Exploring robotics for the factory of the future

Control Engineering Europe's Suzanne Gill reports on a European Commission co-funded project that is testing the idea that industrial robot technology could provide a good base for machining, being both flexible and cost-efficient.

Suzanne Gill

> **"While robots are very agile, this agility results in a reduced stiffness compared to conventional machine tools."**

The European Commission is co-funding an €8 million project as part of the European Economic Recovery Plan (EERP) adopted in 2008, which targets the use of industrial robots for high-end machining for cost-effective, flexible, and reliable manufacturing solutions for the 'Factory of the Future."

The inaugural meeting of the European project was hosted in Spain in September 2010 by the coordinating partner of the project, Delcam. The COMET project sees 14 companies from industry, research institutes, and universities sharing and combining their manufacturing expertise with the aim of developing plug-and-produce COmponents and METhods for adaptive control of industrial robots for high-end machining to enable cost-effective, flexible and reliable manufacturing solutions.

Mark Gadsden, product marketing manager at Delcam, explained more about the aims of the project: "The 30-month COMET project aims to overcome the challenges facing European manufacturing industries by developing innovative machining systems that are flexible, reliable, and predictable with an average of 30% cost-efficiency savings in comparison to machine tools."

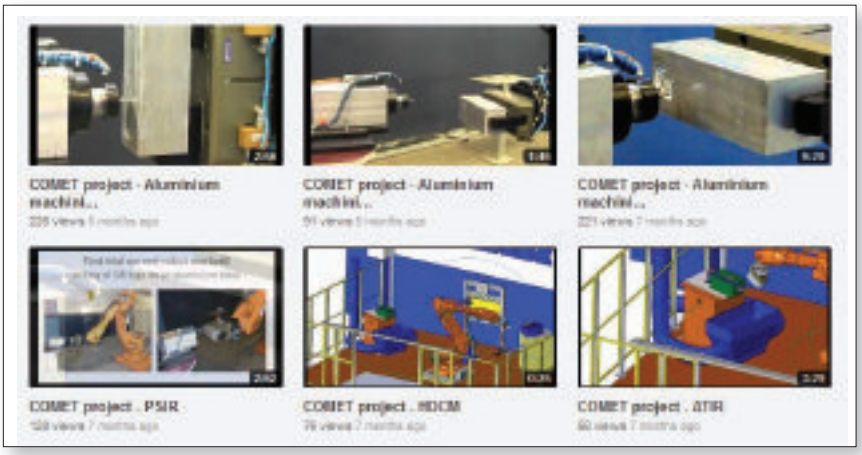
Because it is both flexible and cost-efficient, industrial robot technology could, from a conceptual point of view, provide a good base for machining. However, in real-life situations industrial robots have three critical limitations: a lack of absolute positioning accuracy, an inability to reject disturbances in terms of process forces, and a lack of reliable programming and simulation tools to ensure right-first-time machining when production commences. At the present time these limitations are preventing the use of robots in typical machining applications.

Four elements to overcome limits

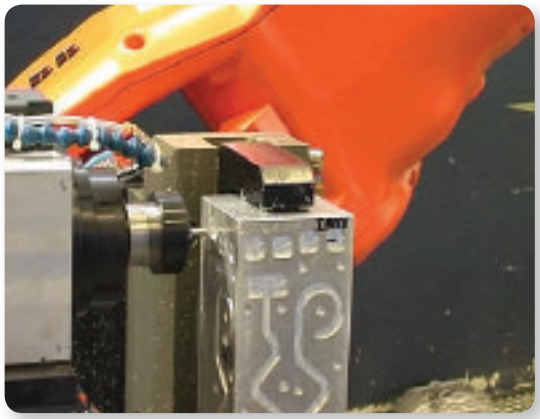
The COMET project consists of four elements that, together, aim to overcome these limitations. These include:

1. A methodology for describing kinematic and dynamic models of industrial robots (KDMIR) to define accurately the static and dynamic behavior of any industrial robot, which then is represented by its unique signature.
2. An integrated programming and simulation environment for adaptive robot path generation for machining with industrial robots (PSIR), based upon the unique signatures.
3. An adaptive tracking system for industrial robots (ATIR) to detect deviations from the programmed robot path and to adaptively initiate real-time corrections via the robot controller to ensure the necessary machining accuracy.
4. A high dynamics compensation mechanism (HDCM) to accomplish an absolute accuracy better than 50 µm; significantly "beyond" the structural capability of the robot system on its own.

Noble aims indeed, but the project has some interesting challenges to overcome, as COMET partner, TEKS, points out. Robots are a compromise between a comparatively low dynamic accuracy, and unrivalled handling flexibility. This means that, while robots are very agile,



COMET project YouTube videos include these and several more, showing how robotics and machining combine.
www.youtube.com/user/COMETproject Courtesy: COMET, YouTube



COMET project test execution: machining of the aluminum workpiece for a different robot configuration (DOE ½ Factorial Plan, 6 factors, 2 levels). Courtesy: COMET

this agility results in a reduced stiffness compared to conventional machine tools.

The TEKS robot cell is based at the Advanced Manufacturing Park (AMP) in Rotherham. The company, which has already co-hosted one of the regular general assembly meetings of the project, was the first with an operational cell to begin undertaking trials for COMET.

TEKS is in the process of developing its robotic cell and with consortium partner, Artis of Germany, it has conducted force measurement tests while machining aluminium. The forces generated by the cutting operation have been recorded in detail with an Artis prototype data acquisition solution, at a high sampling rate of 500 kHz.

Roland Krain, research and development manager at TEKS, explained the potential benefits of this approach: "Traditionally robots are used as handling solutions for assembly. If machining is required in a robotic line or cell, the robot typically would place the part in a conventional machine tool. Such tools range from the high tens of thousands pounds to several hundred thousand pounds. A robotic machining cell could provide a cost-effective machining solution. A second-hand robot can, typically, be purchased for £15k, along with a good quality high-speed spindle for £20k, giving the end user multi-axis machining capability for a fraction of the cost of a comparable conventional machine tool. Obviously, the second-hand robot has to be in 'as new' condition, be well maintained, and have a compatible controller; otherwise, the accuracy required might not be achieved."

"COMET seeks to bring big innovations to the manufacturing sector in European industry. It will significantly reduce the cost of machining operations."

"Today, customers generally opt for either a 5-axis machine or a handling robot. If we could bring the two things together, we would be able t o make customers more productive and more competitive," concluded Krain.

Setting up cells

Robot cells have now also been set up at a variety of partner facilities using robots from manufacturers such as Kuka, ABB, Motoman, and Comau. The cells will enable industrial tests to be performed on a range of parts, ensuring that all developments take into consideration the acceptability to end users in terms of time, cost, and reliability. Commenting on the COMET project to date, Dr. Ir. Jan Ramboer, research programme officer from the European Commission, said: "The COMET project is an ambitious and innovative project. I am pleased to see robots being used early on to perform physical tests which are relevant to applications in the European manufacturing industry. Everything is very clear...[with] excellent synergy between partners. Dissemination is good across all levels, in particular the use of social media for communicating the project objectives and developments."

Over the next six months almost all the technical tasks in the project will be active. To enable partners to plan and conduct robot machining experiments, a prototype of the high dynamics compensation mechanism (HDCM) will be available. The HDCM will help to accomplish an absolute accuracy better than 50µm, significantly beyond the structural capability of the robot system on its own. The integration of models together with the PSIR, adaptive tracking system for industrial robots (ATIR) and HDCM will ensure that tests are performed in realistic end-user environments.

Jan Willem Gunnink from Delcam, coordinator of the project, said: "I have complete confidence that European manufacturing organizations will benefit from the combined knowledge of the COMET partners which comes from industry, research institutes, and universities. Since the inaugural meeting in September 2010, partners have demonstrated their ability to work as a team, providing a good foundation for the COMET project to move forward and develop new and exciting robot technologies in 2011."

Klas Nilsson, associate professor from COMET partner, the University of Lund in Sweden, also believes that the project will have major benefits. He said: "This type of project, where you bring together competencies from across Europe, will find new problems too! Together we are able to complement each other to find the best solutions to these problems."

John Pandremenos from the University of Patras in Greece and dissemination manager of the project, said: "If the project achieves its objectives it will bring big innovations to the manufacturing sector in European industry. It will significantly reduce the cost of machining operations." **ce**

A video about the project can be viewed at www.youtube.com/user/COMETproject, or visit the project website at www.comet-project.eu.

- Suzanne Gill is editor of Control Engineering Europe.

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