METHODS FOR TRAINING IN AUTOMATION ON A PROCESS STATION

Dorin Popescu, Dan Selisteanu, Nicu Bazdoaca, Dorin Sendrescu
University of Craiova, Faculty of Automation, Computers and Electronics
Craiova, Romania, 107 Decebal Street, 200440
dorinp@robotics.ucv.ro

Abstract: In this paper is presented the real, simulated and virtual experiments for a process station (part of a Flexible Manufacturing System FMS-200) and the benefits of the application of Virtual Reality in education. The used basic concepts of Virtual Reality and description of flexible manufacturing system are provided. The real and simulated experiments of the process station are presented. Finally, the "Virtual Repair" is discussed.
Keywords: real, simulated and virtual experiments; programmable logic controller; process station.

1. INTRODUCTION

Modern information technology is rapidly being adopted in education as a tool for enhancing the educational experience of students. Modern Multimedia and Virtual Reality (VR) technologies offer good potential for presenting the theory and practical experiments in an interesting and economical way ([1], [2], [3], [4]. In this paper is presented the real and simulated experiments for a process station (part of a Flexible Manufacturing System FMS-200) and the benefits of the application of Virtual Reality in training process.

2. THE PROCESS STATION

Flexible Manufacturing System FMS-200 is a Flexible Assembly System (fig. 1). The system comprises a flexible automation cell which carries out an assembly process involving a number of predetermined parts, initially with a total of 24 different possibilities, but now with a total of 34 different possibilities through some own developments.

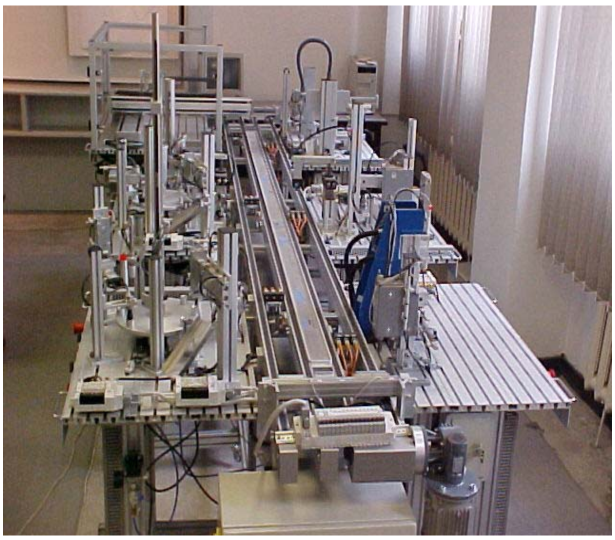

Fig. 1.

Parts are transported between the different stations by an automated transfer line with corresponding stoppers and precision lifters-positioners. Parts are mounted on pallets. The pallets incorporate a magnetic coding system using inductive detectors which allow the control system to identify the position of each pallet at any time. The standard layout includes a programmable logic controller (PLC), Mitsubishi model FX2N-32MR. The FX2N-32MR PLC has 16 inputs and 16 outputs, timed and programmed interrupts, internal PID, high-speed counter and 0.08 μs instruction time. It incorporates an RS-422 port for programming, and an RS-485 port for communication with other PLCs or PCs.

3. EXPERIMENTS

For some of process stations of FMS-200 was developed real, simulated and virtual experiments.

VRML simulation. It was developed the VRML simulation of first and second stations (Fig. 2). For station simulation we have created *Script nodes* that describe the plant and we have used *Interpolator nodes* and *Sensor nodes* for animating the work station. We also used *TimeSensor nodes* for synchronisation. The work station is created based on elementary geometric shapes and it was preserved the aspect ratio between components. The simulation respects the order and the speed of the process steps ([5], [6], [7]).
Now the students can work off-line with our process stations. All achieved VRML applications there are on the website of laboratory. In this way the students can understand how the station works and it is easier to develop PLC programmes for the process station.

PLC used control of simulated process. Another solved task was to create the possibility to write programmes

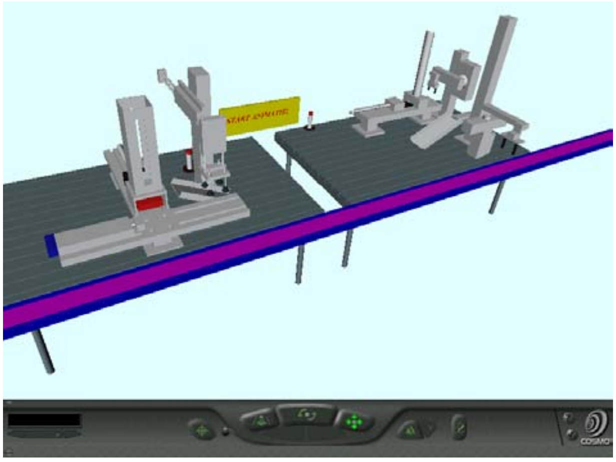

Fig. 2.

for Mitsubishi FX2N-32MR PLC and to test them off-line on simulated model of process station. It was developed an interface (fig. 3) between PLC and computer and the software that can simulate the process station (another software, not VRML simulation). The interface is based on AT89C51 microcontroller. The student will write a PLC program to control the process station in desired way. He will see on computer's display if his PLC programme is design correctly and the movements of station's components are well (Fig. 4).

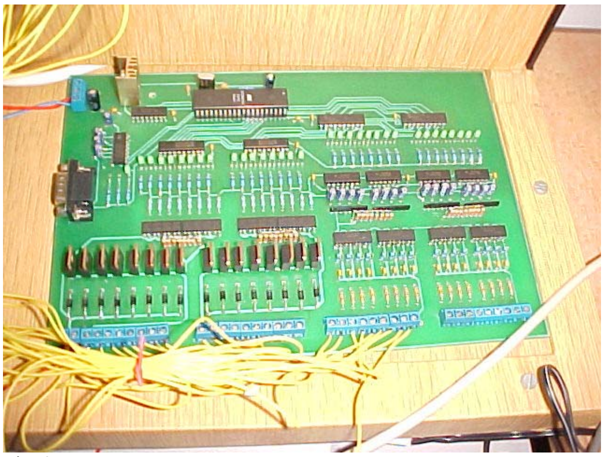

Fig. 3.

Real experiments. After the student tested his PLC program on simulated process he can test his PLC program on real station. In this way the student will see if the real movements of the process station are the same as movements of simulated process. The student will not occupy to much time the real equipment and the possibilities to demage the equipments are decreased.

Virtual repair. In order to increase the number of didactical experiments with this process station we tried to develop a fault simulation system for the stations. The system consists of a lockable box containing a number of switches (16 switches) which, when operated, cause a fault in the station.
It was offered for the station the possibility of generating 16 different dysfunctions. There are two ways of causing the faults/dysfunctions in the station. The first way, developed till now, is the traditional method, by means

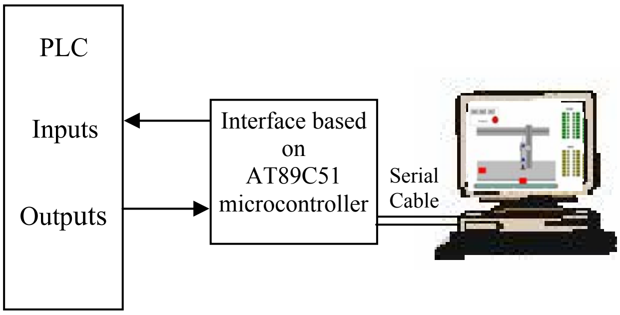

Fig. 4

of switches. Each switch, when activated, will make a dysfunction in some components of the station.
There is no limit in the number of faults that can be activated at the same time. After the fault is activated, the student has to analyze the system to find out which the broken component is. Then the student has to substitute or repair the broken component and the verification of the system in order to make sure that the dysfunction has been repaired correctly.

4. FUTURE WORK AND CONCLUSIONS

One of our present tasks is to develop a similar project for all the process stations of FMS-200. With our achieved and future developments the students will have new possibilities to understand and work with FMS-200.
The practical activities drawn up from the modular concept of the system allow the development of skills such as: analysis, installation/assembly/implementation, maintenance/diagnosis/fault repair, start-up/set-up, design/layout, programming, preparation of documentation, definition of procedures, measuring, etc., integrating different technologies including: Pneumatics/Electro-pneumatics, Electrical Actuators, Robotics/Manipulation, Industrial Communications, Control Systems, Electric Automatisms, Safety Devices, Basic Mechanical Systems, and so on.

REFERENCES

[1] Figueiredo, M., Böhm, K., Teixeira, J., "Advanced Interaction Techniques in Virtual Environments", Computers & Graphics Journal, Vol. 17. No. 6, Pergamon Press Ltd, pp. 655-661, 1993.
[2] Carrie, A.S., Adhami, E., Stephens, A., Murdoch, I.C., "Introducing a flexible manufacturing system, Int. J. of Prod. Research, Vol.22, No.6, pp. 907-916, 1984.
[3] Haidegger, G., Kopácsi, S., "Telepresence with Remote Vision in Robotic Applications", Proceedings of the 5th International Workshop on Robotics in Alpe-Adria-Danube Region, Vol. 1, pp. 557-562, 1996.
[4] Broll, W., "Augmenting the Common Working Environment by Virtual Objects", ERCIM NEWS, No.44, pp. 42-43, 2001.
[5] * * *, "The Virtual Reality Modeling Language", International Standard ISO/IEC 14772-1:1997, VRML Consortium, 1997.
[6] Carey, R., Bell, G., „The Adnotated VRML 2.0 Reference Manual", Addison Wesley, 1997.
[7] Marrin, C., Campbell, B., Sonstein, J., "Teach Yourself VRML 2 in 21 Days", Sams Publishing, 1997.