ANNALS of the ORADEA UNIVERSITY.
Fascicle of Management and Technological Engineering, Volume VI (XVI), 2007

ROBOTICS, DIRECTIONS FOR RESEARCH DEVELOPMENT AND INNOVATION

Inocentiu MANIU, Valentin CIUPE

"Politehnica" University of Timisoara, Department of Mechatronics

inocentiu.maniu@mec.upt.ro valentin.ciupe@mec.upt.ro

Keywords: mechatronics, robotics, training, FMS, simulation, modeling.

Abstract: At the Department of Mechatronics from "Politehnica" University of Timisoara the concept of research, development and innovation is taken one step further by means of acquiring and integrating new robotic equipments, flexible manufacturing cells and modeling and simulation tools, used in both research and training.

1. INTRODUCTION

At the Department of Mechatronics from "Politehnica" University of Timisoara the concept of research, development and innovation is taken one step further by means of acquiring and setting up new robotic equipments, flexible manufacturing cells and modeling and simulation tools. All these are meant to integrate and interact in order to help developing new concepts in robotics, conducting efficient and oriented training and maintaining the traditional RDI directions. In the paper are presented the main laboratories and equipments found at present time at the Mechatronics Department, exposing their capabilities and uses along with the main threads that were opened in the field of robotics training and research.

2. FLEXIBLE MANUFACTURING SYSTEMS

The first flexible manufacturing system used in the department is the *CIM Pilot Station* (figure 1). It is a scaled FMS, used for training in cell workflow programming, CNC manufacturing, robotized storage and manipulation, PLC programming, and vision-based shape recognition. The system is equipped with Eshed-Robotec components and comprises of 3 work stations:

- the automated storage, having a rotary indexed storage space and being serviced by de ER-VII robot;
- the numerically controlled mill EMCO F1 CNC, fed by the ER-V robot;
- the automated assembly and testing station, serviced by the SCORA ER-14 robot;
- the interconnecting conveyor with stations at every robot and pallet identification.

Fig.1. The CIM pilot station

Another training equipment is the *FESTO MPS* (figure 2), a scaled Flexible Modular Production System for training in Mechatronics and Robotics. It is designed to be used for line-assembly programming and optimization, PLC programming, electro-pneumatic actuation, fault detection and correction. The system has four stations:

- distribution, which extracts pieces from a vertical storage and by making use of a swing arm and a suction cup moves those pieces to the next station;
- testing, its role being that of piece height measurement and comparison; it also features an inclined slide with air cushion for piece transportation to the next station;
- processing, this station simulates milling of a groove in the piece (cylinder end cap) and also features a rotary indexed table with presence and piece orientation sensors;
- manipulation with insertion, it is essentially a two axes cartesian robot that collects pieces from the previous station and sorts them on different criteria in two inclined storages; it also features fiber-optic sensors for piece presence confirmation.

The Festo MPS is extendable by chaining more stations (up tot 9) to simulate an entire assembly and testing production line.

Fig.2. The FESTO modular production system

3. TRAINING IN ROBOTICS

As the necessity of renewing the robotics park in the department, the *KUKA Technological Transfer and Training Centre* was founded (figure 3). It is formed by two cells with last generation, high performance industrial robots, valued at 100.000 Euro. The system is used for programming different applications in manipulation, path planning and robot cooperation operations and it comprises two cells:

- one cell is fitted with the Kuka KR-15 robot;
- the other with the Kuka KR-125 robot;
- both robots are electrically actuated with pneumatic grippers having large payloads, high speed and acceleration.

Fig.3. The KUKA robot cells

The beneficiaries trained on this robotized cells (SC Terra Constructii SRL Botosani) report increasing productivity and production flexibility by implementing and production-wise programming their own flexible robotic cells.

Because industrial robots mean more than manipulation, a *CLOOS robotized cell* was assembled (figure 4). This is built around a CLOOS Rotrol II industrial robot that is used for welding and plasma cutting, robot programming and spatial path planning techniques. It was set up alongside with the partner SC Robcon™ SRL Timisoara;

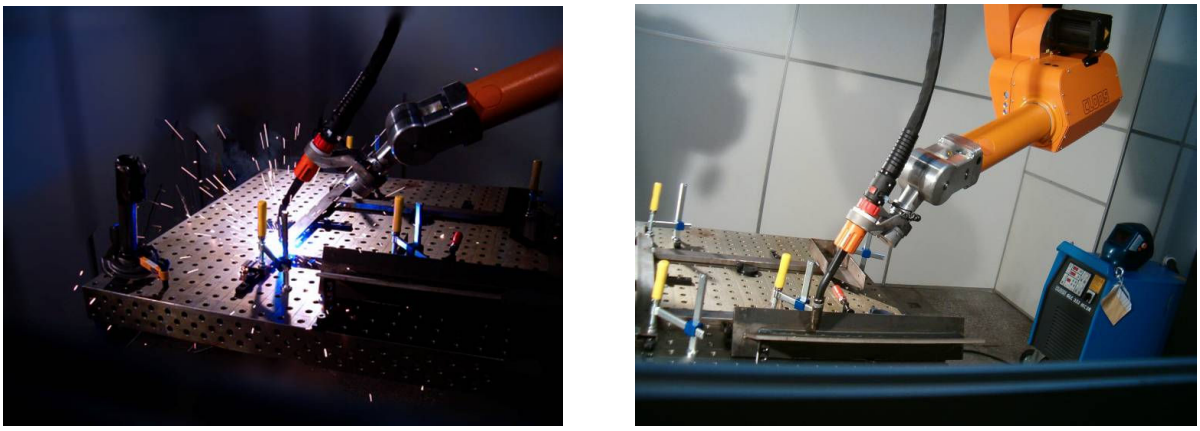

Fig.4. The CLOOS welding robot in action

The cell was founded from an Excelence Research Contract (CEEX), entitled *"Researches Regarding the Possibility of Using Robotic Systems to Increase the Technical-economical Competitiveness of the Romanian Industry".*

Another piece of equipment found at the department is *Dynalog's CompuGauge™ Robot Measurement and Performance Analysis System* (figure 5). This is a high precision opto-mechanical device, attached to a robot's flange in order to measure its positioning performance and repeatability. The system's software allows for on-line measurement, off-line visualization and analysis.

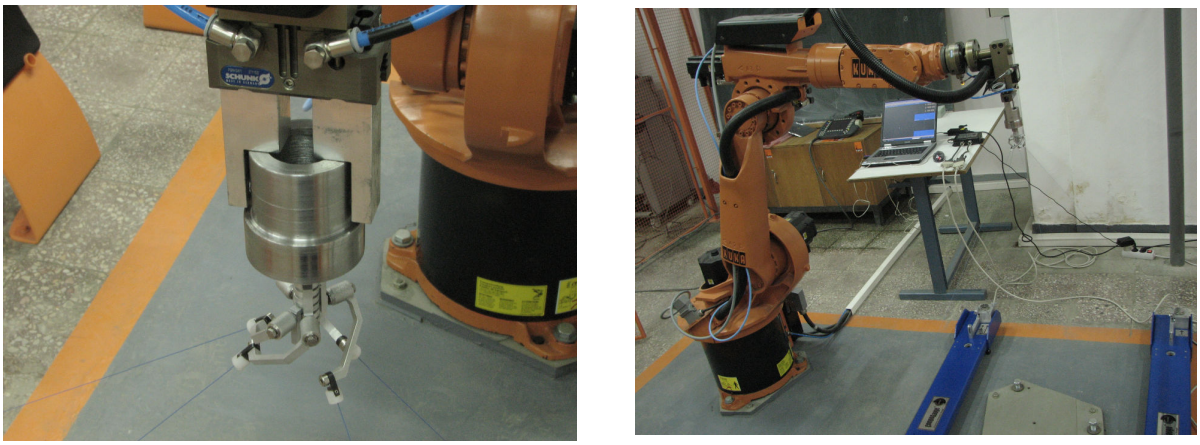

Fig.5. Dynalog's CompuGauge robot MPA system

4. SIMULATION AND MODELING IN VIRTUAL REALITY

Following the tendencies in the field of robotic design, the *Virtual Reality Laboratory* was built up (figure 6). It is used for modelling, simulation and 3D visualization of robotic systems and comprises of:

- 6 DOF and force feedback haptic device, type Phantom Desktop;
- virtual helmet type 5 DTHMD 800 and also the required software packs;
- virtual hand glove with 16 sensors type 5DT;
- head tracker type Inertiacube 2,
- three-dimensional 23" TFT monitor with 3x26º viewing angle;
- 3D DLP video-projector;
- 10 pairs of 3D wireless glasses, synchronized to the video-projector;
- graphic station type Silicon Graphics Prism™ Deskside;
- 6 Intel P4 workstations.

Fig.6. The virtual reality laboratory

In order for the above stated equipments to integrate seamlessly and to work efficiently the *DELMIA Resource Modeling & Simulation Tools* was acquired (figure 7), containing the following module packs:

- Delmia IGRIP, which is a physics-based, scalable robotic simulation solution for modeling and off-line programming of complex multi-device robotic work cells;
- DELMIA VIRTUAL NC, being the complete digital manufacturing solution for rapidly emulating, validating and optimizing NC machine processes;
- DELMIA QUEST, acting as a complete 3D digital factory environment for process flow simulation and analysis.

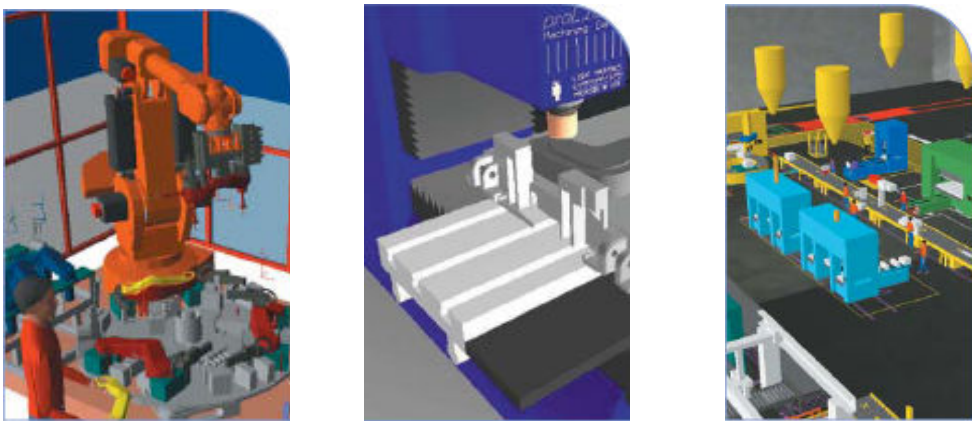

Fig.7. DELMIA resource modeling & simulation tools

5. RDI DIRECTIONS

All the equipments present in the Robotics Laboratory dictate the main directions in research, development and innovation at the Department of Mechatronics, directions that can be summarised as follows:

- training in robotics and mechatronics;
- maintaining the traditional research directions;
- developing adaptive robot control based on sensorial information;
- work on robotized flexible manufacturing systems synthesis;

Also new research paths will be opened in the mobile robots and general robotics field of interest:

- teleoperating installations;
- artificial intelligence elements used in robotic systems (artificial vision, modelling/simulation, fuzzy logic, artificial neural networks);
- robotic devices for interacting with virtual reality and virtualized reality.

As part of RDI present activities, the Mechatronics Department is partner alongside other 7 research institutions, renowned universities and companies among which is found S.C. Robcon S.R.L., in the European FP6 project, no. 017146/14.03.2005, *"Skill-based Inspection and Assembly for Reconfigurable Automation Systems"*, acronym SIARAS. This project is coordinated by IPA Stuttgart and with a budget of 206.000 Euro for the Mechatronics Department, has as main objective insuring simple and dynamical reconfiguration of complex production systems, so that they meet the economical efficiency and reliability criteria required by consumers.

6. REFERENCES

[1]. Maniu Inocentiu, Ciupe Valentin, Joni Nicolae – Reconfiguring the Robotics Laboratory at the "Politehnica" University of Timisoara, Buletinul Institutului Politehnic din Iasi, Tomul LII (LVI), Fasc. 7B, 2006, Sectia Constructii de Masini, pp.47-52, ISSN 1011-2855

[2]. Maniu Inocentiu, e.a. – Contract 21 CEEX I 03 /07.10.2005 Cercetari privind posibilitati de utilizare ale sistemelor robotice in scopul cresterii competitivitatii tehnico-economice a industriei romanesti (CUPSR)