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E-LEARNING TRAINING MECHATRONIC SYSTEM

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ABSTRACT
This paper describes the architecture of an e-learning training mechatronic system developed at the University of Oradea, based on an intelligent mechatronic system useful for research and e-learning. Details are given related to the e-learning solution developed by University of Oradea.
Keywords: e-learning, mechatronic system, tele-robot.

1. INTRODUCTION
Experimentation is a very important part of education in engineering including mechatronics engineering, which is a relatively new field, combining three engineering disciplines: mechanical engineering, electrical engineering and software engineering [1]. The equipments needed for experiments in mechatronics are generally expensive. Examples are robot manipulators, mobile robots, electrical motors, fast DSP cards, CNC machines, etc [2,3]. One solution for these expensive equipments is their sharing with other universities or research centers from different locations [4, 5].
The goal of our team is to build a networked tele-robotic system so that the Internet users, especially researchers and students, to be able to control the mobile robot to explore a dynamic environment remotely from their home and share the robot system with the department. The required knowledge is based on previously reported international experience [6, 7, 8]. The long-term goal of the research is towards real-world applications such as tele-manufacturing, tele-training, and tele-service [9, 10, 11], based on Virtual Reality technologies [12, 13, 14]. The basic VR systems allow someone to gather visual or sound information using computer screens, stereoscopic displays or headphones. Some advanced systems, also known as haptic devices, can offer tactile information. Interaction between users and VR systems is ensured by standard input devices (keyboard, mouse) or multimodal devices (wire glove, the Polhemus boom arm, omni directional treadmill)[15, 16].
The system under development will be able to connect more video cameras. The visual feedback module allows for fast image updating, and presents a quite reliable view for the remote user. We are currently investigating both supervisory control and cooperative learning control. The focus of this project is directed to provide a tele-robot system with a high degree of local intelligence in order to handle restricted bandwidth and transmission delay of the network. There is a great interest, also, to integrate multiple mobile robots into a tele-robotic system to achieve redundancy and robustness in a fault-tolerant reliable architecture.

2. REMOTE HUMAN-ROBOT INTERACTION
Several e-learning laboratories have been developed for robotics and mechatronics [17-20]. It can be distinguished two categories of them:
a) remote laboratories, which offer remote access to real laboratory equipment and instruments (including wireless transfer), and

b) virtual laboratories, which offer access to a virtual environment.
The human operator, in the case of remote laboratories (fig. 1), in interaction with the real remote environment uses an actorical interface that sends a command signal to the actuators. The sensors will collect the information about the movements of the real remote environment and send it back through a sensorial interface [21].

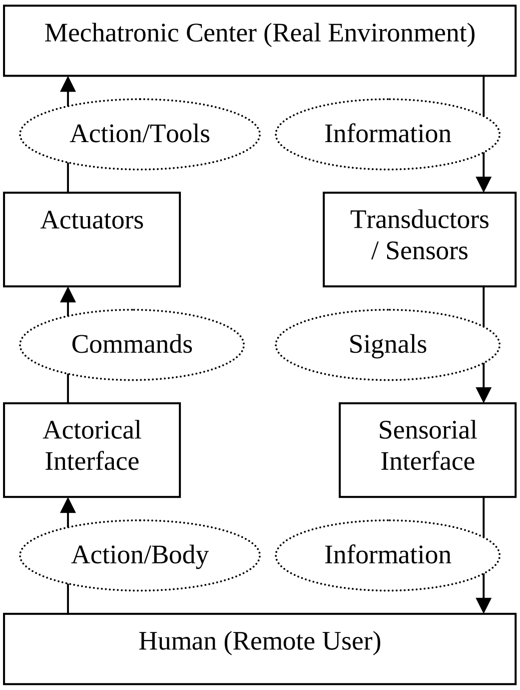

Figure 1. Remote laboratory

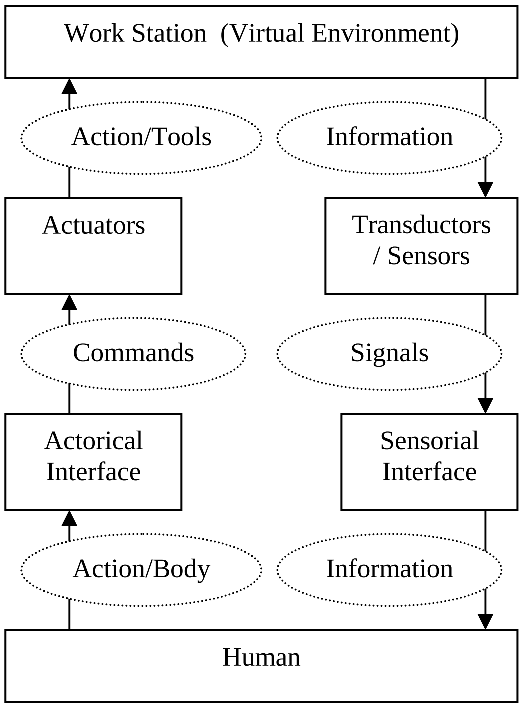

Figure 2. Virtual laboratory

A virtual laboratory structure (fig. 2) asks that the human operator through an actorical interface interact with the virtual environment. The sensorial interface "collects" the information about the state and movements of the virtual environment and sends it to the operator [21].
The remote access can use different physical layers and protocols. A common approach is based on Internet protocol (TCP/UDP or HTTP controlled). At low level, an implementation has to use the socket philosophy for data transfer management. However, a special designed communication interface can be used. At the University of Oradea both types of e-learning laboratories for mechatronics were developed.
A general architecture of a second generation of Internet robot is presented in fig. 3. [22-23]. Controllers of the mobile robot will consist of three layers. Based on a priority level, it will be decided, at a given moment, the layer to control the actuators. Unconditioned reflex (UR) of stopping and moving from the nearest vicinity of the obstacles layer will have the highest priority being the first layer. This reflex will be activated each time when obstacle in the "security area" around the mobile base would be detected. Each time when series of this kind of reflexes will occur, velocity and distance of the reflex movement will be reduced. After avoiding the obstacle, all setting will be set back to normal levels. Conditioned reflex (CR) of avoiding obstacles layer is the second priority layer of the controller. There will be an "attention area" defined around the "security area". If an obstacle will be detected in this area, the robot will stop and inform the remote operator. Then human operator has to decide how to avoid the obstacle. Data concerning range finders and human decision will be stored and the remote operator will be informed. Data concerning range finders constitute the (CR) module of the controller. Remote human operator's decisions represent the third layer (HD) of the controller. This layer has the lowest level of priority. The human operator would control the robot's movements as long as no obstacle is detected in the "security area" or in the "attention area". He would also show the CR module how to behave in the unknown situations.

Another important module deals with vision asking for efficient data compression algorithms [24]. The remote computer has to deal, also, with: Sensor Data Uncompression, Development Data Environmental Map, Environmental Map Visualization, Vision Data Uncompression and Human Decision Acquisition. Internet programming techniques can be used to implement a client-server approach for Internet robots manipulation. Mainly, the Robot Control Program can be designed along the following lines: Input/Output communication using an ergonomic and functional graphical user interface; a multi-thread JAVA method for collecting Internet clients' requests; a FIFO (First In First Out) strategy for processing the clients' requests; robot moving according to the current request; sensor information capturing and generate the appropriate answer to the client.

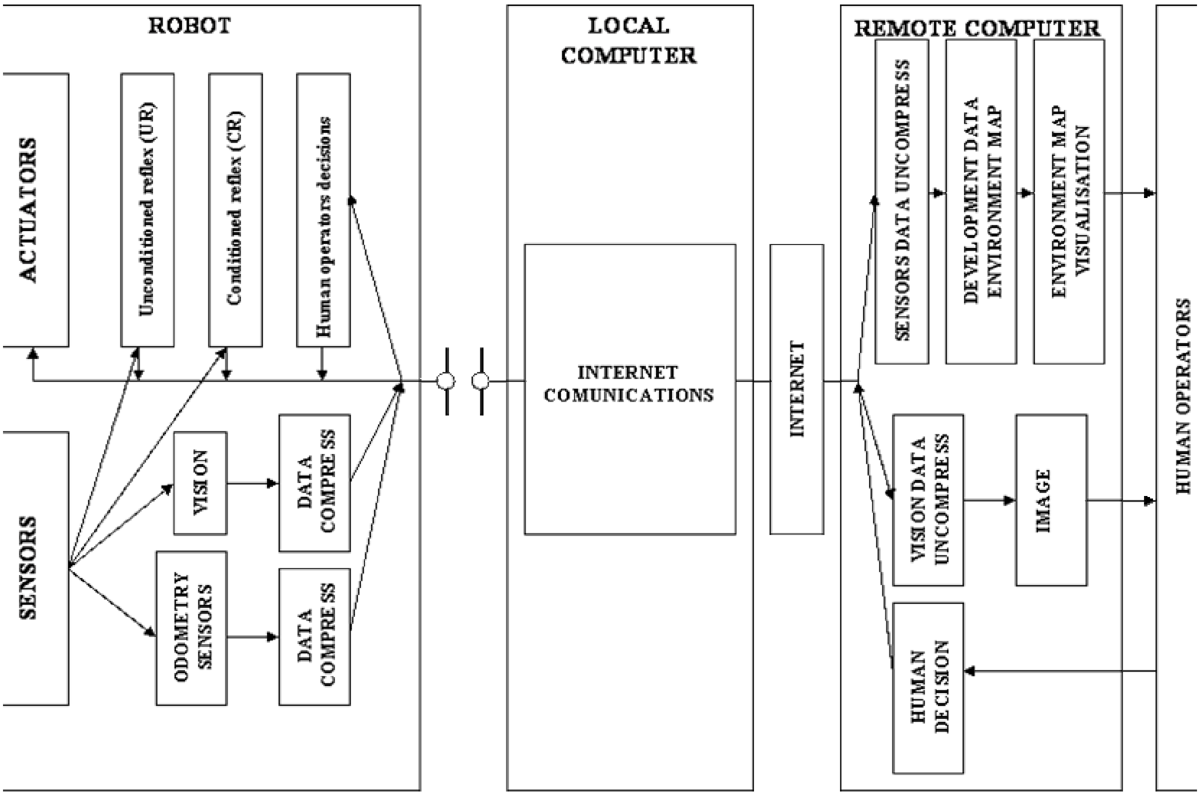

Figure 3. Internet Robot Architecture

The remote laboratory system at University of Oradea was realized using a client-server network approach that allows the concurrent execution of multiple experiments using separate experimental set-ups. Experiments that require the same set-up are queued and executed in the order of the incoming requests. The connection from the laboratory to the outside world is established using a Linux-enabled web server. This server hosts the process queue, the data input and output files generated as well as the graphical user interface, which was developed using conventional HTML pages, Java applets and CGI/Perl scripts. The Human-Robot interaction is solved according to common approaches presented in [25-27]. Algorithms dealing with collision detection are implemented, some of them being inspired from [28]. A Neural-Network approach was considered for obstacle avoidance as shown in [29].

3. CONCLUSIONS

This paper has described the architecture of an e-learning training mechatronic system implemented at the University of Oradea. Principal approaches in such a design were investigated along with the most important milestones to be addressed. The current investigation increases our department capacity for the remote exploration of mechatronics through the Intemet and to develop important applications such as tele-training, tele-service, and tele-manufacturing.

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