NEW CONCEPT IN REMOTE LABORATORY: HIGH-SPEED MULTITASK SYSTEM DEVELOPED AS ONLINE RECONFIGURABLE PLATFORM

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Abstract

A new architecture for an educational high-speed remote laboratory is described in this paper. In order to remove the users' waiting list, we used a multitask type access on laboratory work platform, and a real-time reconfiguration of electric test circuits. Students are accessing from distance a system equipped with real instruments and perform online test workbenches. The errors detected in prescribing the commands towards the machine, are not automatically corrected. Instead, the student is warned, and the results of the tests are supplied to the user in the same way the real instrument does.

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 can now 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' home. [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 [9-14]. 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.

System Architecture

System's architecture (Figure 1) is structured on three main levels: reconfigurable workstation level, multitask server level and user server. The initiation of a laboratory work comes from the user level, by accessing the server's web interface through a commercial browser (S.M.).

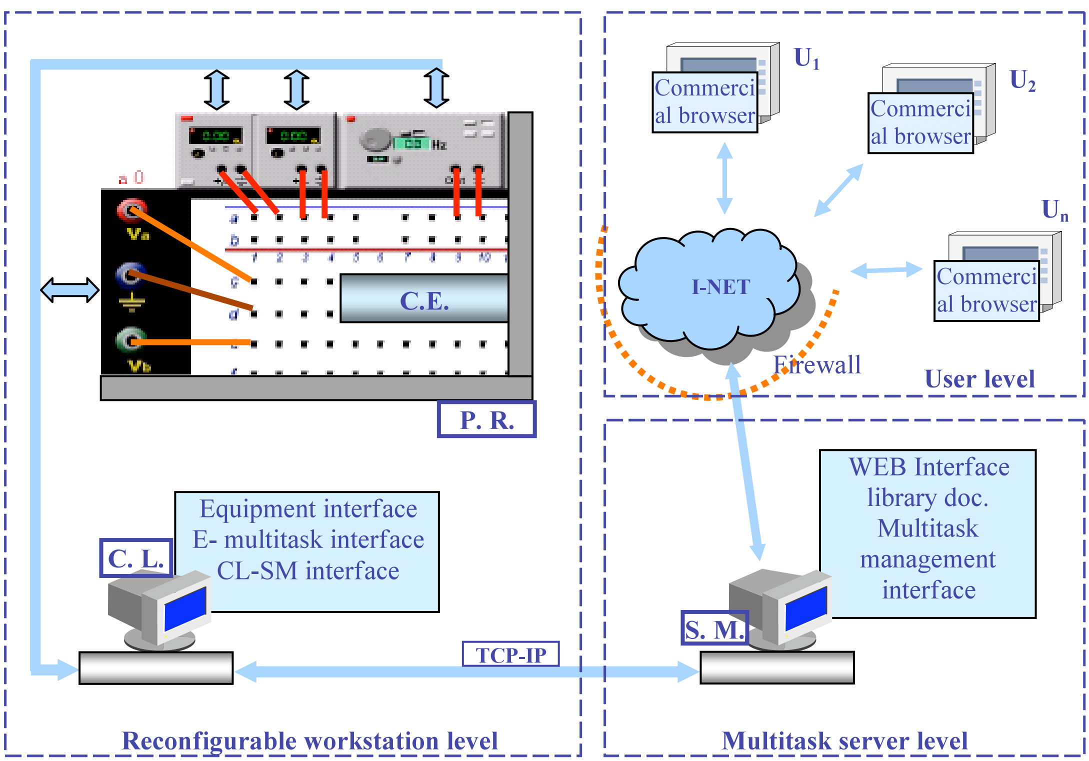

Fig 1. General system architecture

The Multitask management interface (Figure 2) allows access simultaneous to all solicitants towards the selective routine of laboratory work development parameters, in which the entrance/exit data and electric circuit configuration are settled. This routine has, as a front panel, a graphic interface of the laboratory work. In this stage the user define the configuration of the electric circuit, choose the measurement instruments, measurement points, electric components and signal sources and then configure the parameters of all the circuit equipments. The checking block of the multitask management interface verifies the configuration defined by the user and, if correct, transfer the execution parameters of the laboratory work to the E-Multitask routine resident on the computer of the reconfigurable workstation.

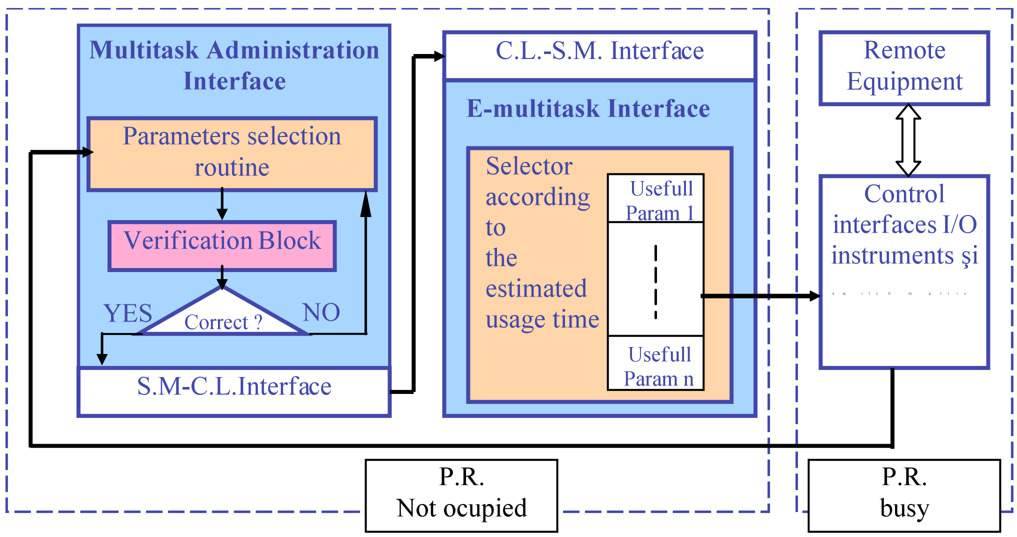

Fig 2. Diagram of the software procedures

The specific laboratory work is accomplished under the E-Multitask routine control, based on parameters received from the user. This routine determine the moment to execute the work request by estimating the effective time the reconfigurable platform will be occupied by this work. Physical area for development of laboratory work, named the reconfigurable platform (R.P.) will only be occupied during running of laboratory work by the E-Multitask routine. After obtaining the exit data, the reconfigurable platform is free, being able to put a new request into execution. The obtained output data are transferred to the graphic interface of the laboratory work. The structure thus conceived of software procedures allows removing inactivity time of users and slow execution speed, transferring control of the execution commands from users to the E-Multitask routine. As you can notice in Figure 2, the occupation time of the reconfigurable platform is reduced to the effective execution time in commanded software regime (occupied R.P), the platform being relieved during execution of the routines in the area (unoccupied R.P.). In case of launching in execution a laboratory work, the time for the zone (R.P. unoccupied) can reach up to 98% of the total accomplishment time, leading to an occupation time of the reconfigurable platform of 2 % of the total time.

Reconfigurable platform (R.P.), the physical area for laboratory work development, consists in a matrix of nodes with software controlled switches. The open/close state of switches (located by schematically placement coordinates) determines the realization of some specific electric circuits. Middle nodes are destined to the electronic component block (E.C.)

The primary role of the workstation (C.L.) is to control the realization of laboratory work through the E-Multitask routine, which settles the execution entrance order on the reconfigurable platform. The routine selection criterion is the effective time of occupation of the reconfigurable platform. Priority goes to work with minimal execution time. The switch matrix command interface, as well as the entrance/exit instrument command interface is resident on the workstation. Communication with entrance/exit instruments is accomplished through GPIB protocol. Management of information exchange with the multitask server is insured by the interface (CL-SM) through the protocol of peer to peer transmission TCP-IP.

Multitask server (M.S.) accomplish some basic functions as establishing the interactive communication with users through the intermediate web interface, as well as realizing bidirectional communication with (C.L.) through the interface (M.S.-C.L.), using the TCP-IP protocol. The web interface is structured in two levels, the first one containing the library of documents specific to users training, and the second one realizing the connection to the graphic interface of the laboratory work. On this server is resident the multitask management interface that allows all users to simultaneously access the routine of execution parameters.

Connection to the (M.S.) server can be done in two ways: as user or as operator. As user, one can do laboratory work, having total control on them, or can watch without any right to control, the realization of these by other users. Experimental data, obtained by the users after the accomplishment of the laboratory work can also be received by them by e-mail. Also, a copy of these data, together with the identification code of the user is stored in the data base. Connecting in *operator mode* is permitted only to instructors, giving them some control facilities at a superior level, so they can intervene during the laboratory work by taking over control or they can create demo sessions at certain dates known by users.

Laboratory Work Example:
The Study of the Operational Amplifier as an Integrator

To study operational amplifier as an integrator at his input is applied a Vpulse=2V, and switch configuration is S2_12 (Vpulse), S2_16 (R1_AO), respective S3_21 (C3_AO) are ON. As long as Vout is not saturated, Cr1 $\neq 0 \rightarrow$ V3 = V2, V3 = 0V, and if t= 1ms $\rightarrow$Uout = -2V.Voltage on capacitor is rising linear after 1ms at -2 V. In Figure 3 is depicted the circuit diagram.

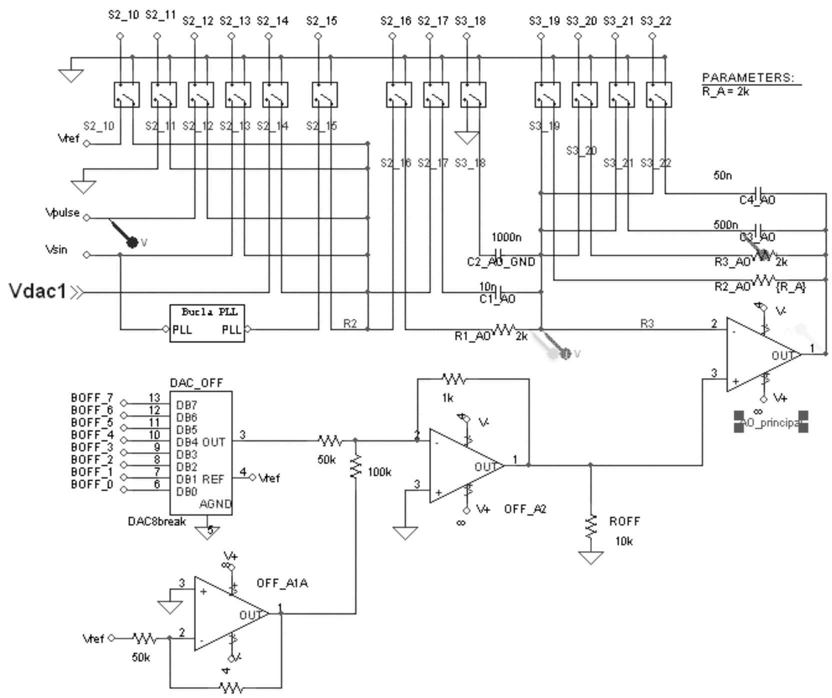

Fig.3. Operational amplifier as an integrator

Conclusions

The described high-speed laboratory architecture eliminates the waiting queues, a common problem of all remote laboratories. It introduce the multitask concept through multitask management interface and multitask execution interface.

As in any other electrical measurements laboratory, the user will study all the theoretical issues and then he will set the parameters for the laboratory work, the execution being developed automatically, under soft control. The optimization of the execution order is insured by the E-Multitask interface. When confirmed, the work request is passed to the reconfigurable platform and the switching matrix is configured as for requested electric circuit. The results of the experiments, either text or graphic files, are returned to the user for further processing.

Acknowledgements
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