

From Virtual Instruments to Virtual Laboratory

Luis M. Fernandez¹

Guillermo Alvarez¹

Miguel Machirán¹

Ileana Sanchez¹

Luis Alejandro Sánchez²

¹Automatic Control Department

Institute of Cybernetic, Mathematic and Physic.

Minister of Science, Technology and Environment.

Street 15 #551 C y D. Zip Code 10400. C. Havana. Cuba.

(537)-8320319 Fax :537-333373

²Higher School of Computing, Nacional Polytechnic Institute

Av. Juan de Dios Batiz s/n casi esq. Miguel Othon de Mendizábal.

Col. Nueva Industria Vallejo CP 07738. MexicoCity, Mexico.

luis@icmf.inf.cu

Abstract: A Conventional Automatic Control Lab is expensive because it needs industrial equipment. Space requires are very large. Installation and verification time are very long. Maintenance cost is expensive too. Virtual instrument concept (created by James J. Truchard and Jeffrey L. Kodosky from National Instrument Corporation, USA) is a low cost solution to implement virtual laboratory. This concept is using by us in a Virtual Laboratory (VL). Our VL is at Institute of Cybernetic, Mathematic and Physic. We offer training support in computer science, automation, instrumentation and digital network communication for industries and universities.

1. Introduction.

Teaching is one technology transference path because it takes the liberty offer accumulated experience to futures engineers.

Automation's techniques using computers occupies an important place in present and in immediate future of industry.

Majority of computer control techniques take place and passes by university laboratories before arrive in industry.

The cost of necessary devices to equip an automation laboratory is very expensive if we want to prepare students for actual industry or if we want to offer training for industry engineers. Virtual Instruments (VI) requires an important initial inversion but its can help us to reduce considerably effective cost. Let me to show a simple example.

A two channels oscilloscope, a digital multimeter and a signal generator (basic elements of any laboratory), has an approximate costs of 20 000 USD meanwhile a Personal Computer (PC), an interface card (with input-output digital-analogue signals possibility) and a LabWindows/CVI license (for VI development) can cost approximately 8 000 USD.

The difference is almost 12 000 USD. It can help us to think about laboratories equipped with VI. Laboratories equipped with VI will be denominates Virtual Labs. The virtual sense of VL isn't given only by fact that VIs are used. The fact is also that laboratory can be employed for different training subjects. If we only modify software on the PC then our automation LV can be transformed in an electronic lab or in measuring lab, or in networks lab, etc. The VL with adequate software can change from programming languages to digital network communication. This versatility contributes to reduce laboratory effective costs and raise its flexibility of uses. Then we consider this laboratory in practice as a VL.

Another important advantage of VL is given by space saving and cheap maintenance expenditure. Software is the instrument then we are saving space because software is store in digital supports while that oscilloscopes, signal generators, multimeter, indicators, etc. requires many more real spaces and cleaning.

Cheap maintenance expenditure is given by equipment used. In this case, it is used as hardware PCs and interface cards. Its have more economic maintenance that real instruments. Then we can say that effective cost is reducing with VL.

Additionally, VI is easy updating because necessary additional code to join new functions to instruments is very little. But updating of real instrument signifies a new one.

Finally, VI can be prepared in order to process information obtained up to ours needs. It is possible to give specific solutions to specific problems. Real instruments were creating by producers to give general service. They resolve only considerate problems by producers. Many times these are not all ours problems.

Undoubtedly changes take places on concepts about what is a laboratory to teach ?, papers from [1], [2], [3], [4], [5], all presented in the San Francisco 13th IFAC Congress. [6] and [7] both presented in the Beijing 14th IFAC Congress. [8] and [9], both presented in the Barcelona 15th IFAC Congress, [10], [11] [12], all presented in the Prague 16th IFAC Congress, shown interest level on this area.

In this paper, I have dedicated first part to present the methods and materials employed in different experiments of a VL; second part is to show one of these experiments, principally: developed VI and obtained results. Next part contains conclusions and the last one contains references.

2 Methods and Tools

Laboratory equipment was carefully selected. It was settling with 6 work places with capacity of until 2 students per place.

In each case we employ the following tools:

- PC Pentium III 766 MHz, 128 Mbytes RAM, HD 40 Gbytes, SVGA.
- Microsoft Corporation Windows 2000 Professional.
- SCADA programming in C.
- Microcontroller digital communication between process and PC, RS-232C.

VL project was supported by Nuclear Energy Agency of Cuba.

Many different experiments were designing for this VL [13], [14], [15] y [16]; we present here each one briefly.

2.1. Fast process, DC motor.

This experiment consists in a DC motor with tachometer coupled and communication board, based in PIC microcontroller, as show in figure 1.

SCADA is placed in PC and it solves human – machine communication problem, see figure 2.

Target is to use a PID digital control of fast process. Students can take measurements or dc motor parameters, make identification and design control with digital PID.

2.2 Slow process, Low Temperature furnace.

This experiment consists in little furnace, see figure 3 and communication board, based in PIC microcontroller.

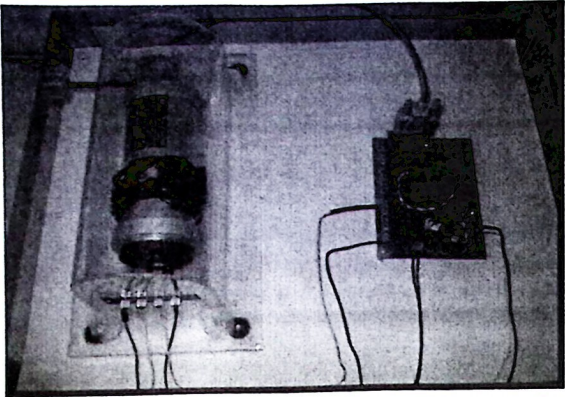


Fig. 1. DC motor and communication card.

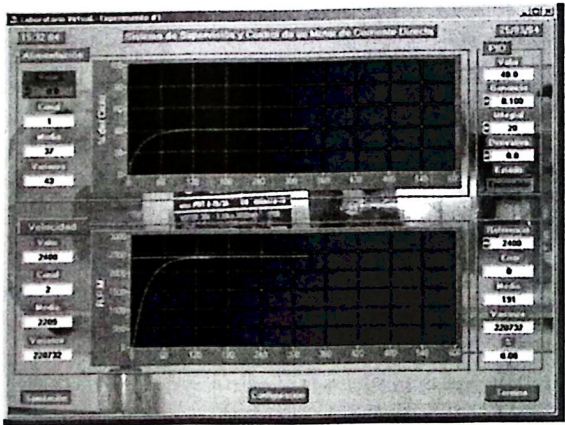


Fig. 2. DC motor SCADA

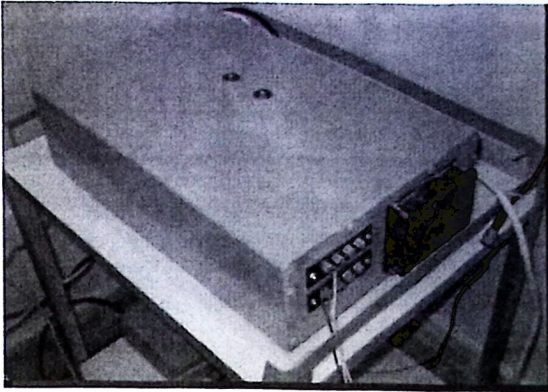


Fig. 3. Furnace

SCADA is placed in PC and it solves human – machine communication problem, see figure 4.

Target is to use a PID digital control of slow process. Students can take measurements or furnace parameters, make identification and design control with digital PID.

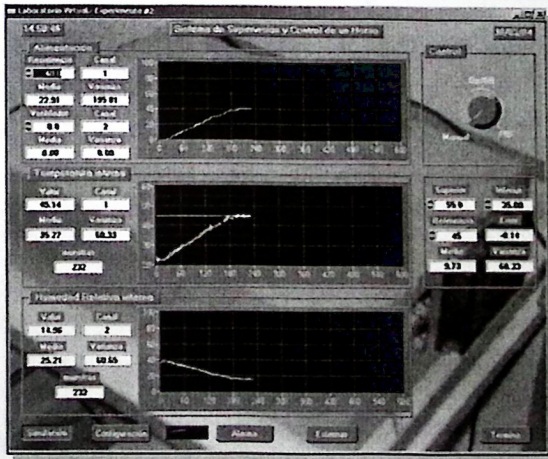


Fig. 4. Furnace SCADA.

2.3. Sequential control, Traffic Control network.

Experiment consists in a Traffic Control network located in Salvador Allende and Infanta intersection in Havana City, see figure 5. Communication with PC is across a board, based in PIC microcontroller.

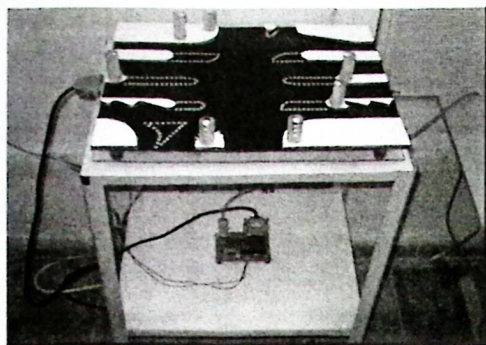


Fig. 5. Network for Traffic Control.

SCADA is placed in PC and it solves human – machine communication problem, see figure 6.

Target is to find a solution for each traffic problem in the net (priorities, collisions, wait time, etc.).

2.4. Advanced technology and data post processing, Vibration studies.

This experiment consists in 3 step motors; see figure 3, one optical fibre sensor and one communication board, based in PIC microcontroller.

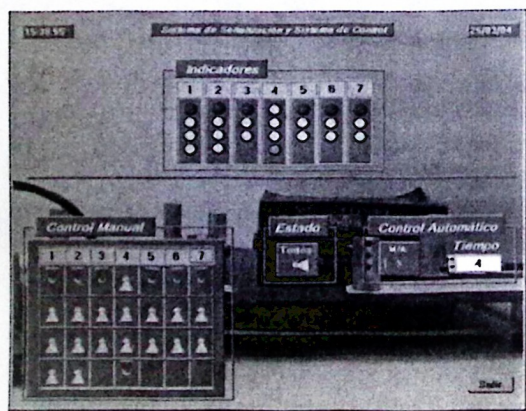


Fig. 6. SCADA for Traffic Control Network

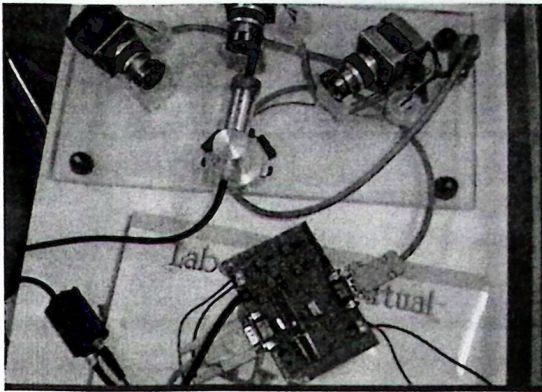


Fig. 7. Vibration studies.

SCADA is placed in PC and it solves human – machine communication problem, see figure 8.

Target is to study of cutting edge of technology with optical fibre sensor and mathematical tools for data post processing in bearing vibration problem.

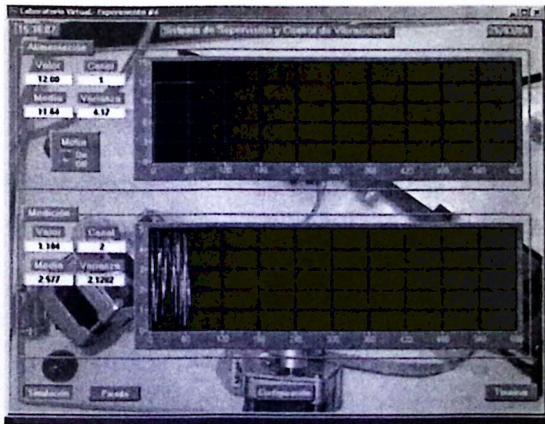


Fig. 8. SCADA for vibration studies.

2.5 Complex process, Vacuum control.

This experiment consists in one AC motor, one vacuum pump, one cylindrical tank, one valve with step motor for positioning, see figure 9.

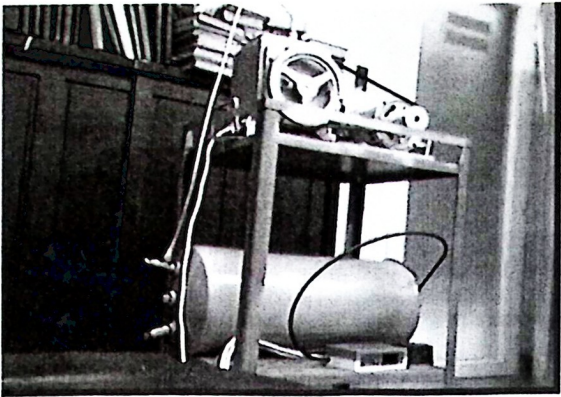


Fig. 9. Complex process.

SCADA is placed in PC and it solves human – machine communication problem, see figure 10.

Target is to use a PID digital control for complex process. Students can take measurements, make identification and design control with digital PID.

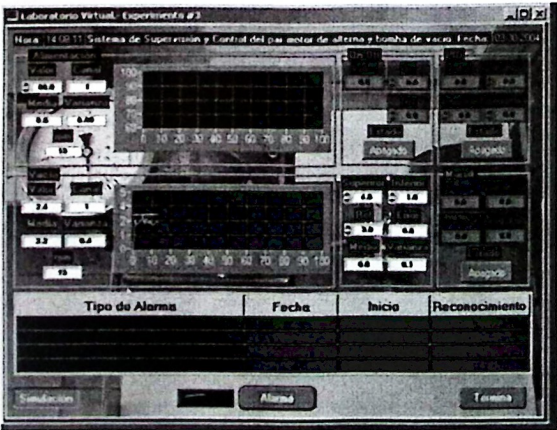


Fig. 10. SCADA for complex process.

3. Results.

Each experiment has prepared students to develop different abilities in measurements and control techniques.

VL can be used for training in hardware design, industrial digital network protocols, software develop, data acquisition techniques, post processing data techniques, identification and control.

Training is doing with middle level students, university students, postgraduate students. For Curricula of Masters and Doctoral courses, experimental activities were made.

4. Conclusions

Virtual Laboratory is a low cost solution in relation with traditional laboratory. This economic solution can be employed by non rich institutions.

A Virtual Laboratory with capacity until 12 students by group has been created at *Institute of Cybernetic, Mathematic and Physic, Havana, Cuba*. Then it is possible to use this solution for university laboratory.

Many different Virtual Instruments has been developed to experimentation in the laboratory conditions. This instrumentation type opens the possibility of Virtual Instrument interchange between institutions. Actually, this experience exists.

Automatic control with Virtual Instrument has been employed in many different country industries. This path reduce gap between university and industry and smooth new engineer adaptations.

Therefore, there is a solution to bring near industry problems at university. Moreover this can help to create Virtual Instruments at university for industry.

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