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

COMET

The COMET news

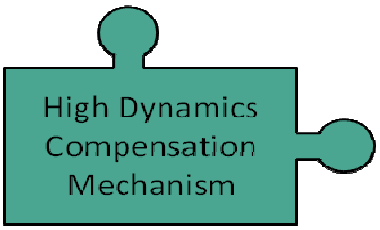
The COMET EU Project Newsletter
Issue 3 — July 2011

COMET technologies: the High Dynamics Compensation Mechanism – HDCM

The development of a High Dynamics Compensation Mechanism (HDCM) is part of the overall approach of the COMET project and one of the scientific developments needed in order to meet the project challenges. The COMET platform aims to bring standard robots to a machining accuracy level comparable to what is today guaranteed by CNC machining. Together with the kinematic and dynamic models (KDMIR), the tool-path calculation software (PSIR) and the tracking system (ATIR), the High Dynamic Compensation System (HDCM) will enable the robot to achieve a machining accuracy better than 0.05 mm.

The HDCM, developed at Fraunhofer IPA, is a high frequency mechanical 3D actuator on which the spindle will be attached, that will continuously compensate for the positioning errors and oscillations of the robot, so that a stable machining process can be obtained.

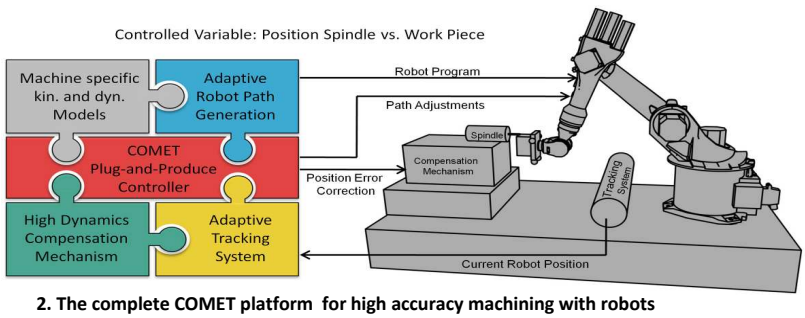
Building an HDCM with its requirements of high speed and accuracy presents many challenges. After assessing several actuation approaches, piezo-actuators combined with flexure elements have been used. The positive effects of the piezo-actuators, such as high resolution, positioning, frequency



1. HDCM cornerstone of the COMET platform

and acceleration can be merged with the positive effects of flexures, which are - compared to mechanical systems - free of friction, back lash and wear. The small displacements of the piezo-staple-actuators can be increased to reach a system displacement up to 500 µm when developing a transmission out of the flexure elements. System design has been almost completed. The optimal actuators configuration (parallel vs serial configuration) has been defined in order to minimise the total mass born by the system and thus increasing its dynamic properties.

FEA-simulations are ongoing to optimise material stress distribution, linear displacement, dimensioning of the gear ratio, stiffness and dynamics. Future steps include the integration of the closed-loop control with the tracking system and the construction of the surrounding body frame. The final design of the HDCM is due in September 2011.



2. The complete COMET platform for high accuracy machining with robots

In this issue:

COMET news & events

4th General Assembly

@ Modena, 15-16 September

All consortium members will meet in Modena for the periodical general assembly meeting to revise the action plan and share results. Special focus will be on WP4 for the 1st milestone of compensation system, i.e. the 1st prototype of the HDCM .

New COMET robot cell operational @ partner BTU

@ Cottbus, June 21

The 7th COMET robot cell is now operational at partner BTU using Delcam's Robot Interface (PSIR). BTU performed milling experiments using their KUKA KR125 in collaboration with partner Artis, investigating process force behaviour and milling strategies.

Nikon Metrology exhibited Adaptive Robot Control at Control 2011 in Stuttgart

Germany, May 3-6

Nikon showed the current Adaptive Robot Control solution for drilling holes. A simulation was demonstrated on pre-drilled holes with a commercial robot.

3. Nikon & COMET booth @ Control 2011

COMET Robots machining experiments

What are the main differences in machining with robots compared to CNC machines? That's the main question behind the numerous machining tests now ongoing on the robot cells already set up in COMET project. A specific meeting was held in Stuttgart at IPA in May to share the results of the first experiments and plan additional experiments.

4. 'Machining tests' meeting @ IPA & SIR test piece

Some partners, such as SIR, are investigating the relevance of various configuration parameters and using simplified milling paths on an aluminium block. Other partners, like TEKS, are planning a straightforward comparison between a piece machined with CNC machine tool and one machined with the Robot cell. Lund University is investigating the machining forces while cutting an aluminium part with a force-torque sensor on their robot.

The common goal is to discover the 'robot's machining secrets', share them between partners and test them in all COMET robot cells. Finally a shared qualification test on a common test piece will be defined to check machining performances of the robot cell, before the final demonstration on real industrial parts.

COMET Publications

"Exploring robotics for the factory of the future"

Control Engineering magazine— June 2011

"Spanende Bearbeitung mit Industrierobotern - Robot machining with industrial robots"

IPA's article appeared on Maschinenmarkt, a German magazine specialised in machining technology — August 2011

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COMET platform set up simulations

While the COMET technology platform is going to be developed piece by piece by the COMET research partners, the robot integrator SIR has been asked to help in simulating the possible different configurations that a COMET robot cell could adopt. The solutions shown by SIR have the machining spindle on a fixed table and the work piece handled by the robot (the opposite solution with spindle on the robot is also possible).

The main idea is to have different configurations adopting the essential part of the platform or the full platform.

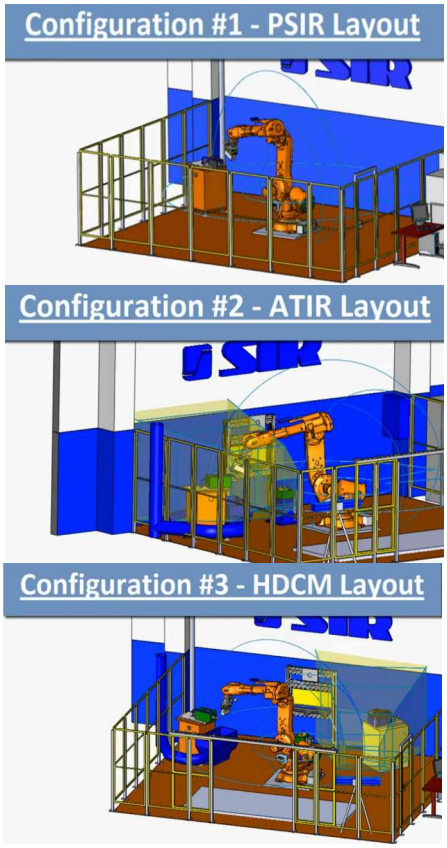
Configuration #1 is the basic COMET platform configuration, with only 2 of the 4 control technology components, the Programming and Simulation Programming System (PSIR), and the Kinematic and Dynamic Model (KDMIR) . This configuration should significantly improve the robot accuracy, better than a calibrated robot.

Depending on the application needs, an optical tracking system (ATIR) could be added, as shown in configuration #2. This aims to reach 0.05 mm accuracy. The optical tracking system is correctly positioned to 'see' the robot handled work piece and the machining spindle.

Finally, the complete solution is shown in configuration #3. On the left side there is a heavy duty spindle for roughing and on the right side a lighter one for finishing which is fixed on the HDCM and controlled by the ATIR.

Have a look on the configuration simulation videos on our YouTube channel to get a clearer idea on how the COMET robot cells can be configured:

http://www.youtube.com/user/COMETproject



5. Screenshots from SIR simulation videos

COMET partner profiles

BTU Cottbus - Brandenburg University of Technology - is an internationally recognised, innovation-driven institute of technology with a sharply defined academic profile. Its mission is not only to impart knowledge and skills in engineering and natural sciences in a forward-looking and sustainable manner, but also to explore and to convey interdisciplinary competencies to its students.

The chair of automation technology is directly involved in the COMET project. The main focus of the research activities in this area are the programming of CNC machines with high-end CAM systems as well as industrial robots with progressive technologies.

In the COMET project BTU takes the lead of the development of the kinematic and dynamic models of the robots, one of the 4 cornerstones of the COMET platform that will help to achieve more accurate robot path generation.

Find more about BTU at:

http://www.cometproject.eu/btu.asp

SIR SpA is a leading international robotic system integrator company; it designs and produces high-tech tailored robotic workcells and lines for manufacturing, assembly, loading/unloading, handling and offers fully automated plants and LGV (Laser Guided Vehicles) based logistics. SIR is a certified Official Partner for all the most important world robot manufacturers such as ABB, FANUC, YASKAWA MOTOMAN AND KUKA.

SIR and University of Modena and Reggio Emilia – Department of Mechanical and Civil Engineering – are strategic partners, sharing human resources and knowledge within LaPIS, Research & Development University Lab for Integrated Design and Simulation.

In the COMET project SIR plays the role of an end user, specifically in the industrial area of automotive, bringing more than 20 years of experience in designing and setting up industrial robot work cells to the consortium.

Find more about SIR at:

http://www.cometproject.eu/sir-spa.asp