European SMEs Robotics Applications

ESMERA Partner self-description

Laboratory for Manufacturing Systems and Automation [LMS]

Introduction of the institution

The Laboratory for Manufacturing Systems & Automation (LMS) is oriented on research and development in cutting edge scientific and technological fields. LMS is involved in a number of research projects funded by the CEU and European industrial partners. Particular emphasis is given to the co-operation with the European industry as well as with a number of "hi-tech" firms. LMS is organized in three different groups: 1) Manufacturing Processes Modelling and Energy Efficiency, 2) Robots, Automation and Virtual Reality in Manufacturing, 3) Manufacturing Systems and it has a fully equipped machine shop that contains high payload industrial robots, collaborative robots and machine tools.

Role in ESMERA

LMS is the coordinator of the ESMERA project and will host in its premises one of the ESMERA Competence Centres, so as to provide its expertise and all available robotics technologies, infrastructure and support for the application experiments. LMS will provide background knowledge and expertise related, but not limited, to human-robot collaboration, collaborating robots, robot path planning and programming, virtual commissioning (VC) of robotic cells, robotic vision systems, intelligent control of flexible cells, Virtual Reality & human simulation, Augmented Reality for maintenance and operator support, ergonomics, safety and other. LMS will also participate in the Exploitation and Impact Assessment as well as the Dissemination of the ESMERA results, exploiting its current activity of creating a Digital Innovation Hub in the region of Western Greece, utilizing the established network of SMEs, associations and public authorities to actively promote robotics in the Region of Western Greece. LMS has also a strong connection with the industrial sector and is cooperating with Automotive, Aerospace, Consumer Goods, White goods industry and their suppliers.

LMS Competence Centre infrastructure and services

LMS is running a Competence Centre with a fully equipped robotics facility, where several robot cells (industrial and lightweight) are installed and used for research, supplemented by a machine shop for inhouse production of prototypes and components. In addition, LMS owns and operates a CAVE system where VR applications can be developed for multiple sectors as well as development equipment for Augmented Reality Applications. The following infrastructure is available:

High payload robotic cell

This cell was initially developed under the MyCar project for the investigation of robotized welding of multifunctional materials used in body in white components. It has been further enhanced with several sensing technologies (vision systems, RFID based part identification etc.) for process control and part identification. The following technologies are included:

- COMAU NJ130 robot
- COMAU NJ370 robot
- Medium Frequency Welding Gun
- Control PLCs
- Destako grippers
- RFID sensors
- Metal proximity sensors
- Stereo vision system
- Safety Fences

The robots in this cell are able to perform handling and spot welding operations and the Open Control Architecture that has been implemented within the FP6-AUTORECON project allows a dynamic reconfiguration of the cell. The concept of manufacturing ontologies has been combined with service-based control and applied on the system allowing it to dynamically re-allocate and execute production tasks, overcoming the fixed control logic of conventional robotics. The stiffness and high payload of these robots allow for multiple processes such as disassembly, milling of light materials and so forth. Tools allowing the complete offline programming of the cell including the validation of all mechatronic components are provided.

Dual arm robot cell

This cell was developed during the EU project FP7-X-act where handling applications for dual arm robots operating in collaboration with operators have been developed and tested in automotive applications. This cell contains the following technologies:

- COMAU Dual-arm robot
- C5G Open Control
- PILZ SafetyEye 3D safety camera
- Schunk grippers
- Kinect sensor
- Leap Motion sensor

The main advantage of the dual-arm robot is that it can perform bi-manual synchronized movements, simulating the human arms' activity. The better utilization of the workspace thanks to the overhead torso structure and the combined payload of both arms can be coupled with the simplification of the gripping devices which can substitute rigid end effectors for handling large parts. The 3D safety camera can ensure the safety of robot's actions but also serve as a means for human robot interaction by an appropriate mapping of the monitored areas and the robot controller programming. Lastly, HRI sensors, such as Kinect, can help the operator communicate more easily with the robot.

Collaborative hybrid cell

The collaborative hybrid cell developed during FP7–LIAA project, is based on overhead, low payload, collaborative robotic resources able to work in collaboration with humans. More specifically this cell contains the following:

- UR10 robot
- SICK S3000 laser scanner
- Sensor network for process status monitoring
- Wearable devices (HoloLens and smartwatch devices)
- Customized grippers that handle different parts and tools

The focus of this system has been given on the reconfigurability of the cell by using a collaborative lightweight robot that can manipulate multiple parts and tools without the need for tool changers (pneumatic screwing machines) by using a flexible gripper. Augmented Reality applications supporting the operators with 3D virtual model overlay, text instruction and visual alerts have been integrated and easily customizable for each operation. Depending on the process the safety system can be reconfigured to allow several types of human robot collaboration scenarios.

High-payload, industrial robot hybrid cell

This cell was developed during the FP7-ROBO-PARTNER EU project where high-payload industrial robot has been enhanced with supplementary technologies tested in handling applications for large weight automotive parts. This cell contains the following technologies:

- COMAU NJ130 robot equipped with RoboSafe safety system
- PILZ SafetyEYE 3D safety camera
- Wearable and portable devices (AR glasses, smartwatch, smartphone, tablet)
- Force/Torque sensor
- Tool changers and end effectors with Operator Interfaces
- Control PLCs
- Proximity sensors
- Destako grippers

This cell contains a high payload industrial robot that enables the human-robot cooperation during assembly by using3D Safety sensors, speech recognition, manual guidance control algorithms and equipment allowing fenceless human-robot collaboration. The safety and control systems are programmable and integrated with the safetyEye camera allowing dynamic zone monitoring considering with the actual position of the robot.

Low-payload, industrial robot hybrid cell

A hybrid cell that contains a pair of industrial robots for low payload assembly operations is also available, used in the project FP6-AUTORECON, FP7-ROBO-PARTNER and H2020-VERSATILE with the following infrastructure:

- Two COMAU RACER 7 robots equipped with RoboSafe safety system
- Two conveyor belts for different part size
- Vision system using Basler industrial cameras and Ensenso 3D sensors
- Custom grippers for handling multiple parts
- Relay system to control the conveyors through robots' controllers

This reconfigurable assembly cell uses small payload robot resources that can handle multiple parts using different grippers. The main advantage of this cell is that it is easily programmed, under an Intelligent Control& Monitoring system, enabling enhanced performance and high level of re-configurability of production processes using distributed controls (peripheral & centralized) and open architecture (e.g. ROS, Linux based, C4G Open controller) linked to information from sensors.

Mobile robotic solutions

Under the H2020-THOMAS project, a mobile dual arm platform is being developed using two UR10 robots as a dual arm manipulator equipped with different sensors (laser scanners, Roboception rc_Visard etc.). The main focus is given in the flexibility offered by the mobile resources, enhanced by perception modules as well as the implementation of Digital Twin concept allowing to configure the cell based on the reported shop floor status. Small mobile robots, such as the FESTO Robotino are also integrated in the system and will be available for experimentation.

All the aforementioned equipment is hosted at LMS' machine shop, which also contains machine tools for manufacturing custom parts, fixtures and devices.

Virtual Reality Room

The Virtual Reality (VR) room contains Virtual and Augmented Reality devices and infrastructure, meant to support a wide range of VR and AR applications. More specifically, the following application is available and has been used in projects such as i-VISION, HUMAN, ProRegio and other:

- Three-wall CAVE equipped with three BARCO RLM-W12 projectors and four VICON Bonita marker tracking IR cameras
- Oculus Rift VR glasses and Touch controllers (with three tracking sensors)
- Smart gloves
- AR enabling devices (Vuzix STAR 1200XL glasses, tablet, smartphone)
- Windows Kinect Sensor
- Leap motion sensor
- Microsoft HoloLens Mixed Reality glasses
- EON ICrystal holographic display

The Virtual Reality room contains state of the art technologies related to VR and AR, enabling the development of intuitive, user-centred applications covering the needs for HRI, maintenance and operator training.