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COLLABORATIVE LEARNING ENVIRONMENT USING DISTRIBUTED MIXED REALITY EXPERIMENT FOR TEACHING MECHATRONICS

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Abstract: This work presents a virtual learning environment which uses a distributed mixed reality remote experiment for professional education in the area of Mechatronics. The proposed collaborative environment makes use of the system named deriveSERVER, which has been developed by the Bremen University, and extends it, in order to allow the integration with remote hardware or software used by the students. The remote experiment will be used to enhance lessons used in SENAI-RS, a vocational education institution in southern Brazil, enabling the development of collaborative projects among students at different SENAI sites. *Copyright © 2007 IFAC*

Keywords: Remote Control, Control Engineering, Learning Systems, Virtual Reality, Pneumatic Systems, Process Automation.

1. INTRODUCTION

Mixed reality laboratories take advantages from virtual laboratories and real laboratories. The use of mixed reality systems for distance learning has been increasing over the last years. SENAI-RS as an important technical education institution in Brazil, have decided to use such techniques for Mechatronics education and established cooperation with the University of Bremen and the Federal University of Rio Grande do Sul to develop a mixed reality application with electro pneumatic devices used in industry.

The basic idea of the project was to extend the deriveSERVER (Bruns and Erbe, 2004) developed at University of Bremen to the educational needs of SENAI Mechatronics Technology Center.

The system developed by the University of Bremen is a powerful tool to teach not only pneumatics but also system automation and development process (Bruns and Erbe, 2004). The use of hyper bonds provide interface to any discrete pneumatics or electric equipment in the real environment.

This project also proposes to enhance the server to be more robust and platform independent. Currently this server is fixed on commercial programs that are not supported by other browsers and operational systems. This work will be organised into 5 Sections as follows: In Section 2 a shortly description of the system (deriveSERVER) developed by the University Bremen. Then a description of the industrial training in SENAI-RS in Section 3. The proposed enhanced version of deriveSERVER will be presented in Section 4. Finally in Section 5 the results of the running project then in section 6 the concluding remarks.

2. DERIVESERVER DESCRIPTION

2.1 Mixed Reality Remote Experiment

The deriveSERVER is a system that provides remote access to a virtual reality environment (based on 3D virtual models) and also a real experiment. DeriveSERVER stands for distributed real and virtual learning environment for mechatronics and tele-service.

The used experiment in the remote and virtual laboratory was a traditional electro pneumatics workbench used in mechatronics with cylinders,

valves with pushbuttons, solenoid valves and much more, providing a simple discrete control.

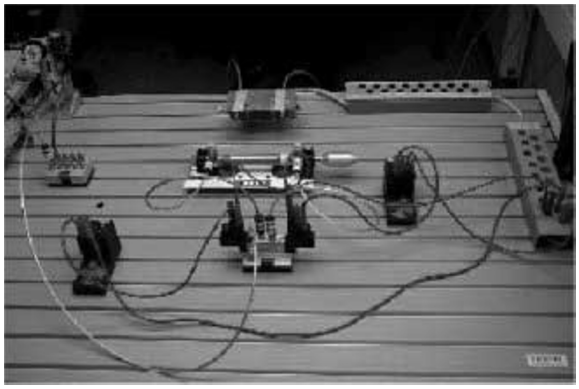

Fig. 1. Simple arrangement of pneumatics device in a real experiment workbench.

The system provides mixed reality experiments through the extensively use "hyperbonds". The hyperbond tool realizes a tight coupling between physical and virtual phenomena (Bruns, 2004). Hyperbonds are bridging the gap between reality and virtuality by transmitting physical phenomena (air pressure, electric potential) from one side to the other and vice versa. They follow the theory of Bond graphs which provides a unified view on different systems using the notion of effort and flow (Paynter, 1961). The bond graph theory has been than further developed by Karnopp *et al.* (1990).

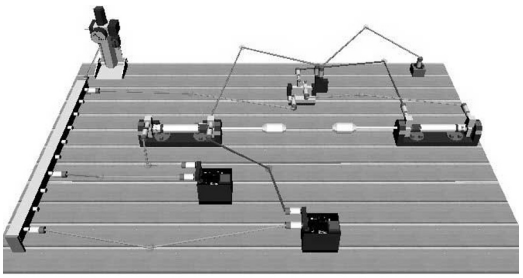

Fig. 2. Simple arrangement of pneumatics device in a virtual experiment workbench.

The system was not designed (developed) to treat analog signals, so analog devices are not used, therefore only discrete control is possible with boolean variables. Solenoid valves can be driven by electrical current, making electrical control possible as typically used in eletro pneumatics systems.

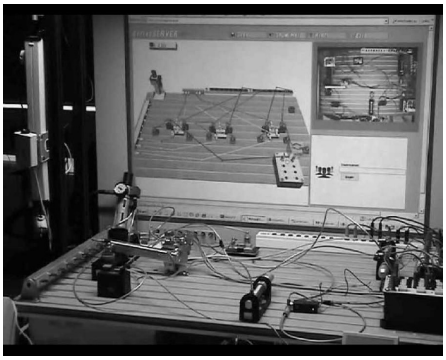

Fig. 3. Local tests mixed reality installation.

2.2 Architecture

The master (server) software of the deriveSERVER system architecture is the ROMAN (Real Object Manager). Other softwares attached are called ROMAN plug-ins (clients). So: the VCK (Virtual Construction Kit), the hyperbond (software and hardware) are plug-ins that communicates with the ROMAN through communication sockets using the specific created ROMAN-protocol.
The VCK is the Java developed web interface responsible for managing and displaying the virtual workbench interface to the user. Virtual models (VRML's) are displayed in this interface by the use of the commercial (free only for personal and non-commercial use) VRML plug-in called Cortona VRML Viewer (ParallelGraphics, 2006). Virtual reality models are manipulated using EAI 2.0 (External Authoring Interface) and Java Scripts. Java Scripts capture the client user inputs (like mouse and keyboard entries) and the EAI, performed in the VRML plug-in (based on the ActiveX Automation Technology), is used to transform the virtual workbench (virtual reality models scene). The real equipment video, used in the mixed reality experiment, is acquired by a simple WebCam. The real video capture is available in the experiment interface using the simple WebCam2000 free open source software (WebCam2000, 2006).

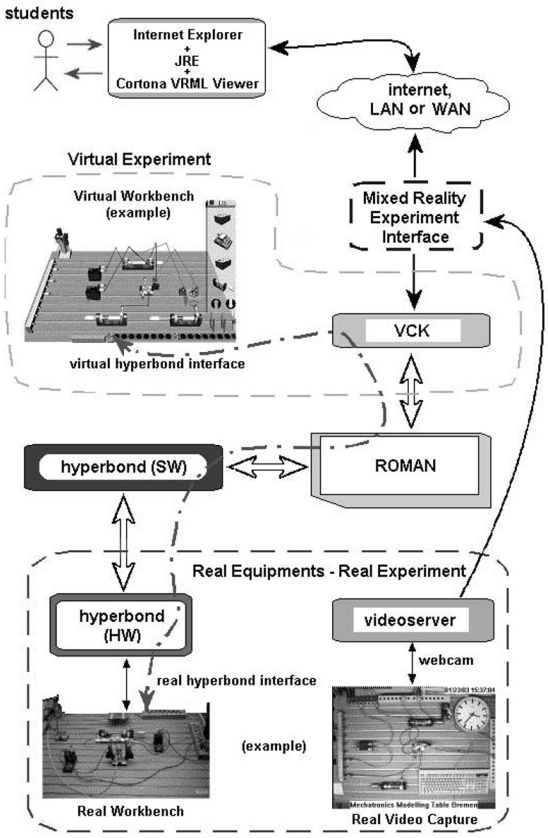

Fig. 4. DeriveSERVER interaction architecture.

According to the Fig. 4 the mixed reality interface is available in the internet displaying the real video capture and the virtual workbench using the Internet Explorer (IE) web browser from Microsoft, Java Runtime Engine from Sun Microsystems and the