SEVENTH FRAMEWORK PROGRAMME

Plug-and-produce **CO**mponents and **MET**hods for adaptive control of industrial robots enabling cost effective, high precision manufacturing in factories of the future

The COMET news

The COMET EU Project Newsletter
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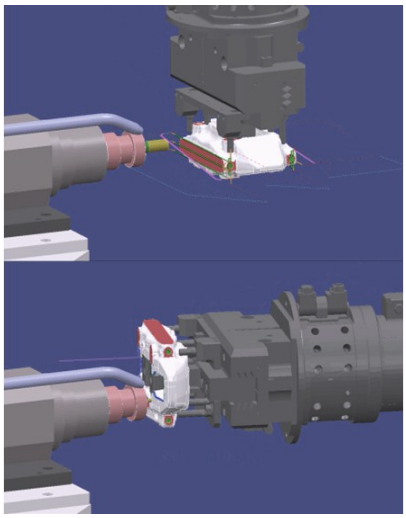
Machining case studies begin, starting with PSIR software

COMET demo cells are now all working on demonstrations using PSIR, the first component of the COMET puzzle that has been made available by the research partners. The Programming and Simulation environment for Industrial Robots is a full CAD/CAM solution to generate machining tool paths for robots. It is also the platform for implementing the other COMET innovations for accuracy improvements. PSIR allows calculation of a robot milling path based upon the geometrical description of the part being manufactured, corresponding to a specific robot stored in the robot library taking into consideration the machining process requirements coming from the material to be milled. It also enables precise simulation, not only of tool position and orientation but also of the full kinematic lay-out of the robot to avoid any collisions or process mistakes. It also has a dedicated application to avoid singularity points.

The robot library now contains all the COMET demo cells; 3 ABB (AMRC Ltd, TEKS and SIR), 2 Kuka (BTU and IPA) and 1 Motoman (Gizelis Robotics). End users have been able to start machining tests on the demo parts, which are in aluminium, steel and inconel. In some cases the goal is to fully machine the part from a block through both roughing and finishing machining: for example a wing aluminium structural part for TEKS and a steel injection mould for Nisaform. The automotive case study focus is instead on the refinement machining of a casted aluminium component, with a complete automation of the full process using a robot for both clamping the part and changing milling tools. Finally, AMRC Ltd is using its robot for deburring the teeth of turbine discs, a specific application aimed at enabling the robot to take advantage of its large working envelope.

PSIR development benefited from Delcam's experience in CAD/CAM solutions for CNC machining, implementing all the know-how gained from years of development. Different



1. PSIR simulation of automotive part machining (SIR); top: face milling; bottom:

machining strategies for roughing, rest-roughing and finishing have been simulated and tested before choosing the most effective for the diverse cases. A workshop meeting in July at Delcam Birmingham facilities was held in order to optimize milling strategies for all the demo parts and simulating it with the help of Delcam experts. You can find the simulations videos of demo parts machining on our YouTube channel.

Partner SIR, a robot integrator expert on the diverse robot brands, compared the PSIR performances with the main robot supplier's solutions. PSIR really proved to be superior in offline programming and tool path generation: its CAD/CAM approach provides many ways to adjust tool paths and offer several machining strategies while traditional robot programming has a more limiting point-by-point approach. The machining tests done comparatively on the same test geometry also showed the PSIR being better, allowing a significantly more accuracy on the machined part. Point highlighted was also the very good path simulation feature that enables the user to go through a complete process simulation and check prior to machining the real part.

In this issue:

COMET news & events

COMET PSIR workshop @ Delcam

Demo cell owners met in Delcam on July 24-26 for an in-depth workshop on the use of PSIR program. Robin Smith, Applications Manager in Delcam, taught the 3 day course which ended with revising the PSIR path milling programs of COMET case studies.

Preliminary milling experiments with online compensation @ LUND

Robotic milling experiments with online compensation using Nikon Metrology optical tracker K600 has been successfully performed at Lund University.

KDMIR kinematic and dynamic models calibrations @ SIR and Gizelis

After BTU, AMRC and TEKS partners cells, the SIR and the Gizelis cells were also measured to get the necessary parameters for Kinematic and Dynamic models. BTU and UPatras teams visited SIR and Gizelis completing the calibration sessions.

7th GA meeting in Cottbus

The consortium met @ Cottbus University on 27th – 28th Sept. for the 7th General Assembly. It was also an opportunity to visit the BTU lab, to see the Kuka robot cell used to test and validate the kinematic

2. Marcel Halbauer shows BTU COMET Kuka cell.

COMET project as FoF success story

COMET project coordinator Jan Willem from Delcam was asked to present the COMET project during Public Private Partnerships (PPP) info days held in Bruxelles on 9th-10th July. The Factories of the Future program (FoF), under which COMET has been funded, is one of the PPP initiatives to fund research and innovation in key industrial sectors through a joint financial effort by industry and the European Commission.

See the COMET success story presentation on our YouTube channel.

4. Jan Willem Gunnick presenting COMET at PPP info days, see it on COMET YouTube channel

COMET Publications

"Increasing time-efficiency and accuracy of robotic machining processes using model-based adaptive force control."

By Department of Automatic Control, LTH, Lund University, presented at IFAC - Symposiums on Robot Control - Sept. 2012, Dubrovnik, Croatia.

"Precise milling with industrial robots – a plug-and-produce approach to reduce and compensate for process force induced accuracy and positioning errors."

Scientific paper by BTU University published on ZWF German journal Jul-Aug/2012 pag. 533-536.

"Increasing the accuracy for a piezo-actuated micro manipulator for industrial robots using model-based nonlinear control."

By Lund University –LTH and IPA Fraunhofer presented at IFAC - Symposiums on Robot Control - Sept. 2012, Dubrovnik, Croatia.

"Milling with industrial robots: strategies to reduce and compensate process force induced accuracy influences."

Scientific paper by BTU University and Artis GmbH, presented at the 17th ETFA Conference, Sept. 2012, Krakow, Poland.

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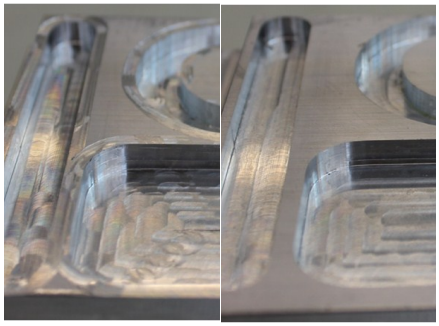
COMET off line kinematic calibration: validation test at BTU Robot cell

Part of the KDMIR - Kinematic and Dynamic Models for Industrial Robots - that is developed within the COMET project is a procedure for offline kinematic calibration. This part of the KDMIR is now fully implemented within the previously developed PSIR – Programming and Simulation environment for Industrial Robots. For this calibration procedure the kinematic parameters do not have to be changed within the robot controller. The PSIR outputs a robot program that includes a compensation for the robot's kinematic errors. Due to this approach this calibration is applicable to arbitrary robots and is independent from the robot brand. In order to enable the PSIR to generate such a program, the nominal kinematic robot parameters in the software are enhanced with the kinematic parameters determined during the kinematic calibration measurements at the robot cell.

Recently a machining experiment to validate the outcome of the kinematic calibration in terms of work piece quality was performed at the robot cell of project partner BTU. The kinematic parameters of the robot have been determined earlier in the project with the use of the Nikon Metrology K600 tracking system (which is further involved in the ATIR – Adaptive Tracking system for Industrial Robots within the project). During the experiment a set of test features were machined twice on an aluminum work piece. The first time without the calibration applied in the software, the second time with the calibration switched on. The machined result shows better surface quality on the work piece and improving total measures of the features when the calibration is used. Besides the better absolute positioning accuracy of the robot the improvement of the surface quality seems to be due to the better perpendicularity of the tool with respect to the work piece. After the validation at the BTU cell, similar experiments are planned for the other demo cells where the kinematic parameters have been determined (AMRC Ltd, Gizelis, SIR and TEKS).



4. Aluminium test piece machined without (left) and with (right) K model compensation

COMET partner profiles

AMRC Manufacturing Ltd is an SME formed from the AMRC. The Advanced Manufacturing Research Centre is a £45M partnership which builds on the shared scientific excellence and technological innovation of leading aerospace companies and Sheffield University. Its expertise ranges from materials, dynamics and composites to assembly and additive manufacturing.

AMRC Ltd is a new commercial entity, set up to exploit the research being developed at AMRC especially within the Aerospace sector, replacing standard machine tool design platforms with multiple robot solutions. In the COMET project AMRC Ltd is responsible to test the COMET robot solution for deburring Aerospace turbine discs.

AMRC Ltd works closely with the AMRC partnership network, including companies such as Rolls Royce, The Boeing Company, BAE and Messier Dowty. This enables AMRC Ltd to implement the findings from COMET into these networks.

Find more about AMRC Ltd at:
www.cometproject.eu/amrc-manufacturing.asp

FONDAZIONE Democenter-Sipe (DCS) is a technology transfer centre committed to promoting innovation with particular focus to Industrial Automation.

Established in 1993, It now comprises public administrations, research institutions, enterprise associations and more than 60 industrial companies mainly acting in the mechanical, electronic-mechanical, electronic and other fields of the manufacturing industry. This network enables DCS to act effectively as a technology transfer centre, promoting demonstration programs and specialised conferences but also providing managerial and technical support to the companies wishing to pursue innovation and carry out research projects.

In COMET, DCS is mainly responsible to coordinate all industrial demonstrations activities, with the goal to test the COMET platform in different real industrial environments. It also has a leading role in coordinating the training events foreseen to disseminate the project results to the industrial audience.

Find more about DCS at:
www.cometproject.eu/demo-center-sipe.asp