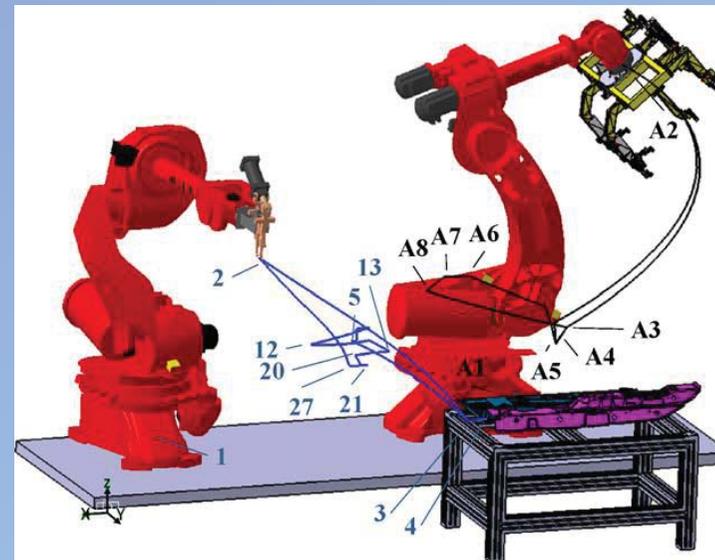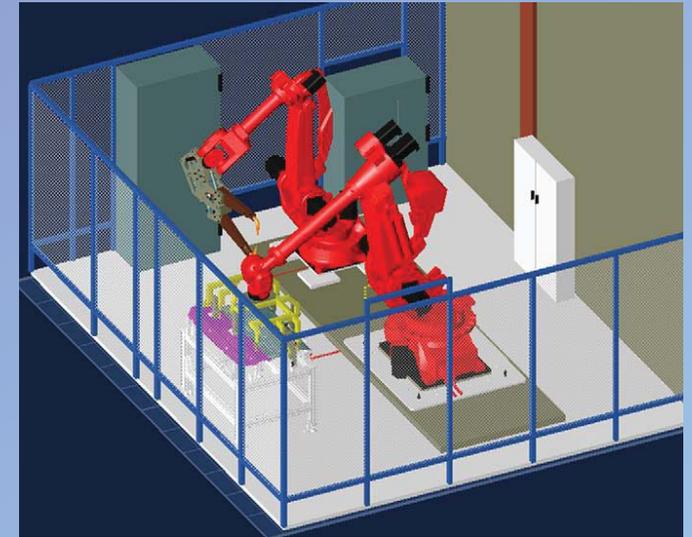# Robot path planning and programming

- State of the art simulation tools (DELMIA, Robcad)

- Intelligent path planning

- Off Line Programming (OLP) of industrial robots

- Applications include
  - Welding
  - Handling
  - Assembly

N. Papakostas, K. Alexopoulos, A. Kopanakis, "Integrating Digital Manufacturing and Simulation Tools in the Assembly Design Process: A Cooperating Robots Cell Case", CIRP Journal of Manufacturing Science and Technology, Volume 4, No.1, pp.96-100 (2011)

Virtual commissioning (VC) of flexible robotic cells

- Complete workflow for applying VC techniques on industrial assembly cells

- Development of complete cell mechatronic model including:

  o Detailed 3D modeling (geometry, kinematics, robot programs etc.)

  o Complete behavioral modeling (I/O signals, control logic, safety features etc.)

- Reliable way of validating the operation of a cell prior to each installation

  o Ramp-up time reduction

  o Reduction of investment costs

  o Enhancement of re-configurability
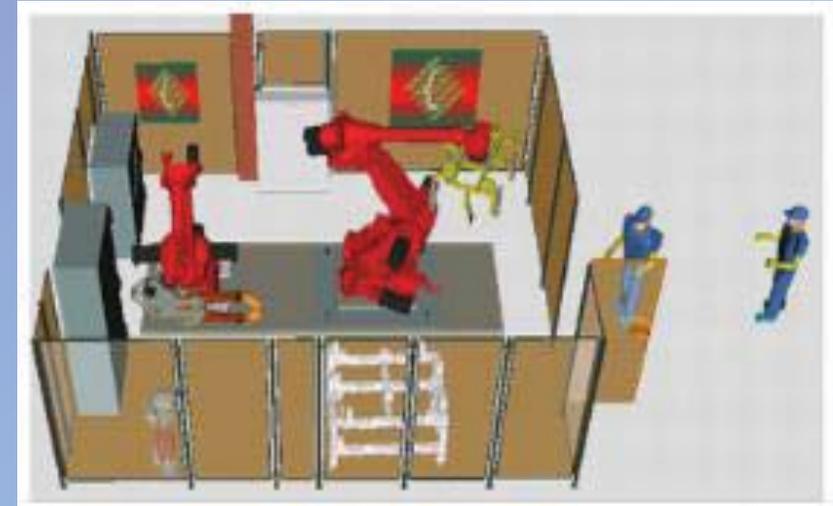
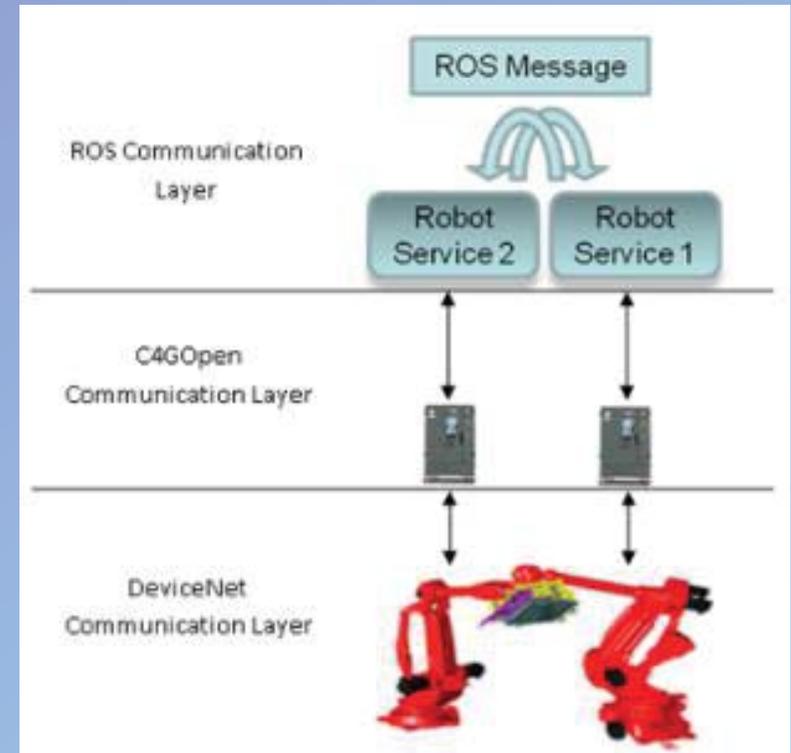# Design and analysis of flexible cells using cooperating robots

- Modeling and analysis of cooperative assembly tasks between robots

- Identification of cost, time and complexity implications, under different assembly applications

- S. Makris, G. Michalos, A. Eytan, G. Chryssolouris, 2012, Cooperating machines for reconfigurable assembly operations: Review and challenges, Submitted to the 45th CIRP Conference on Manufacturing Systems (CIRP CMS)

- N. Papakostas, G. Michalos, S. Makris, D. Zouzias, G. Chryssolouris, "Industrial applications with cooperating robots for the flexible assembly", International Journal of Computer Integrated Manufacturing, Volume 24, No. 7, pp.650-660 (2011)

- N. Papakostas, K. Alexopoulos, A. Kopanakis, "Integrating Digital Manufacturing and Simulation Tools in the Assembly Design Process: A Cooperating Robots Cell Case", CIRP Journal of Manufacturing Science and Technology, Volume 4, No.1, pp.96-100 (2011)

Robot programming using open source system such as ROS

- Implementation of communication between the cooperating robots through the use of ROS services

- PC based control of:
  - Arms,
  - Grippers
  - Guns
  - Auxiliaries

S. Makris, G. Michalos, A. Eytan, G. Chryssolouris, " Cooperating robots for reconfigurable assembly operations: Review and challenges", (CMS2012), 45th CIRP Conference on Manufacturing Systems, Athens, Greece, pp.393-399 (2012) PROCEDIA

Development of robotic vision systems for the adjustment of welding processes
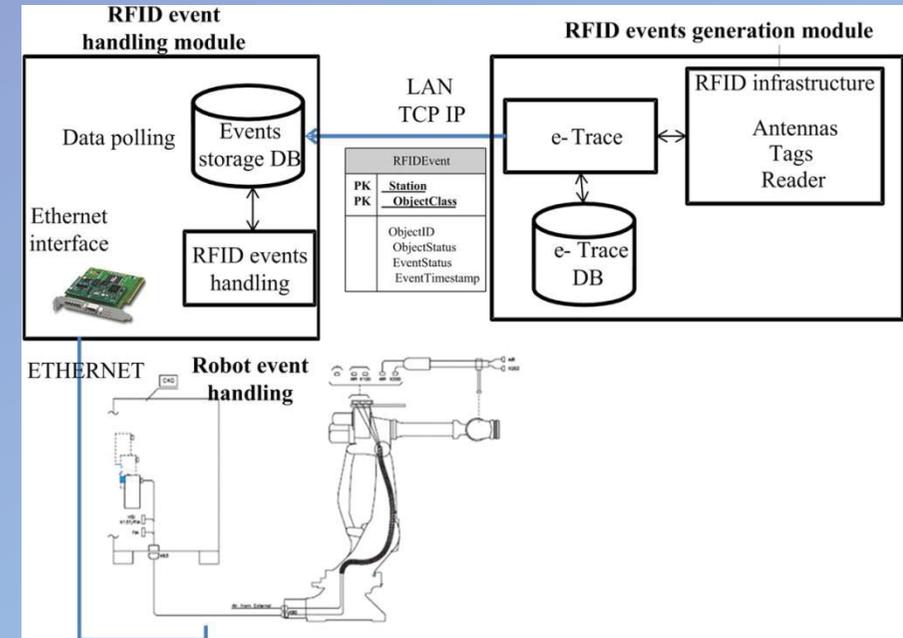
- Development and integration of stereo vision systems on industrial robotic arms for welding operations

- Use of laser diodes for highlighting the welding area and examination of the laser line distortion to correct the path of the robot
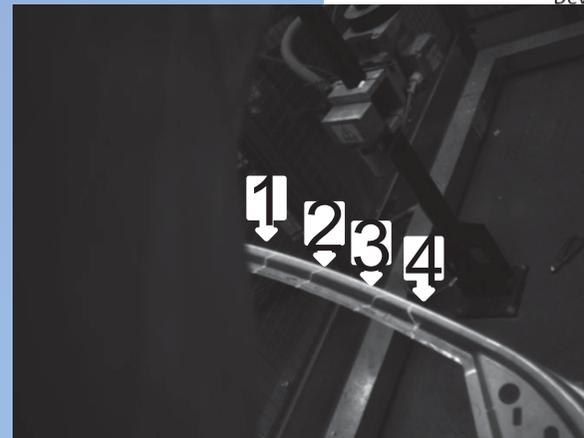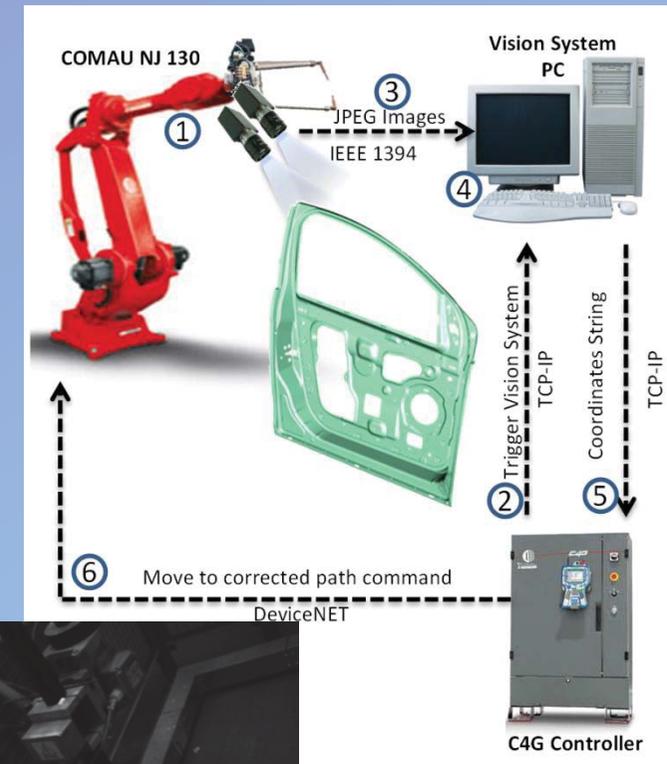
- G.Michalos, S. Makris, A. Eytan, S. Matthaiakis, G.Chryssolouris, "Robot Path Correction Using Stereo Vision System ", (CMS2012), 45th CIRP Conference on Manufacturing Systems, Athens, Greece, pp.400-405 (2012) PROCEDIA

- G. Michalos, S. Makris, N. Papakostas, D. Mourtzis, G. Chryssolouris,"Automotive assembly technologies review: challenges and outlook for a flexible and adaptive approach", CIRP Journal of Manufacturing Science and Technology, Volume 2, Issue 2, pp. 81-91 (2010)

Integration of wireless technology (RFID, WiFi etc.) for the intelligent control of flexible robotic cells.

- Development of an integration driven framework for enabling the RFID based identification of parts to perform robotic assembly operations in a random mix

- RFID infrastructure senses the arriving parts to be assembled and via the integration framework, the robots are able to recognize them and perform cooperative welding operations.

S. Makris, G. Michalos, K. Efthymiou, K. Georgoulias, K. Alexopoulos, N. Papakostas, A. Eytan, M. Lai, G. Chryssolouris, "Flexible assembly technology for highly customisable vehicles", (APMS 10), International Conference Competitive and Sustainable Manufacturing, Products and Services, Como, Italy (2010)

Design, modeling, simulation and optimization of robotic assembly lines

- Development and application of intelligent search algorithms for high quality line designs.

- Use of multi criteria decision making methods using as metrics
  - investment cost
  - availability
  - equipment re-utilization
  - annual production volume

- Implementation of flexibility quantification methods in complete software tools

G. Michalos, S. Makris, D. Mourtzis, "An intelligent search algorithm-based method to derive assembly line design alternatives", International Journal of Computer Integrated Manufacturing, Volume 25, No.3, pp.211-229(2012)