04/05/2015 –"Robots for Automation of Post-Production and other Auxiliary Processes": Cluster on Robotics

Introduction and Framework

Creating clusters of FoF project activities, according to their objectives and addressed themes, is an effective way to enhance the impact of FoF projects. The five participating clusters in FOCUS will share experiences and best-practices to stimulate the take-up of project results and investigate how to best exploit synergies. Not only within these participating clusters, but foremost to define an approach that can also work for future clusters.

The clusters within FOCUS are: **Robots for Automation of Post-Production and other Auxiliary Processes" (in short "Robotics")**, Zero Defect Manufacturing (4ZDM), Clean Factories, High Precision Manufacturing (High Micro) and Maintenance and Support; a diverse 'community' but representative for the European manufacturing industry, enabling us to meet our objectives.

Currently, European Commission is recommending clustering activities within running project. But, why this and why now? Basically, clustering identifies and takes advantage of commonalities and tries to avoid overlapping. Some benefits or advantages associated to clustering are listed below:

- Speeding up industrial exploitation and take up of results of FoF PPP projects
- Stimulation of networks and alliances for further RTD and industrial innovation in the addressed technology and application areas
- Added value beyond the original scope of the FoF PPP projects by exploiting synergies and sharing best practice.
- Increased industrial presence and awareness of FoF PPP activities
- More effective execution of activities of common interest, such as IPR management and standardisation.
- Anticipation of business trends and market prospects
- Joint exploitation, thus paving the way towards a higher industrial impact
- Networking activities that may identify common business & commercial opportunities in the nearest future, as well as the potential creation of spin-offs and start-ups based on the research results.

Within this context, the Robotics cluster already started its activity prior of the start of the FOCUS project. The initial activities were networking activities among the four projects belonging to the cluster. The Robotics cluster is lead by prof. Emanuele Menegatti (of the Università degli Studi di Padova, Italy and at the moment counts 7 projects funded by the European Union on the topics of intelligent industrial robots.

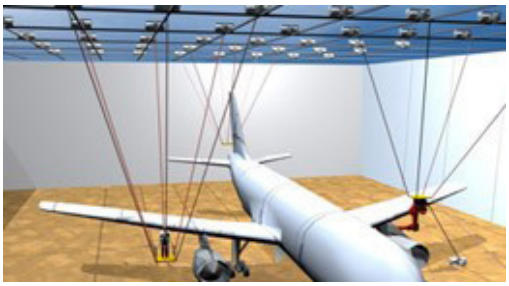
Originally involved projects:

The Robotics cluster was composed by 4 FP7 projects under the same topic FoF.NMP.2011-3: "Robots for automation of post-production and other auxiliary processes", namely:

Miror (www.MiRoR.eu):

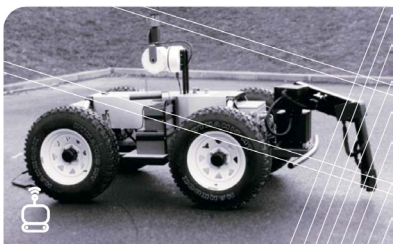
MiRoR (Miniaturised Robotic systems for holistic in-situ Repair and maintenance works in restrained and hazardous environments) developed a fundamentally novel concept of a Miniaturised Robotic Machine (Mini-RoboMach) system, that equipped with intelligence-driven and autonomous abilities, will be demonstrated for holistic in-situ repair and maintenance of large and/or intricate installations. MiRoR is targeted at high investment applications: aero-engines, nuclear, power-generation, oil and gas and large civil engineering structures. MiRoR will be demonstrated by performing in-situ holistic repair/maintenance work (e.g. inspection and processing – material deposition, material removal).

Cablebot (www.CableBOT.eu)



Achieving automation in large-scale maintenance work has always been a challenge. While the replacement of parts in, say, an ocean-going ship requires very specific and precise action, current robotic systems are often not flexible enough to carry out every repair required. As a result, when it comes to large-scale maintenance, potentially hazardous and expensive manual labour continues to be the norm. In response, the EU-funded project CableBOT is developing a new-generation robotic system made up of a network of cables and computer-controlled winches capable of performing different maintenance steps during the life-cycles of large-scale structures. The modular and reconfigurable system can be set up quickly and can be easily scaled up from very small versions for room-sized jobs to a gigantic configuration for large structures.

Mainbot (www.mainbot.eu)



MAINBOT experimented the use of service robots to autonomously execute inspection tasks in extensive industrial plants in order to measure in-field parameters and detect degradation problems (faulty elements, corrosion and leakages, etc.) in equipment that are arranged horizontally (using ground robots) or vertically (climbing robots). The operation of semi-autonomous or fully autonomous mobile robots will increase the efficiency of the plant, reduce the operation and maintenance costs and improve safety and working conditions of workers. These robots have special capabilities for measuring multiple parameters by means of sensors fitted to them and handled by them; they also monitor the state of the installations by identifying faulty or worn parts by means of non-destructive techniques. The consortium validate the prototypes in a real scenario: a thermosolar power plant belonging to Torresol in the province of Cádiz (Spain).

Thermobot (www.thermobot.eu)

Thermobot investigated the automation of **crack detection in parts of complex geometry or large size**. The current procedure for crack detection is a pollutant and manual process that dates back to the 1920s and is called "**magnetic particle inspection**". ThermoBot aimed at replacing this old method for crack detection with a new technology that is based on autonomous inspection robots using thermography to recognize cracks on parts of complex geometry. The robot scans the whole part with a thermo-camera and analyzes the heat-flow to find cracks and other defects hidden under the surface. This is achieved with three key technologies developed during the project: (1) **a thermographic process model** for the thermal behavior of cracks in parts of complex geometry; (2) an **automatic path and motion planning module** to automatically generate a path for the inspection robot from 3D CAD data driven by the thermographic model; (3) novel **thermo-image processing and analysis techniques**. The results of the projects have been validated on two separate demonstrators: one for inspection of metal parts (using a high power laser to locally warm up the part to be inspected), another one for inspection of carbon composite parts (using flash thermography to globally warm up the part).

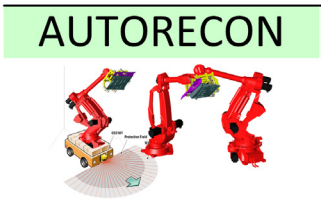
Enlarging the cluster

The four projects initially belonging to the robotics cluster grouped together with another three European projects on industrial robotics funded under different calls to enlarge the experience and the range of applications of innovative application of robots in the industry. These three projects are: **COMET, AUTORECON,** and **X-act**.

COMET (www.cometproject.eu)

The COMET project developed a way to develop innovative machining systems that are flexible, reliable and predictable with an average of 30% cost efficiency savings in comparison to machine tools. Currently, 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 right first time machining, once production commences. These three critical limitations currently prevent the use of robots in typical machining applications. The COMET consortium created a revolutionary framework enabling the use of industrial robots for high-end machining, which in combination with an innovative Plug-and-Produce platform fulfill the needs from the manufacturing industry for cost effective, flexible and reliable manufacturing solutions. This is composed of four blocks: (1) A methodology for describing Kinematic and Dynamic Models of Industrial Robots (KDMIR); (2) An integrated Programming and Simulation environment for Adaptive Robot Path Generation for machining with Industrial Robots (PSIR); (3) An Adaptive Tracking system for Industrial Robots (ATIR) to detect deviations from the programmed Robot Path; (4) A High Dynamics Compensation Mechanism (HDCM) to accomplish an absolute accuracy of more than 50um. The developed solution has been demonstrated in six demonstrators. The project outcomes are available to the manufacturing industry via six exploitable outcomes and one spin off company. Also according to the EC a true success story!

AUTORECON: (www.autorecon.eu)



AUTORECON proposed a radical change in the production paradigm. A wide range of industrial sectors today is still organized in a fixed combination of fixed linear sequences of operations where manual and automated tasks are repeated in the same way each cycle time in the most suitable and optimized way. AUTORECON demonstrated that in the same plant the sequence can be changed by introducing mobile robots, as autonomous production/handling units, which can change task and position around the shop floor to react quickly to the stop of production and reducing losses as much as possible. Mobile robots are equipped with flexible grippers and controlled by an intelligent software architecture. The proposed approach was demonstrated in two scenarios: automotive production plant and in consumer goods industry. The automotive pilot demonstrates the feasibility of an autonomous and flexible production line which will be able to reconfigure dynamically according to the current situation. The demonstrator took place at TOFAS premises. The consumer good pilot demonstrates the proposed system to package assembled shavers that are delivered from the assembly machine and which are first oriented and accurately feed inside the relevant trays.

X-act (www.xact-project.eu)

X-act aims to increase the infiltration and exploitation of highly intelligent and cooperative robotic systems inside European manufacturing and assembly facilities. X-act focus is on enhancing dual arm robots for making them applicable in a manufacturing environment by the development of:

a) Dual arm robots enhancement/extension modules,
b) Dual arm robot intelligent motion planning algorithms,
c) Dual arm robot instructions libraries,
d) Simulation technology,
e) X-act sensor guided programming.

X-act investigates human-robot interaction along the following directions:
a) "Highly intuitive interfaces for cooperation of humans and robots", for enabling the cooperation of humans and robots.
b) X-act develops the so-called "Fenceless human robot supervision system", intending to provide the means for detecting/ monitoring human presence and adjusting the behavior of the robots.
The dual arm robot advantages have been demonstrated in three industrial cases. In the automotive industry the dual arm robot has been used for manipulating a variety of large parts, small parts and for performing screwing operations. Assembling these parts produces a car dashboard. In the second scenario for the automotive industry, the dual arm robot has been used for manipulating and assembling small parts producing a hydraulic pump. Finally, the third demonstrator involves the disassembly of electrical appliances, applied in the disassembly of a sewing machine.

Scientific & Technological background

Factory automation systems and industrial robots are surprisingly "closed" structures: proprietary and closed software is often at the heart of automation systems. This tends to prevent factory automation to benefit from the most recent achievements in terms of software frameworks; moreover, this causes a frequent "reinvent-the-wheel" approach: closed systems need development efforts for achieving results that are already available for other systems. The goal of the activities foreseen in the robotics clusters is to foster the advances of intelligent industrial robots by promoting open solutions for robot programming (like the ROS-industrial software framework) and implement a wide dissemination of the results of the involved project stressing the exploitable results achieved by the seven projects already belonging to the cluster.

Events

- Large virtual meeting over the Internet was held on June 2014 to present the details of the four projects to all the 29 partners in this cluster.
- First workshop on the FoF cluster "Robots for Automation of Post-Production and other Auxiliary Processes" (RAPPAP): A physical meeting with presentations by the partners of the four projects of the Robotics cluster, which took place in Padua (Italy) in July 2014. This scientific workshop was a great opportunity to discuss the status and future trends of robotics and automation for post-production in the industrial environment.

For more information about Robotics' Cluster please contact:

Emanuele Menegatti *emg@dei.unipd.it*

Acknowledgement:
This project has received funding from the European Union Horizon 2020 Programme (H2020) under grant agreement n° 637090.

For further information please visit:
http://ec.europa.eu/research/industrial_technologies/factories-of-the-future_en.html

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.

Contacts:

Project Coordinator: Odd Myklebust, NTNU *odd.myklebust@ntnu.no*
Dissemination Manager: Ro Green, Delcam *rsg@delcam.com*

www.focusonfof.eu