WORKSHOP ON INTERACTIVE DISTANCE LEARNING SYSTEMS

SoftCOM '97
events

Split, Dubrovnik, Croatia
Bari, Italy,
October 17-19, 1997

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UNIVERSITY OF SPLIT

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Foreword

The first Workshop on Distance Learning Systems was held from 17 to 19 October 1997 in Split and Dubrovnik (Croatia) and in Bari (Italy). It was organized by the University of Split (Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture), HPT-TKC (Croatian Post and Telecommunications) Split, Technology center Split and University of Lecce, Italy. The Workshop was sponsored by the Ministry of Science and Technology of the Republic of Croatia and the University of Split.

The papers presented at the Workshop were classified into two groups. A part of papers were concerned with particular approaches and solutions of IDL systems. The other papers were concerned with a concept of development of IDL in Split-Dalmatian County and underlying technologies. The International Program Committee has also invited several outstanding experts both from Croatia and abroad to present the state of the art in the field of distance learning systems.

Vice Minister of Science and Technology of the Republic of Croatia, Prof. I. Mandić in his keynote speech presented an overview of political and social aspects of introducing distance work and education in Croatia.

Five years of SoftCOM was one of the main reasons why this year's Conference was held in a special environment: all participants went aboard the ship Marko Polo started from Split, and visited Bari in Italy and Dubrovnik in Croatia. In each location, a part of the Workshop program and related events (SoftCOM and seminars) was held.

We would like to thank to all the authors and the reviewers for their contribution to the quality of the Proceedings. We are also thankful to our organizers and sponsors as well as to members of the Organization Committee and the Program Committee.

Split, October 1997

N.Rožić

DISTANT TRAINING - VIRTUAL LABORATORY

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Abstract: The article deals with the idea and concept of remote control systems based on universal widely accepted standard protocol (TCP/IP) - the Internet based remote-control system. These systems present a unique combination of automatic control, computer technology and telecommunication, with the universal multimedia environment. The overview of present stage of development shows strong and clear tendencies of functional system development, that will contribute to commercialisation in short period of time.

KEYWORDS: distant training, remote control systems, TCP/IP protokol, WEB based interface

INTRODUCTION

Remote object control and surveillance has special importance in development, construction and maintenance of technology systems in all areas of everyday life. Development and expansion of computer technology, and availability of computers to large number of potential users, open the possibility for extensive application of computer-based remote-control systems. The usual remote control systems are based on specific protocols and non-standard communications, but the universal widely accepted standard protocol (TCP/IP) and standard LAN/WAN networks, with permanent or contemporary access open the new frontier - the Internet based remote-control system.

Rapid expansion of Internet, broad acceptance and low-prices of computer technology are significant elements that determine the importance of remote-control systems based on computer networks. On the other side, new software concepts and technologies (Java, ActiveX, ASP, VRL) contribute to the idea of universal multimedia environment, completely user-friendly, with the significant improvement in presentation techniques. Existing low-price software solutions enable easy and simple use of all resources, which decreases time necessary for training and adapting of new users. This article shortly reviews existing systems, technical solutions and their developments.

1. REALISATION AND TECHNICAL SOLUTIONS

The realisation of telecontrol system is rather complex, because there are lot of circumstances and technical facts that should be taken into consideration, and which determine quality, safety and reliability of them.

- **Hardware solutions, which obtain connection between server computer and controlled process**

  In selection of appropriate hardware solutions, the main condition is type and character of controlled process and the algorithm to be applied. In that sense, there are two basic concepts:

  1. Digital control algorithm realisation using digital signal processors on server computer
  2. Data acquisition AD/ DA hardware with special analog and digital control units

- **Software solutions for server**

  WEB server (UNIX, Windows NT),
  Programs and routines for process control,
  Programs and routines for sensor data acquisition and presentation.
  New software development and upgrading of existing programmes, including creation of high-quality user interfaces
  Realisation of new protocols for server controlled processes.

- **Definition of data and sensor information required for complete process control, and its presentation to the user**

  In order to obtain high quality presentation and comfortable user environment, the system should include, not only sensors vital for elementary process functions, but also the elements for presentations and surveillance of process status that are intuitively acceptable to the user. Therefore existing systems mostly include not only graphics and spreadsheet-type process data, but also the CCD camera based video surveillance, which is usually most acceptable to the human operator.

- **Security issues, user authorisation, physical process protection**

  As Internet based remote control systems are world-wide accessible to all the users at any time, efficient measures should be applied to enable proper system functioning:
  - Limited access to system, enabled to authorised users only;
  -Auto-protection system that overrides user-selected requests and parameters

in potentially hazardous situation;
- User requests buffering, which prevents multi-user access in the real-time control;
- Physical system protection and remote user notification when process is controlled locally.

Figure 1. shows virtual laboratory with remote process control. The laboratory is based on a local area network with TCP/ IP protocol that is connected to the Internet through a gateway computer. Network is organised as client-server structure, with server computer acting as gateway, receiving and processing Internet users requests. Each remote controlled process is attached to one client computer with AD/ DA board interface.

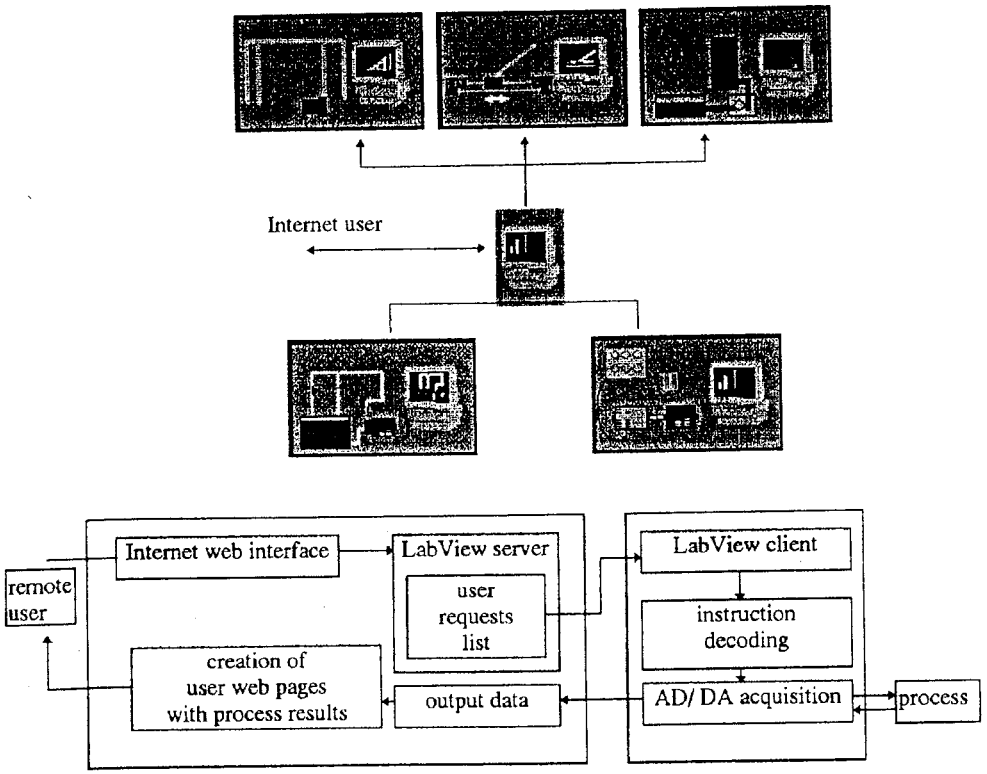

Figure 1. Virtual laboratory structure based on TCP/IP LAN

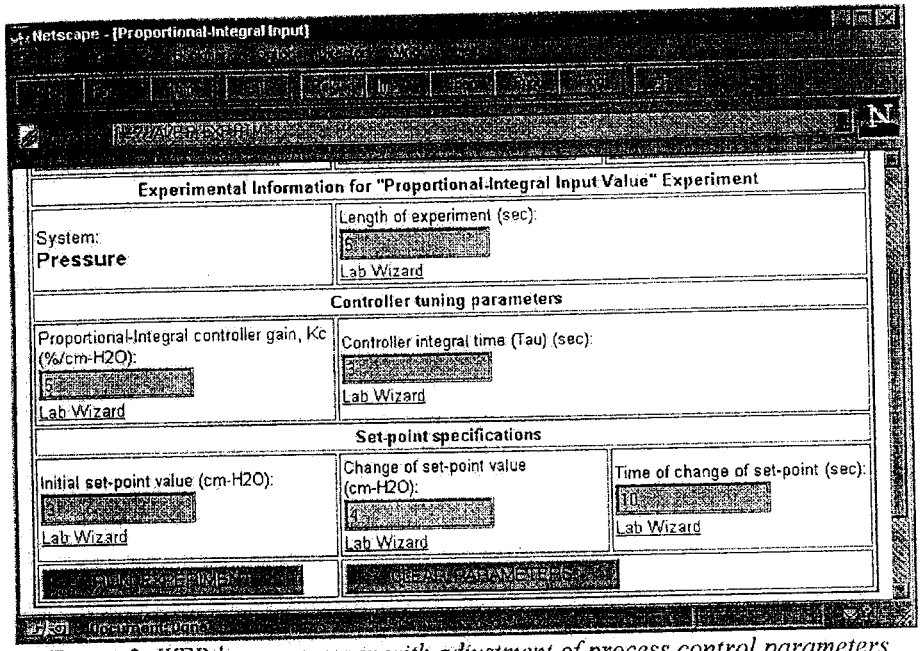

Figure 2. WEB browser screen with adjustment of process control parameters

Using Internet WEB browser, user selects process and control parameters. Web server receives user requests from WEB-based interface (Fig.2.) and stores them in a buffer. As each processes is accessible to all potential Internet users, for the security issue, it is necessary to form the user request list for each process, which manages that each task can be processed through the time determined by the user. At the end of execution of the first user request, the client computer checks the request list and carries next demand. Instructions are decoded, interpreted and applied as parameters of existing AD/ DA process interface.

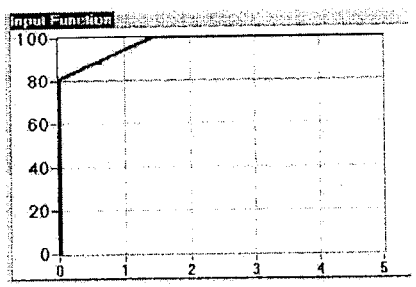

Fig.3. Input function graph for remote controlled system

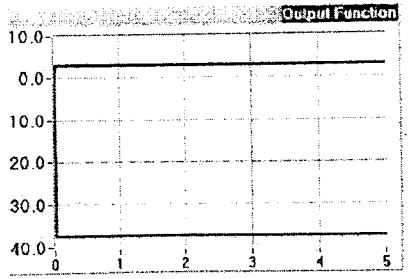

Fig.4. Output function graph for remote controlled system

At the end of the experiment the process status data, received by sensors, are stored on the server. After that the Web page generator automatically creates web pages with graphical and textual presentation of process status (Fig. 3. and 4).

Described Internet based remote control system presents a unique combination of automatic control, computer technology and telecommunication. In the future we expect developments in following areas:

Automatic control
- development of digital control principles and systems based on standard and intelligent procedures;
- implementation of digital controllers based on microcontroler and DSP technology;
- implementation of server based digital controllers, using real-time operating system;

Communications
- development of new protocols based on TCP/ IP, suitable for high quality data transfer;
- signal processing techniques for optimal bandwidth use;
- increasing speed of communication;

Computer technology
- software support development based on cgi-bin routines, as well as Java and ActiveX technology;
- integration of remote controlled systems with other services (RealAudio, RealVideo, etc.).

2. STATE OF THE ART – OVERVIEW AND DEVELOPMENT

Present stage development of remote control systems based on computer networks can be still considered as experimental. Development and realisation are mostly binded to academic institutions. Nevertheless, strong and clear tendencies of functional system development are present. These systems enable performing interesting tasks, that will contribute to commercialisation in short period of time. Therefore, following areas of application can be highlighted:
- video control systems (traffic control, object control, pan-tilt video platforms)
- integrated meteorological systems
- relay communication system control
- equipment and etalon testing

- remote programming of controllers, electronic displays, ...
- integration with contemporary telecommunication technologies (GSM, paging system)

Especially interesting example of remote control process is Legal Tender Verification Laboratory (www.counterfeit.org) - on line lab for banknote verification and analysis. The laboratory is remotely accessible through WEB site, and enables users to perform complete analysis, including sophisticated ones to determine validity of banknotes - abrasion, observation, puncture, stain and thermal analysis (Fig 5). The simplest procedure (observation) offers remote control of the microscopic ocular with two degree motion freedom. For banknote verification, user microscopically selects segment to be observed and compares it with regular banknote, or estimates the validity according to his knowledge (*Fig.6. 7. and 8.*). Using step by step observing and analysis, expert can determine if the banknote is valid or forgery. For the less experienced users on-line knowledge base is offered with useful remarks and comments. If the microscopic examination is not sufficient, other suitable analytical on-line procedures are offered.

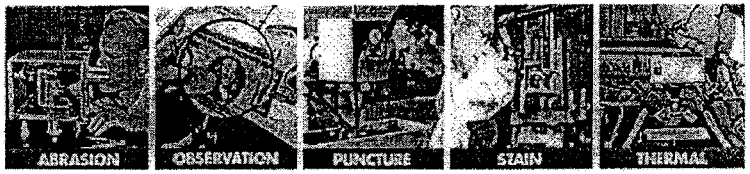

Fig.5. Legal tender lab - on-line remotely controlled procedures

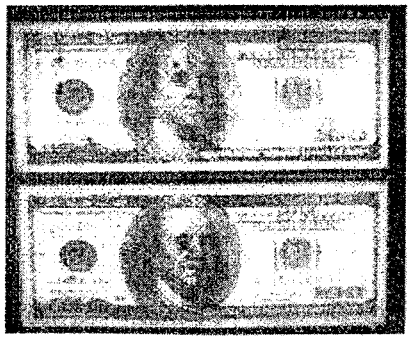

Fig.6. On-line banknote verification starting point

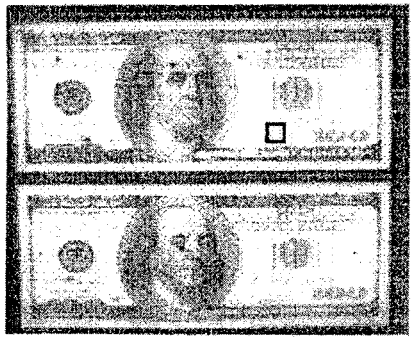

Fig.7. Interactive mouse-based selection of ROI (region of interest)

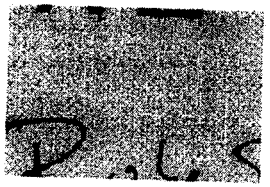

Fig.8. Microscopic view to selected banknote ROI

As an another interesting example of universal system constructed to provide access for schools, amateurs and professionals, let us emphasize the remotely controlled telescope at University of Bradford (http://www.telescope.org). This project integrates the telescope into the rest of the Web allowing user manuals, live reports, and astronomy lessons all to be accessible from the same interface. The telescope is controlled robotically using a simple form interface where jobs are submitted in advance, or remotely for real-time events. The telescope is a 46cm Newtonian reflector with an alt-az mounting and a cooled CCD camera. Four PCs interface with the telescope and its instruments, and a block diagram of their connections is given in Figure 9.

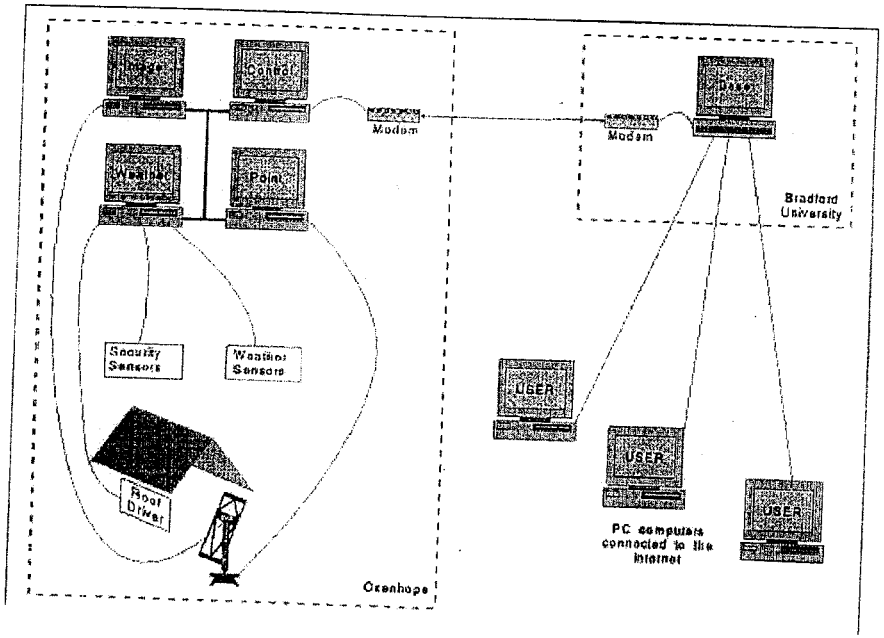

Fig.9. PCs interface with the telescope and its instruments

To distinguish specific tasks assigned to LAN components a short overview of tasks should be analized:

Control Computer

The control computer is a 486DX33 with 8Mb of RAM.
Installed Hardware: Ethernet NE2000 card , 16550 fast UART card connected to CHASE ISDN-TA. O/S: Uses DESQview and QEMM for multitasking support under MSDOS.

The Login system which answers the phone
The System Logging program
The PPP link from Base to Oxenhope
API for Desqview
Micro-scheduler
Support tools: ZUTIL, X00, FITSPRESS, KA9Q

Image Computer

The Image computer is a 486DX33 with 8Mb of RAM.
Installed Hardware: PC23 for focus/filter (0x320), Ethernet NE2000 card, CCD camera card, Video Capture board. O/S: MSDOS (QEMM for memory management)

The Image Grabbing program
The Eavesdrop GIF creation
Image Compression routine
Filter changing system
Focussing system

Point Computer

The Point computer is a 486DX33 with 8Mb of Ram.
Installed hardware: PC23 for telescope control, Ethernet NE2000 card. O/S: MSDOS (using QEMM for memory management).

GPS system and software to get accurate time signal
Telescope Positioning System

Weather Computer

The Weather computer is a 386SX25.
Installed Hardware: Two general IO cards, Ethernet NE2000 card ;O/S: MSDOS

Weather Sensors and how to get the raw data
Security System
Roof control

A control computer handles job scheduling, system logging and communication with the University computers. Environmental and security sensors are monitored by a weather computer and when conditions are good enough to make observations the sliding roof is opened. The telescope's CCD camera is connected to

an image computer that takes the pictures of the sky, processes, compresses and analyses them. This computer also has to control the selection of viewing filters and to make sure that the telescope is correctly focused. The telescope positioning is controlled by a forth PC that is responsible for accurately finding a position in the sky and tracking the stars as they move during a night. Communication between the telescope and the user is handled by a Sun workstation at the University, ten miles from the telescope building.

The telescope normally operates in a "Robotic" mode. Users of the telescope can request observations and these requests are scheduled and uploaded to the telescope based on a priority. The telescope works by itself during the night and returns processed results, operational logs, statistics and weather details the next morning. The telescope can also be controlled in real-time, in its "Remote" mode. In this mode the user submits a request in a similar way but the job is processed immediately and the results are

available for analysis or viewing as soon as the telescope has finished the observation. In both modes the telescope is always operating robotically and this ensures that no damage can be caused to the telescope and that it is safe to leave unattended.

The remote control facilities are reduced but this makes operation much easier since there is no need for the user to learn complex operating procedures. For effective use of the telescope's resources there is an ability to eavesdrop, where multiple users can watch the results of the telescope being controlled by a single operator.

3. RESEARCH AT LARIS

Our Laboratory for Robotics & Intelligent Systems (LaRIS) is involved in research of remote control system based on computer networks, too. Two projects are in realisation:

- Virtual control laboratory (Vi-LaRIS) - which will enable our students to do some experiments with digital control using distant terminal access and Department of electronics Intranet network. Two experiments will be realised:
  - control of DC motor and
  - distant measurement of process variables necessary for process model identification;
- Distant control of simple greenhouse model which will include distant monitoring of all process parameters and "on the fly" changing of process controller settings in order to adjust them to environmental conditions;

The second project is specially interesting because the process controller will have a certain level of autonomy and intelligence in order to be more capable to function satisfactory also in the cases when problems with communication occur. We hope that this kind of research will have a lot of commercial application in the future.

CONCLUSION

Recent trends of development in all fields of electrical engineering pose reliable background for further progress of the computer-network based remotely operated systems. As can be concluded from some examples shown in this article, some already functional systems provide a great and interesting way of solving telecontrol problems in various fields. Commercial influence and support will encourage further efforts that will bring us reliable distant control systems, that will significantly change our everyday life and work.

REFERENCES

Real-time Meteorological Data around Monterey Bay, California
http://sapphire.cse.ucsc.edu/MosaicMet/ - Visit various meteorological stations located in the Monterey Bay region, monitor current conditions in real-time, and generate time-series plots and more of sensor data over the recent past.

Robotic Tele-Excavation
http://www.usc.edu/dept/raiders/ - Allows users to tele-operate a robot arm over the net. Users view the environment surrounding the arm via a sequence of live images taken by a CCD camera mounted on a commercial robot arm.

Telegarden at the Ars Electronica Center
http://telegarden.aec.at/ - Telegarden, The - view and interact with a remote garden filled with living plants. Users can plant, water, and monitor the progress of seedlings via the tender movements of an industrial robot arm.

Australia's Telerobot
http://telerobot.mech.uwa.edu.au/
An ASEA 6 axis industrial robot that can be controlled by remote user.

Legal Tender
http://www.counterfeit.org/ - Tele-robotic laboratory with two $100 bills. One is real, the other is counterfeit. Analysts may observe the bills and perform experiments.

UC Santa Barbara Remotely Operated Telescope
http://www.deepspace.ucsb.edu/rot.htm - The Remote Access Astronomy Project on-line enables access to Remotely Operated Telescope and requests submitions.

Remotely operated telescope
http://www.telescope.org - Remotely operated telescope at Univeristy of Bradford

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