Industrial Robots Gain a Finer "Touch"

UW and Boeing collaborate on laser-tracker system

By Stephanie Wing-Robertson

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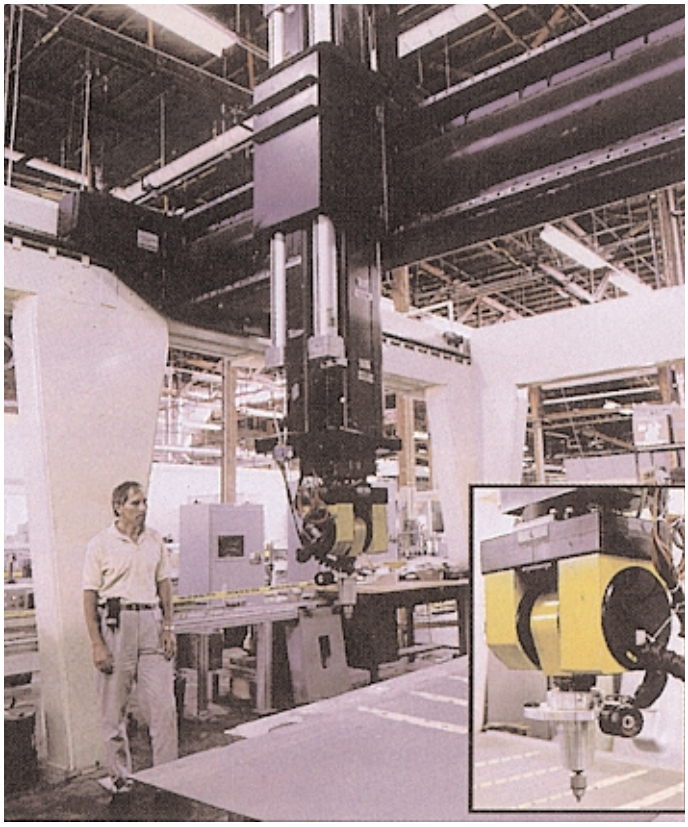
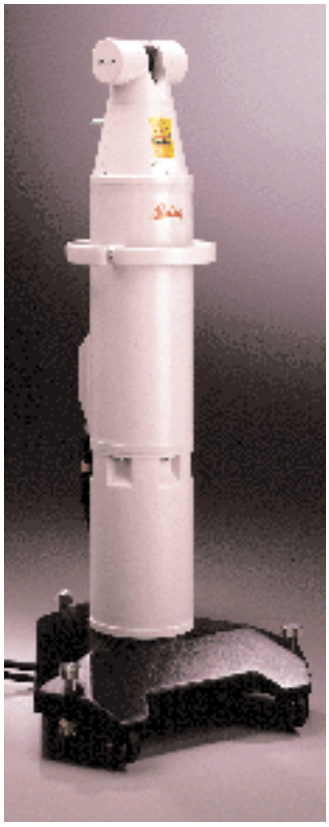
Many companies today employ industrial robots to do manufacturing tasks. However, the ability to position these robots accurately has been limited, and therefore their use has been restricted to doing only repetitive tasks.

Now, the University of Washington and the Boeing Company are collaborating on a project that promises to improve the accuracy of industrial robots, allowing companies to use them in more sophisticated ways.

The problem with today's industrial robots is not precision, but accuracy. That is, their end-effectors (the "fingers") may be placed time after time in the same spot with little variation. Once a robot has been taught a series of movements needed to complete a particular job, it can repeat this path over and over, with small variations from one repetition to the next.



Martin Berg observes the gantry robot test bed in action. Inset: Wrist with retroreflector for the laser tracker



Leica laser tracker LTD500

But repeatability does not imply accuracy. An archer may consistently hit the right side of the outer ring on a target – but that's not the same as hitting the center of the bull's eye.

Today's robots lack accuracy because they can only estimate the end-effector position based on indirect measurements. That estimate is based on measuring joint positions and then mathematically modeling the relationship between the joint positions and end-effectors. But these models are imperfect: such things as mechanical friction, temperature, and mechanical wear make it virtually impossible to determine positions to accuracies of a thousandth of an inch.

To compensate for this limitation, manufacturers take advantage of the robots' repeatability. They do this by using a special fixture, or jig, for each machining operation; the jig keeps the workpiece in precise registration with the robot path. These fixtures are extremely expensive, especially in the aircraft industry, where workpieces are large.

The idea behind the UW-Boeing collaboration is this: if one could control the position of robot end-effectors with accuracies equal to the repeatabilities they already provide, manufacturers would use robots very differently than they do today. Martin Berg, UW mechanical engineering professor and principal investigator of the project, says that the "technology has finally reached a point where we are able to pull this off."

Laser-tracker sensors have recently been developed that make it possible to measure the position of a reflector on a robot's moving end with great accuracy. The team is currently using a laser-tracker sensor made by Leica that measures position to within 25 and 250 micrometers for stationary and moving targets, respectively.

According to Craig Battles, a technical fellow at Boeing working on robotics and manufacturing R&D, the monetary savings that can be realized from this advance are considerable. He explains that when a new production machine such as a mill or lathe is installed, a hole is first dug in the floor of the building where the machine will be located. This hole can be 15–20 feet deep. Pylons are then driven into the bedrock for support, and the machine is installed and anchored with reinforcing

steel and concrete. All this is necessary to keep the machine from moving even a little bit; otherwise, the machined parts will be faulty. The costs of construction and equipment are very high. And, in the end, the accuracy provided by these measures only lasts for a short time, due to wear and tear.

With the new laser-tracker technology; many of these costs can be avoided. The new robots are very light and can sit on the floor with no special provisions. And the robots may be moved if required – an impossibility with current machines.

Battles says that in spite of the advances the researchers have made, production use is still two or three years off.

Besides the anticipated cost savings, this collaboration is benefiting both Boeing and the UW in other ways. Boeing gains the assistance of university researchers in the development of the new technology. In return, Boeing support has helped to create a state-of-the-art laboratory for robotics research at the UW.

Berg believes the team approach is profitable in more ways than one: “I am convinced that there are many real problems out there, which include subject matter that is the right stuff for MS-level and Ph.D.-level research,” he observes. This research can be conducted most cost-effectively by teams from industry and academia, he says.

Graduate research assistants working on projects such as this one will have significant experience at tackling real-world problems by the time they receive their degrees. Says Berg, “This will give them a tremendous leg up when it comes time for them to go after a real job.”

For more information: http://www.me.washington.edu/~bergweb/

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