

# MACHINE DESIGN

DECEMBER 12, 2002  
www.machinedesign.com



A PENTON PUBLICATION  
Periodicals  
USPS 881 Approved Poly

## Basics of design engineering

Motion control

# Sensible sensing

**Robert Little**  
ATI Industrial Automation  
[www.ati-ia.com](http://www.ati-ia.com)  
+1 919-772-0115

Six-axis force/torque (F/T) sensors measure force and torque in many applications, including electrical and mechanical assembly, product testing, and robot material handling. The sensors help verify part insertion, maintain constant force during buffing, polishing, and deburring, and collect force information for lot testing and statistical process control (SPC). F/T sensors need high-speed data outputs and must work with a variety of bus formats such as PCI and USB. A recent development by ATI Industrial Automation called DAQ F/T integrates sensors directly into desktop and laptop computers using off-the-shelf data-acquisition (DAQ) cards. The result: higher data speeds, easier installation, and flexibility in bus selection and operating systems.

A conventional sensor system consists of a transducer, high-flex cable, and a controller to convert strain-gage input to force and torque values. Output is sent to a computer or robot controller using serial, analog, or a customized bus controller. Serial communications are typically slow, and analog output must be converted to digital format. Customized bus controllers are fixed to only one bus format so that improvements in resolution, data speed, or format change requires an expensive upgrade. Because of this, customized bus controllers are only developed after large technology improvements are made over an 8 to 12-year span.

By contrast, the DAQ F/T lets users keep up with technology improvements by using off-the-shelf DAQ cards. DAQ F/Ts modify strain-gage signals from transducers and send them to a DAQ card which controls resolution and data speed. These cards change their hardware and software with new



**DAQ F/T sensors are currently compatible with PCI, cPCI, PCMCIA, ISA, and USB data-acquisition cards with a variety of resolutions and sampling rates.**

bus formats and operating systems, thus keeping the DAQ F/T updated to fit any desktop and laptop computer on the market. The six-axis DAQ F/T system consists of a transducer, high-flex cable, interface board, power supply, DAQ card, and software tools. A proprietary interface card on or near the transducer produces a low-noise seven-channel signal that can be read by most off-the-shelf analog-input DAQ cards with at least seven available channels. PC-based software converts the signals to force and torque output. The computer, through the DAQ card, powers the interface card and transducer.

Bundled software includes a reusable, hardware-independent Windows ActiveX component that configures the transducer system and converts raw voltages into forces and torques. Non-Windows target platforms include a C library to perform the necessary F/T conversion. The system can be used in development platforms that support ActiveX or Automation containment, including Microsoft Visual Basic 6.0, Microsoft Visual C++, Microsoft .NET Platform, and National Instrument's LabVIEW, among others.

A key application area for F/T sensors is in industrial robotics. Devendra Garg of Duke University's Robotics and Manufacturing Automation (RAMA) Laboratory explains, "We employ Gamma F/T sensors on each of our two ABB IRB-140 six-axis industrial robots." F/T sensors measure force and torque at the base of the tool attached to a tool changer. This supplements the force feedback from the robot axes and precisely measures gripper forces. Software controllers use feedback data to correct motion errors, calibrate work-cell parameters, and verify object positions. The F/T sensing information is integrated with a vision system in the flexible work cell. "The accuracy and high polling rate of the sensors are vital to real-time force control applications and were the deciding factor in our decision to use ATI F/T systems. The compatibility of the National Instruments



**MIT's Newman Laboratory for Biomechanics uses a rehabilitation robot equipped with an F/T sensor to significantly improve patients' recovery of arm movement following strokes.**

DAQ cards also saved us time integrating the equipment with our existing software controls."

Other applications include automated production lines that use the data to supplement quality assurance programs. DAQ F/T sensors measure place, movement, and position-dependent functions. The results are statistically processed and fed back into the production process to assure quality. ■