. "The impressive price/performance ratio was the de-

DeltaBot from AEMK Systems is an ultra high-speed robot capable of over 120 pick-and-place cycles per minute.



terminating factor in selecting the CX1010 as the DeltaBot's control centerpiece. We wanted the smallest possible footprint for the controller that would also give us the most programming flexibility," Khajepour said. "The basic DeltaBot configuration features the CX1010, however we can also easily scale up in performance using the CX1020 or CX1030 for the robots with an integrated vision option."

Embedded PC replaces two PC controllers

The previous DeltaBot controllers were all PC-based, but not as powerful or flexible. The Embedded PC from Beckhoff replaced an architecture that included two PCs; one served as the real-time robot controller, the other PC generated the robot's path, ran the HMI and connected with vision systems or any other applications that were needed. "The major drawbacks of the previous system were unreliable communication and the difficulty of running at a consistent, low scan time," Khajepour said.

The AX5000 EtherCAT Servo Drives are installed above the pick-and-place unit.



EtherCAT helps keep the jitter away

"TwinCAT's real-time control system gives us an all-in-one platform to create high-speed, reliable control architectures," Khajepour explained. "The Structured Text programming language, one of TwinCAT's many available IEC 61131-3 languages, makes the DeltaBot's code easy to program."

The DeltaBot moves extremely fast and completes most of its paths in less than 500 milliseconds. "This barely permits any time for communication jitter, even in the range of single digit milliseconds," Khajepour noted. "Fast access to the I/O and ease of integrating remote I/O into our systems are among EtherCAT's key features. Also, the AX5000 drives were instrumental to accommodate a wide range of power requirements, drive communication at 'EtherCAT speed' and very low cycle times. Plus, the seamless integration with the rest of the DeltaBot's system components is exactly what AEMK was looking for."

Improved positioning and repeat accuracy

"We are able to run the DeltaBot position controller at 2 kHz, which came without the hassle of having to integrate various proprietary technologies into the same system. This allows AEMK to increase the DeltaBot's positioning precision as well as the repeatability at the same robot speed. Due to its deterministic features using its precise timebase, the new DeltaBot system has made great gains in reliability, consequently generating fewer errors than the previous system," Khajepour stated.

Cost-effective pick-and-place

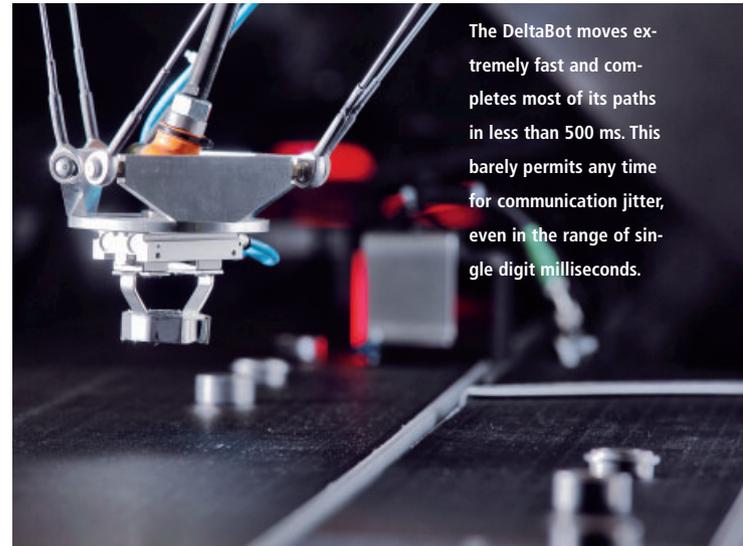
AEMK Systems has successfully implemented DeltaBots in several projects and has introduced the robots as stand-alone products to the market. "Because of its reliable nature, the new DeltaBot has greatly reduced our testing and integration time. Considering TwinCAT's ease of programming, DeltaBot development time has drastically decreased by almost 50 percent," Khajepour said. AEMK has been involved with Beckhoff for more than a year now and will continue to implement Embedded PCs with TwinCAT as the standard platform for future projects.

"Our goal is to offer flexible automation. The Beckhoff control architecture will help advance DeltaBot development and help make it the preferred robot solution for many more cost-sensitive applications," Khajepour concluded.

AEMK Systems www.aemksystems.com
 University of Waterloo www.uwaterloo.ca
 Beckhoff Canada www.beckhoff.ca

The high-speed DeltaBot robot system from AEMK consists of the following main components:

- | Beckhoff motion system incorporating four axes using AX52xx EtherCAT Servo Drives, an AM series servomotor and three other motors from a 3rd party vendor
- | EtherCAT Terminals used for all I/O required on the robot as the interface to all sensors
- | TwinCAT for controlling the robot and all its subsets
- | TwinCAT ADS as the DeltaBot's interface to communicate with the rest of the system



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The DeltaBot line was recently upgraded with Beckhoff CX1010 Embedded PCs running TwinCAT PLC software to boost controls performance while reducing cost.