

## A REMOTE INTER-UNIVERSITY SYSTEM FOR MEASUREMENT TEACHING

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**Abstract** – In the present paper, the prototype architecture of a geographically distributed educational system oriented to electronic measurement teaching is illustrated. It is based on two measurement laboratories, whose instrumentation will be remotely available. In order to access the instrumentation, the students are required to use only a commercial Internet Web browser. In this way, a complete educational proposal can be economically offered by more laboratories specialized in different measuring fields, located in different countries. At now, the core of the system has been developed within an international research agreement between the Technical University Gh. Asachi, Iasi, Romania, and the University of Sannio, Benevento, Italy.

Keywords: Remote measurements, education.

### 1. INTRODUCTION

The low-cost availability of new communication tools based on Internet is opening more and more horizons to remote teaching. Interactive on-line tutorials based on World Wide Web (WWW) sites now can be followed directly on the job site [1, 2].

The recent wide diffusion of (i) easy-to-use software tools for the implementation of Graphical User Interfaces (GUIs); and (ii) communication-oriented instrumentation, often provided with Ethernet interface, in addition to the more traditional GPIB and RS-232 ones, can be particularly exploited in the field of measurement teaching. It is well known, in fact, that for a better understanding of the teaching issues in such a field, the students have to practice with real instrumentation. The computer-based simulations are often inadequate to assure a good experience in that direction. The tools mentioned above give the possibility of accessing real measurement instrumentation from a remote location, such as the students' homes [3-5]. Moreover, it could be possible to repeat the same experience many times in order to make all students able to operate the measuring instrumentation without devoting expert technicians to such activity for many days [6-10].

The feasibility of such a solution has already been proven [9-12]. This approach has been followed in a collaborative manner by two different research groups, with the aim of creating an international knowledge base,

accessible from the students of both the Countries. This is the first step through the building of a common educational background by remotely sharing information and instrumentation among the students and the researchers of the involved Universities. At now, the project involves the Technical University Gh. Asachi, Iasi, Romania, and the University of Sannio, Benevento, Italy. This could lead to a common teaching method basing itself on the reciprocal validation of the student knowledge and on a continuous know-how exchange.

At now, the researchers' main orientation is to develop the remote measurement systems by using Java language [13-14]. The main advantages of such solutions are: (i) the operating system independence of the resulting software, (ii) the easy distribution of instrument GUIs through Internet browsers without heavy band requirements. The main drawback is, of course, the necessity of developing the software without using ready libraries or virtual instrumentation oriented rapid development environments. In other words, time consumption. A less flexible, but much more rapid, solution consists in setting up the remote laboratory system by using a development tool oriented to the virtual instrumentation design with a built-in remote communication mechanism.

The National Instruments LabVIEW, could be used with this aim, as it is a powerful graphic environment for instrument management [11]. It is easy to drive real instruments by using LabVIEW. In fact, a Virtual Instrument, such as a Graphical User Interface (GUI) for a IEEE 488 one, can be easily built just connecting graphical blocks that are made available from the environment. A user-friendly GUI to the instruments can be developed visually in a straightforward way.

Technologies like DATASOCKET are also available in the last release of LabVIEW. This feature, in particular, adds a connection capability to the GUIs through TCP/IP protocol. DATASOCKET enables the sharing of measurements across a network in really easy way. Although the communication over the network is based on the TCP/IP protocols, their use is completely hidden to the user. In such a way the development of intelligent remote measurement nodes and measurement publishing systems is simplified.

There is one additional benefit of DATASOCKET for publishing measurement results: the remote users do not

need to have the same development tool installed on their PC. Instead, it is possible to create a web interface to receive measurement information from the remote measurement instrumentation, and therefore to use a standard web browser on the user side.

DATASOCKET can be used to distribute live data over the Internet, but it doesn't automatically build web pages. However, it is possible to create an interactive Web page on which several users can view data from a remote acquisition application.

Thanking to its implementation rapidity this solution has been preferred for setting up the core of the geographically distributed laboratory system, which can assure to students of different Countries the access to all the resources of both laboratories. The DATASOCKET technology has been chosen in order to obtain the measurement information distribution in the simplest way without giving up the main target that is to share among the students from both the Universities the laboratory premises available from them. In the following the system architecture is briefly illustrated, then some conclusions and future developments are sketched.

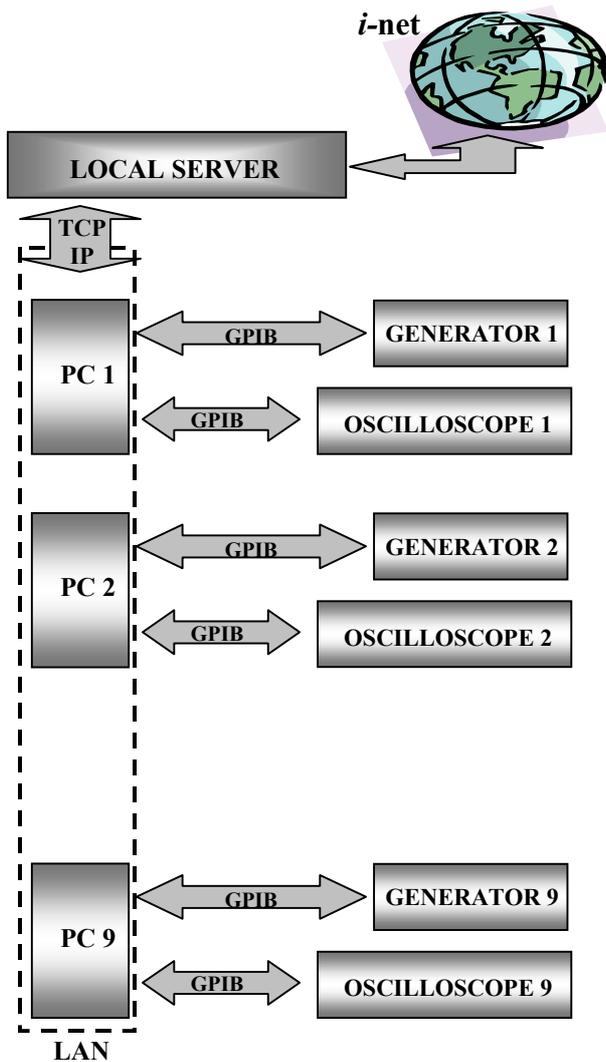


Fig. 1. First station architecture.

## 2. SYSTEM ARCHITECTURE

As quoted above, the proposed educational measurement system is composed by two stations.

The first one, located at University of Sannio, is based on several measurement instruments, such as signal generators and digital oscilloscopes as shown in Fig. 1. Each couple of instruments is controlled via the GPIB by nine computers (PC1...PC9), while a local server interfaces the system to the Internet. All the measurement stations are linked to the local server by means of an Ethernet LAN.

The second station is located at Technical University of Iasi and is focused on environmental measurement. In this case, the computers are connected via data acquisition boards to several environmental sensors or via GPIB to dedicated environmental measurement instruments. In this way, the students are able to perform the evaluation of air, water and soil parameters such as humidity, temperature, air pollution (CO, CO<sub>2</sub>, NO<sub>2</sub>, NO<sub>3</sub>), pH, dissolved oxygen, salinity, ion selective (Ca, Mg, Na, Cl, SO, K, F) and electric conductivity.

A general server has to manage the queries from the clients redirecting them to the correct local laboratory server.

Two cases have been foreseen for remote teaching and education. In the first case, a professor can teach in the same time to all the students connected to the local server from both the countries. In order to obtain this, the local server has to be set to *all users slave* mode. In this way, the students from their home study points can receive and follow the lessons (Fig. 2) on a common web page.

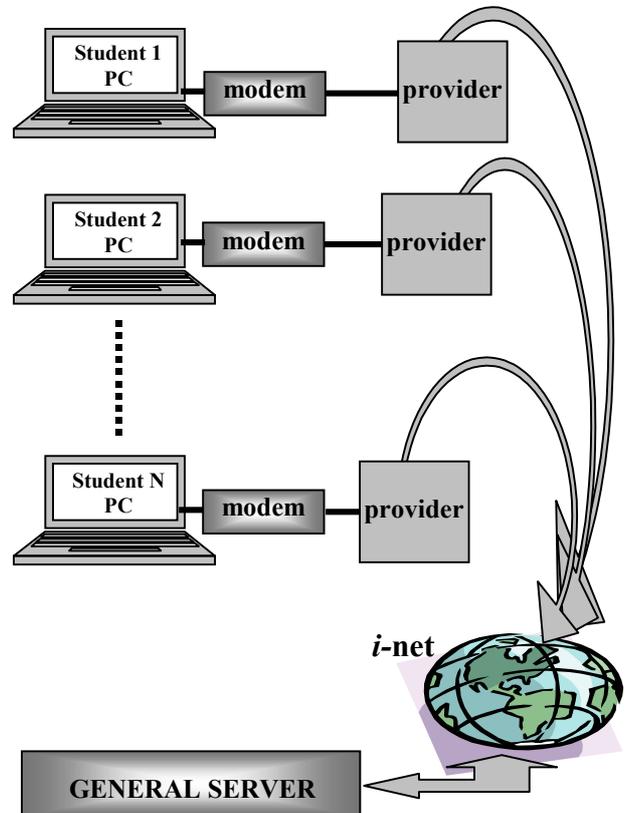


Fig. 2. User connections.

Thanking to the web publication the number of students that can connect to the system at the same time is unlimited.

In the second case, the students should carry out some activity on the instruments. In this case the local server has to be set to *all users master* mode. Of course, the number of students that can establish the connection at the same time is less or equal to the number of operational measurement stations within the two laboratories.

As each student can perform a connection via modem and provider from his/her home, he/she can train by practicing his/her programs on the connected instruments without regarding the Country where these are located.

At now, the Sannio station has been fully developed and is going to be tested. The instrumentation control and communication software has been designed under LABVIEW 6.1 graphical programming language for the reasons mentioned above. In particular, the PC-instruments communication has been developed by using GPIB protocol, the PC-server by using TCP/IP protocol and the client-server communication by using DATASOCKET technology.

From the main web page of the local laboratory server the teacher has the possibility to supervise the student's activity. The front panel of a remote application example is presented in Fig. 3 (<http://smm.ee.tuiasi.ro/RL.htm>).

engineers, because designers of development systems view the Internet as a cost-effective worldwide standard for distributing data. The customers can easily publish data from their programs to the Web using the LABVIEW and DATASOCKET technology.

With these tools, it's easy to create applications that serve images of their front panels as Web pages with very little or no programming. Passing images over the Internet is easy too. Therefore many teachers are looking to this tools for more interactive lessons.

These tools have been used to develop a prototype architecture for a geographically distributed educational measurement laboratory within a collaboration between the University of Sannio in Italy, and the Technical University Gh. Asachi in Romania.

The actual state of the art of the remote education project in the measurement field consists in the realization of the Sannio side laboratory. The work is going on to the realization of the Iasi station, devoted to the environmental measurement. Contemporarily, the general server will be developed. This should act an efficient query ordering and priority assignment function in order to fully exploit the available resources without permitting the rise of conflicts.

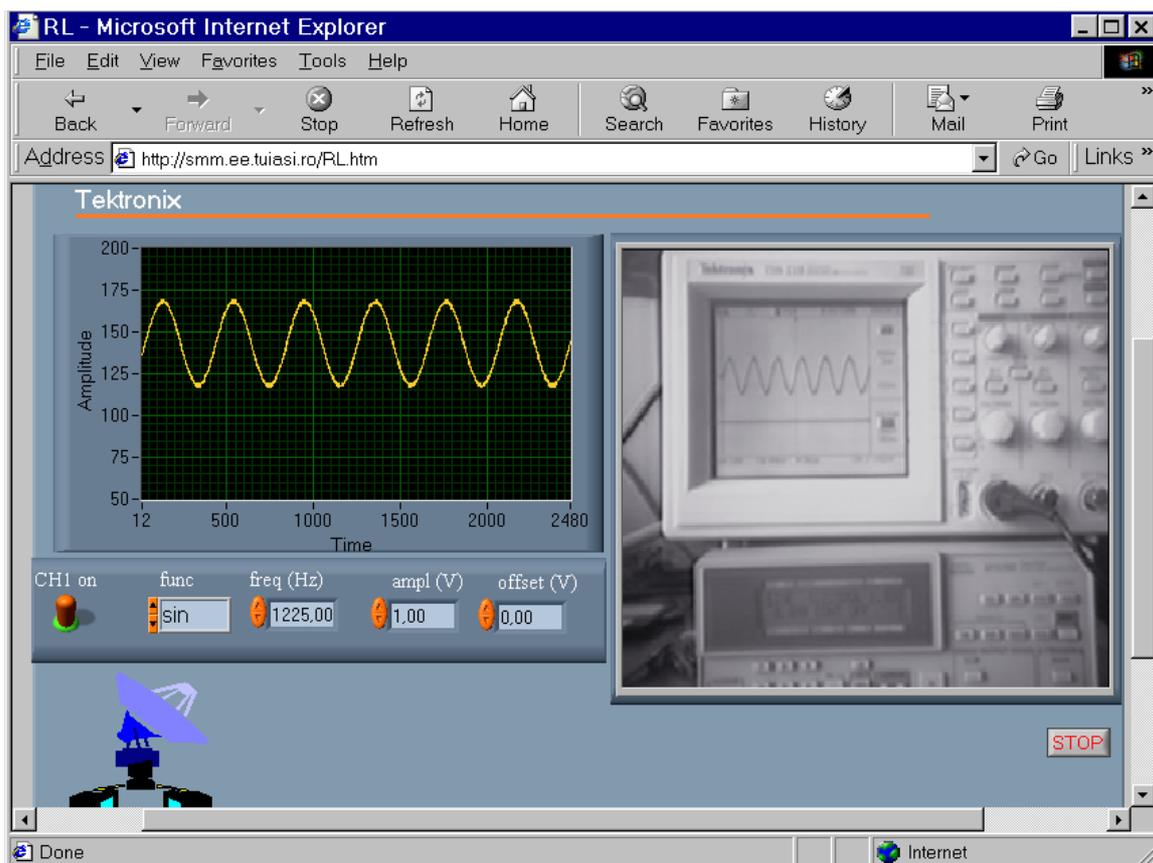


Fig. 3. Application under Internet Explorer

### 3. CONCLUSIONS

The Internet continues to become more integrated into our daily lives. This is particularly true for scientists and

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