COMET Technologies: Programming and Simulation Environment for Industrial Robots

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. From a conceptual point of view, industrial robot technology could provide an excellent base for machining being both flexible and cost efficient. However, industrial robots lack absolute positioning accuracy, are unable to reject disturbances in terms of process forces and lack reliable programming and simulation tools to ensure the correct machining processes, once production commences. These three critical limitations currently prevent the use of robots in typical machining applications. In this article one of the four innovations for solving these limitations is investigated.

The most common robot programming methods involve using teach-and-learn methods or offline programming, which are not suitable for even simple machining processes. For this very reason, state-of-the-art programming methods are being implemented which combine both CAM systems and robot code programming. CAM systems like Delcam PowerMILL are able to generate toolpaths from imported CAD data, incorporating large amounts of process knowledge. The resulting CNC code can then be translated into a robot code in the native robot language, e.g. Rapid for ABB or KRL for KUKA systems. However, there is no closed ‘chain’.

What the CAM systems do lack is knowledge about the kinematics and dynamics of the robot system; they are programmed to compute the toolpaths for the simpler kinematics of standard machine tools. When confronted with a robot kinematic profile the system cannot produce automatic collision free path planning, automatically avoid singularities and identify reachability. Also the redundancy of certain robot axes is not used for potential optimisations. The COMET programming system will be specifically developed to incorporate the robot kinematics and dynamics, to cope with the aforementioned problems and use all possible optimisations.

The PSIR (Programming and Simulation environment for Industrial Robots) system is one of the four innovations developed in the COMET project with the ultimate aim to be able to perform high-accuracy machining using industrial robots. With the PSIR system a software platform is developed, tested and demonstrated allowing the output of 100% correct robot programs to form one of the four cornerstones of the COMET solution. The PSIR system is a full CAD/CAM solution to generate machining toolpaths for industrial robots, including simulation, optimisation and post processing.

Another related innovation is the KDMIR module (Kinematic and Dynamic Models for Industrial Robots), which is a methodology for describing kinematic and dynamic models of industrial robots to accurately define the static and dynamic behaviour of any industrial robot. This behaviour is stored in a unique signature that contains mathematical models to optimise and adapt the robot toolpath to improve the accuracy of the robot movement. The models contain measured data on specific robots, making the signature unique for an individual robot. The KDMIR models are used in the PSIR system to generate optimised robot toolpaths specific to each robot.

The PSIR module contains a set of tools to either manipulate the robot toolpath to calculate robot poses, to avoid singular points, to analyse robot behaviour using the kinematic and dynamic models from the KDMIR module, to optimise and adapt the toolpath for specific robots using the unique signature developed in the KDMIR module or to perform 3D collision simulations of the robot movements in a 3D simulation of the complete robot cell. Delcam’s commercial product name for the PSIR being used in the COMET project is the PowerMILL Robot Interface. The Robot Interface is an add-on product to Delcam’s PowerMILL CAM package. The software is commercially available and used across various robot cells in Europe and has been adopted by the COMET partners for performing real-world industrial machining tests with various brands of robots, including ABB, Kuka and Fanuc.
Toolpaths are calculated using the powerful machining strategies within PowerMILL. From these toolpaths it is possible to calculate the required robot poses and analyse the movement of the robot arm for the calculated toolpath and identify any problems such as singularities. The module contains a set of analysis and edit tools to manipulate the robot and optimise the robot toolpath and the robot poses and position. The final step is to post process the fully simulated and verified toolpaths to a specific robot language; for example, ABB RAPID or KUKA KRL. Currently most robot brands are supported, including external axes such as rotary tables or linear rails. Future developments will add optimisation tools using the KDMIR signature of a robot to correct the toolpath for a number of error sources to improve the overall accuracy of the machining operation.

The project launched in September 2010. The majority of the work in the first six months of the project has focused on setting up of various robot cells across Europe, training of the COMET partners and the requirement setting for new developments for the PSIR during the project. The first new developments have been implemented in the software and pilot tests are now starting to add the first of the KDMIR models into the PSIR system. The partners received a dedicated PowerMILL for Robots training course in January 2011 at Delcam’s headquarters in Birmingham and are now starting to use the software in their first real world machining experiments. They will regularly provide feedback to the developers to further improve the PSIR in addition to the scheduled developments. For more news and regular updates, please check www.comet-project.eu or follow the project’s developments live on our Twitter account (@Comet_project).

Acknowledgements:
This project is co-funded by the European Commission as part of the European Economic Recovery Plan (EERP) adopted in 2008. The EERP proposes the launch of Public-Private Partnerships (PPP) in three sectors, one of them being Factories of the Future (FoF). Factories of the Future is a EUR 1.2 billion program in which the European Commission and industry are collaborating in research to support the development and innovation of new enabling technologies for the EU manufacturing sector. For further information please visit: