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REMOTE LABORATORY: HOW TO RENDER LESS VIRTUAL AS POSSIBLE THE MEET WITH THE INSTRUMENTATION

Maurizio Caciotta, Francesca Germoni, Antonio Trifirò

Dept. of Electronic Engineering, Roma Tre University, Rome, Italy

Abstract − The system is based on a client-server architecture. Clients accede to laboratory through a standard web-browser, without plug-ins.

Exploiting HTML pages, ASP scripting and software drivers, resident on the web-server, users are able to select the experience that they want to run, to manage the instrumentation that reside in laboratory, and to re-configure measure's object according to parameters that they want to test. The instruments reconfigurability and measurement objects is performed by switch/relays module and to keep to reality as much as possible, every result is returned to client by a web cam.

Keywords: Measurements, Remote Laboratory, Didactics

1. INTRODUCTION

Technical and scientific knowledge cannot be detached from the practical laboratory activities.

Considering both the equipment and the management maintenance costs, a laboratory is very expensive taking also unto account the specialized staff, necessary to manage complex instrumentation. Being both limited founds and increasing the number of users, problems of accessibility arise. Other considerations can be done with respect to safety of instrumentation, considering the user abilities.

This is essentially an economic problem considering the cost of instrumentation, in case of either the die, or the damage. In the first case, the replacing of instrument is directly calculable in terms of money amount. The inactivity economic pound on laboratory activities due to the acquiring time can be calculable with difficulty. This last consideration can also be done in the second case, adding the probability that the restoring cost may be greater than the acquisition of an instrument that drops in the first case occurrence, with a greater cost of time.

The increasing development of Internet and World Wide Web can be exploited to realize structures that could help to resolve the laboratory admittance related to abilities. This was the aim of both virtual and remote laboratories implementation [1] [2] [3], capable to represent the most common instruments and simplest experiences. The direct contact with the instrument cannot be furnished by these kinds of applications protecting precious instruments equipment.

Both the remote and the virtual laboratories guarantees a great time saving with respect to real ones, starting to get familiar students with instrumentation and measurement methods. This work is about the realization of a "remote" laboratory, less virtual than "virtual" laboratory. Getting a closer approach to the reality the remote laboratory can be utilized to try an operative "pre-experience" training after a "basic training" in virtual laboratory, saving instrumentation security due to inexperience (Fig. 1). Students can use real instruments, connected to real test circuit, so that different aspects of experiences can be perceived also with a possible failure. Instruments functions are all available according to students' knowledge. Mistakes are communicated to the students to allow its understanding. Only students interested on measurement field will be allowed access to the real laboratory. The implementation costs, the flexibility and the reconfigurability have been firstly focused, that are vital for the operative students abilities.

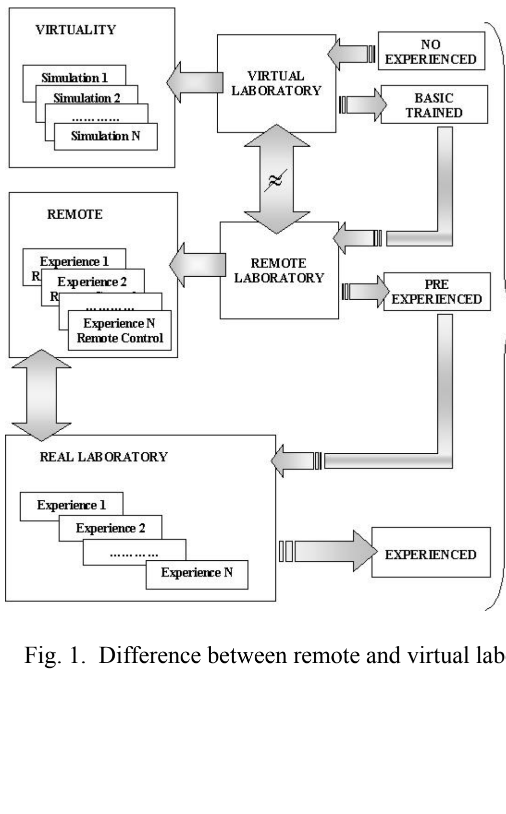


Fig. 1. Difference between remote and virtual laboratory

To make easy and speedy the laboratory use by the students, the application we studied do not require expensive dedicated software or downloading plug-ins.

To save as much as possible reality the students manage measurement operations viewing, by dedicated web cam, the bench on which experience is resident.

2. THE SYSTEM ARCHITECTURE

The system architecture is shown on Fig. 2.

Remote Client starts set-up and manages all the modules that are part of the measuring experience by a common web-browsers.

The server receives commands from client and delivers these inputs to the software driver that communicate with the instruments by standard protocol (IEEE-488, RS232, etc.).

The results of the operations will be available on the client page acquiring the image via a web cam.

Images synchronization are linked to client's commands in order to avoid incomprehension about the results obtained from the measurement.

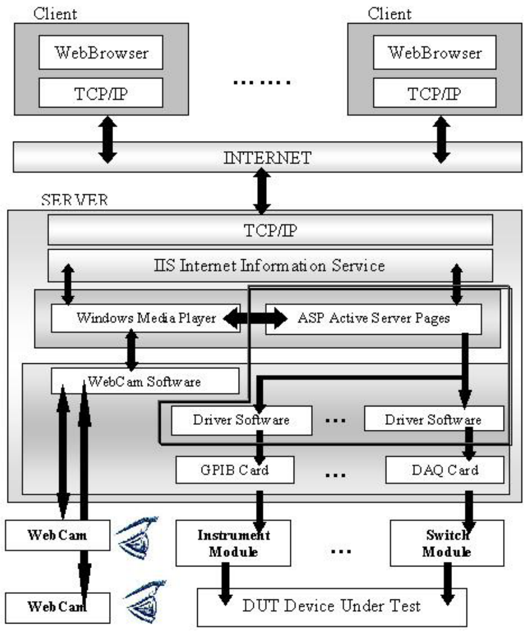


Fig. 2. System architecture

Point of view both of the client and the manager has been considered implementing the system.

2.1. Client point of view

The client considers the interaction capabilities and immediate utilization of the laboratory.

Notices about mistakes correction are available at every level foreseen by Fig.1 arrangement.

They must be both clear and exhaustive to allows a self-learning process of the client, eventually providing a test to obtain the basic trained or pre-experienced patent.

2.2. Manager point of view

The manager is interested in low cost implementation and in a "modus operandi" able to guarantee system flexibility and dynamism.

Windows operating system diffusion and software development tools availability forced our choice to ASP programming solution.

Organizing remote laboratory, we consider a number of workbench depending on application fields.

Every workbench is supplied by the computer, the instrumentation, the measurement object and a web cam but also by an adjunctive hardware interposed between the user and the instrument.

This is the filter that avoids damage of instruments that must be implemented representing an economic overload for the laboratory's manager.

The cost of these apparata can be considered as a productive economic investment considering the money saving on the substitution or the instrumentation repair.

Naturally hardware must be robust to failures caused by mistaken commands.

A dedicated software is necessary able to interface the web connection.

According to measurement object we decide instrumentation: the power supply generator, the signal generator, the digital multimeter, the scope.

Finally to assure measurement object and instrumentation reconfigurability a circuit is realized.

3. INSTRUMENTATION INTERFACE

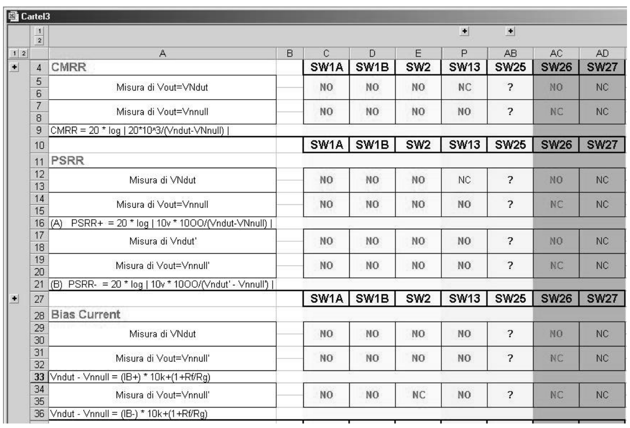
Remote laboratory needs dedicated hardware and software.

3.1. Hardware

According to specific parameters to be measured, we developed dedicated hardware and switch modules getting students the possibility to re-configure the measurement object and the device under test.

This re-configuration can be handled on a remote way using switch modules.

A connection table that avoids wrong instrumental calls and useless circuit configurations allows handling switch modules management.



Cartel3

	A	B	C	D	E	P	AB	AC	AD
4	CMRR		SW1A	SW1B	SW2	SW13	SW25	SW26	SW27
5–6	Misura di Vout=VNdut		NO	NO	NO	NC	?	NO	NC
7–8	Misura di Vout=Vnnull		NO	NO	NO	NO	?	NC	NC
9	CMRR = 20 * log | 20*10^3/(Vndut-VNnull) |								
10			SW1A	SW1B	SW2	SW13	SW25	SW26	SW27
11	PSRR								
12–13	Misura di VNdut		NO	NO	NO	NC	?	NO	NC
14–15	Misura di Vout=Vnnull		NO	NO	NO	NO	?	NC	NC
16	(A) PSRR+ = 20 * log | 10v * 10OO/(Vndut-VNnull) |								
17–18	Misura di Vndut'		NO	NO	NO	NO	?	NO	NC
19–20	Misura di Vout=Vnnull'		NO	NO	NO	NO	?	NC	NC
21	(B) PSRR- = 20 * log | 10v * 10OO/(Vndut' - Vnnull') |								
27			SW1A	SW1B	SW2	SW13	SW25	SW26	SW27
28	Bias Current								
29–30	Misura di VNdut		NO	NO	NO	NO	?	NO	NC
31–32	Misura di Vout=Vnnull'		NO	NO	NO	NO	?	NC	NC
33	Vndut - Vnnull = (IB+) * 10k+(1+Rf/Rg)								
34–35	Misura di Vout=Vnnull'		NO	NO	NC	NO	?	NC	NC
36	Vndut - Vnnull = (IB-) * 10k+(1+Rf/Rg)								

Fig. 3. Switch Modules Management

The table of Fig. 3 is an example allowing understands re-configuration operation.

3.2. Software

Software provides the interface to the network, to the measurement objects and to the instruments involved in the process.

Remote instruments implementation technique is the same one for GPIB, RS232 and SCXI interface.

Using COM technology, we export functions, available in software drivers, used to allow client the setup and the utilization of the instruments as shown in Fig.4.

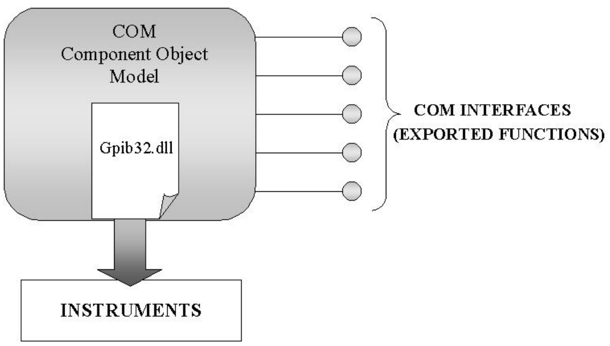


Fig. 4. GPIB Instrumentation Remotization Process

4. STUDY OF THE PROTOCOL

A protocol is "an official account of a proceeding; the notes or records relating to a case or an experiment; the plan of a scientific or medical experiment or treatment"[4]; a protocol statement, is "a basic observational sentence; a statement that reports the non-interpreted results of observations and provides the basis for scientific confirmation" [4].

By such definitions, protocol management has been partially realized for the filter and the operational general purpose amplifier measurements experiences.

An efficiencient verification method occurs during the development phase, assuring the criteria must be used for the quality valuation of the remote laboratory and the real efficacy of such a realization.

5. REALIZATION

In a first application of the present procedure, we consider two benches: one regarding the measurements possible on a general purpose operational amplifiers, utilizing the basic scheme proposed by Fairchild, the other the behavior measurements on filters that can be settled in kind and values of components.

5.1. Parameters measurements of a general purpose operational amplifiers

In this application the base of the development is shown in Fig.5.

Problems on far management of this experience rise by two necessities: one concerning the op-amp offset nulling resistor, the other the power supplies necessary for some parameters measurements.

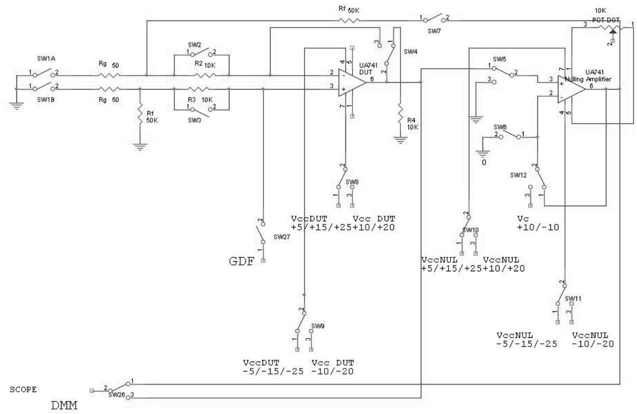


Fig. 5. Re-configurable Circuit

5.1.1. Nulling Resistor

The scheme of nulling offset remote resistor is shown on Fig.6. Taking effect on the two switches, users are able to select and decide the potentiometer increment and direction.

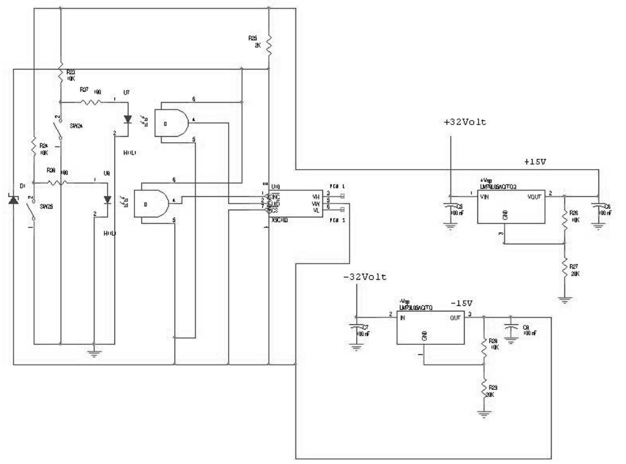


Fig. 6. Re-configurable Digitally Potentiometer Circuit

5.1.2. Power Supplies

All power supplies, necessary to test op-amp parameters, are provided using both positive and negative voltage regulator. The users can set by dedicated switches. The scheme is shown on Fig.7.

Two switches are dedicated to DUT power supplies, two are dedicated to nulling amplifier power supplies and two are dedicated to nulling amplifier inverting input voltage.

This method allows us to use only one ±32Volt power supply generator.

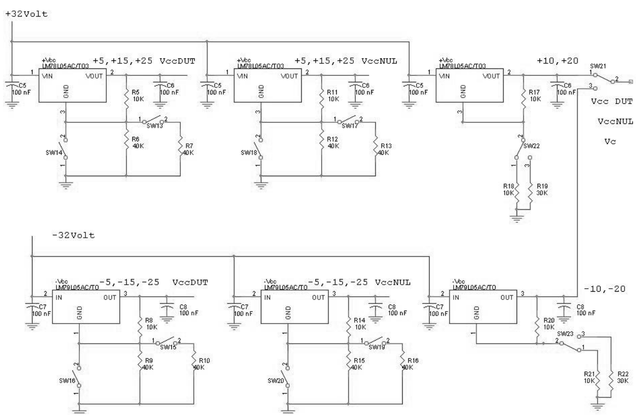


Fig. 7. Re-configurable Power Supply Circuit

5.1.3. Operative Procedure

Internet connection and a common web browser allow students to enter in the remote laboratory.

In Fig.8 the manage-connections and the service-connections are shown in different way.

For manage-connection the scope, the waveform generator, the web cam and the switch/relays module are connected to bench's computer.

For service-connection, the DUT, the scope, the waveform generator and the power supply generator are connected to switch/relays module.

When user has been identified, he enter in the remote laboratory's web page.

All laboratories' experiences are shown to the student and executable experiences are indicated.

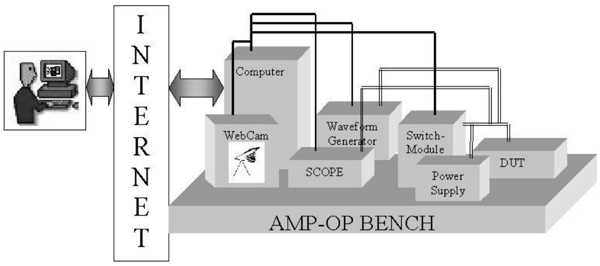


Fig. 8. Operative Procedure

Student that has accessed to the remote laboratory bench chooses measurement parameters; measurement circuit and instruments are shown to him.

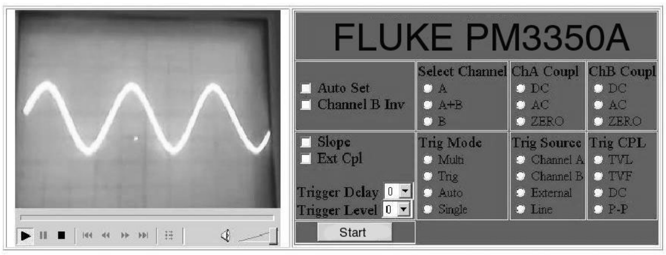


Fig. 9. Scope-Client Interface

Instruments interfaces are shown depending on student's demanding. A Fluke PM3350A scope and a Yogokawa FG120 waveform generator are available for the parameters measurements of the general-purpose operational amplifier experience.

The scope user interface is shown on Fig.9.

Windows Media Player ActiveX shows measurements results to users.

The waveform generator interface is shown on Fig.10.

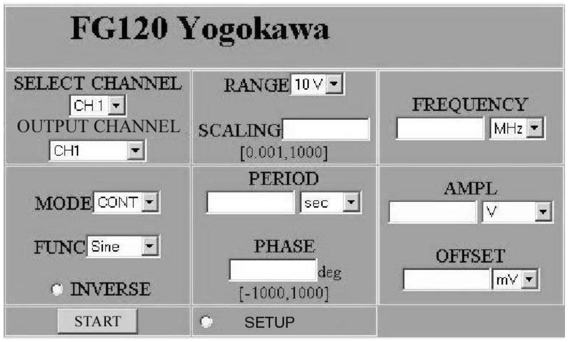


Fig. 10. Waveform Generator-Client Interface

When instrument has been selected, the student is able to reconfigure both the test circuit and the instruments and he starts measurement experience.

In front of the user's mistake or wrong procedure, for example the student uses the scope but has forgotten to supply the DUT circuit, an error message appears and allow him to repair in the right way.

5.2. Measurements on filters

Low-pass, high pass and band-pass filter are available for this experience. User can select the filters kind and the characteristic parameters value by choosing the relative radio button and re-configure circuit every time that they click on "Configure Circuit" submit button.

User interface for this experience is shown on Fig.11.

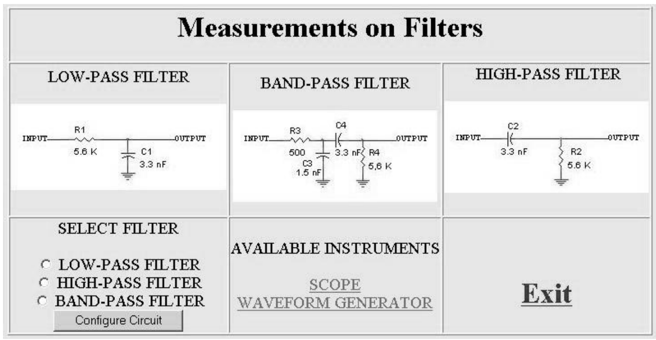


Fig. 11. Measurement on Filters-Client Interface

Scope and waveform generator are available by clicking on the link.

5. CONCLUSION

A client-server system has been implemented. The clients’ access to remote laboratory is possible by a common web browser without download plug-ins or buys dedicated software.

Laboratory experiences can be selected and performed by the Html pages, the ASP script and the server software drivers making use of instruments and reconfiguring measurement object.

A user-friendly interface has been realized for a waveform generator, a scope and National Instruments Switch/Relays Module SCXI 1160 [5][6].

Re-configurable test circuit for Operational Amplifier and Filter Bench has been realized.

A first web site realization managing experience has been implemented.

Nevertheless, the efficiency and the quality check must be still analyzed.

We must test the efficiency of the methods.

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Authors:
Maurizio Caciotta, Dept. of Electronic Engineering, University of RomaTre, Via della Vasca Navale 54, 00146, Rome, Italy, +390655177029-085, caciotta@misure.ele.uniroma3.it.
Francesca Germoni, Dept.of Electronic Engineering, University of RomaTre, Via della Vasca Navale 54, 00146, Rome, Italy, +390655177029-085, franci.ger@tiscali.it.
Antonio Trifirò, Dept. of Electronic Engineering, University of RomaTre, Via della Vasca Navale 54, 00146, Rome, Italy, +390655177029-085, tony.trif@libero.it.