

THE CONTROL SYSTEM FOR THE IFUSP MICROTRON

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Abstract

A Personal Computer (PC) based control system is being developed for the IFUSP microtron. The system is aimed at simplicity, low cost, and easy maintenance, and consists of three layers: the user interface layer, the device server layer and the I/O devices layer. This paper describes the graphic user interface (GUI) and the data flow between the console and the I/O devices.

1 INTRODUCTION

The Physics Institute of the University of São Paulo (IFUSP) is building a 31 MeV continuous wave (cw) racetrack microtron [1,2]. This two-stage microtron includes a 1.9 MeV injector linac feeding a five-turn microtron booster that increases the energy to 5.1 MeV. After 28 turns, the main microtron delivers a 31 MeV cw electron beam. The injector has a capture section and a pre-accelerating section; therefore the complete accelerator has four RF accelerating sections, operating at 2450 MHz.

The accelerator operator will have to deal with approximately 200 parameters, like currents of magnetic lenses and steerings, vacuum gauge readings, and many others, related directly to the machine operation or to safety systems. To manage such a number of parameters adequately, and at the same time to log the operation, a computer based control system was needed.

The main concerns were cost, maintenance and upgradability. We were looking for a system composed by a host computer, to act as an operator console, and front-end computers (the Stations) that acquire the data coming from the different parts of the accelerator and share these data. This approach modularizes the control system and reduces the cabling system. Besides, it allows the distribution of the processing tasks among the various computers, while centralizing the parameters into a database. Thus, we chose a Personal Computer (PC)-based control system, over a local area network.

The system uses the classical three layers approach: the user interface layer, the device server layer and the I/O device layer, as illustrated in the diagram of figure 1.

This paper presents a description of the control system that is being developed.

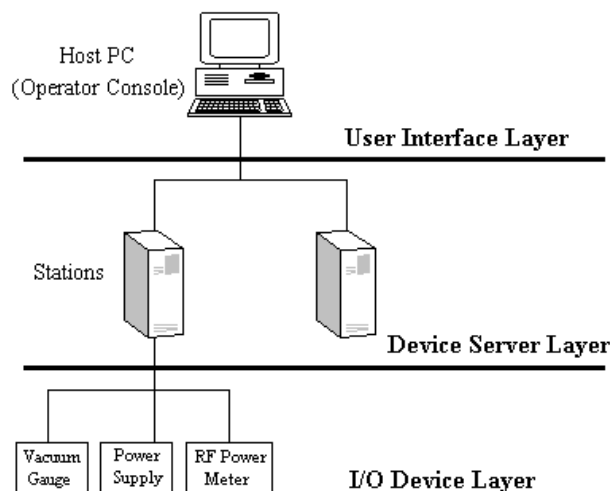


Figure 1: The three-layer approach used in the control system

2 USER INTERFACE LAYER

The user interface layer consists of a PC running Windows NT operational system. The Human-Machine Interface (HMI) is constructed using a commercially available tool, the Labwindows/CVI. This tool allows the programmer to create panels (with simple pick and drop operations) with displays, buttons and tables on the screen.

The Labwindows/CVI tool is aimed at building event-oriented programs, so that whenever there is an event (for example, a button click or a timer event) a callback routine, written in C language, is called to deal with it.

Previous experience with this kind of interface showed us that the operator could be easily overwhelmed if the screen is too busy. So one must resist the temptation to put a meter or dial for each parameter of the machine. A too colorful screen must also be avoided.

The HMI has a menu with a set of options, each bringing a synoptic diagram of different sections of the accelerator. Through these diagrams, the operator can choose the specific device parameter to be checked or changed. Once selected, the device parameter is presented in a table that shows its name, present value, set point and status. Some of the devices have read-only parameters, which are just displayed. The other devices have parameters that can be changed by the operator, acting

through a specific dial presented on the screen. Figure 2 shows a typical HMI screen.

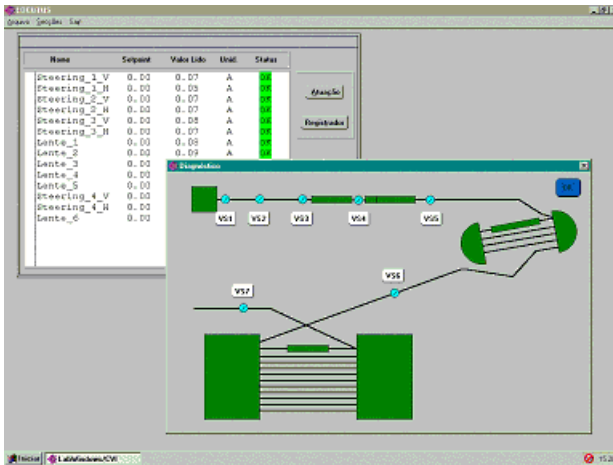


Figure 2: A screen shot of the Human Machine Interface, showing a diagram of the accelerator and a table with some of the parameters.

All device parameters are maintained in a database, in order to centralize the data and ease logging procedures, which are important to investigate malfunctions and optimize operation. The use of a database also allows a future access to the machine parameters by other computers connected to the network. The database management system used is the MS Access.

When the operator needs, for example, to update a magnet current, the HMI changes the database entry for this parameter and notifies a Station, in the device server layer, that a specific parameter has a new value. The Station then accesses the database, fetches the new value, and sets the device.

Periodically, the Stations update all the parameters in the database with the new values read from the devices. Also periodically, the HMI accesses the database and reads all the parameters, displaying those that have been previously chosen by the operator. A diagram showing the data flow is presented in figure 3.

The database transactions are accomplished using ActiveX Automation, which is a way for communication between simultaneously running softwares under Windows.

The ActiveX Automation allows a client (the HMI or the software in the Stations) to invoke the services of a server (in this case the MS Access).

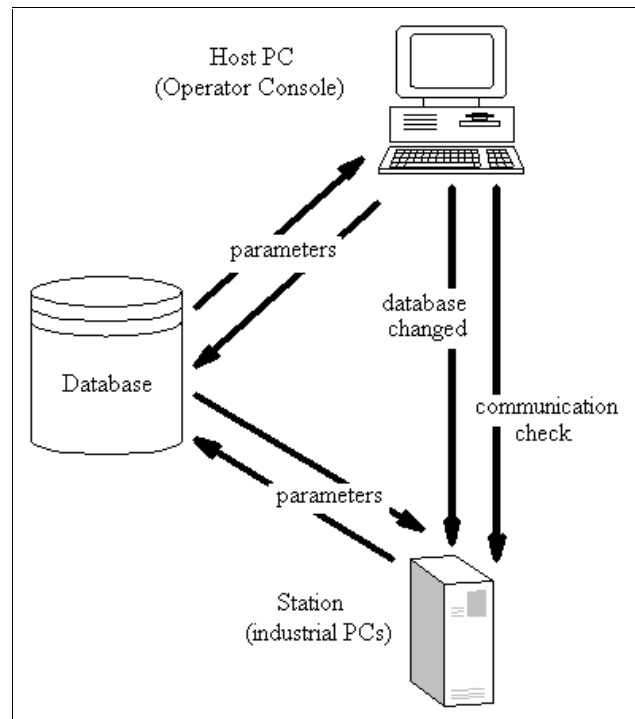


Figure 3: Data flow diagram.

3 DEVICE SERVER LAYER

The device server layer is composed of the industrial PCs (the Stations) that run the dedicated software to operate the various I/O devices. The software contains all information pertaining to addresses, conversion gains and initialization procedures.

A highly structured software design allowed all hardware interactions to be encapsulated in a few routines. Thus, if a piece of hardware is modified, the software changes needed are very specific and localized.

The software checks lower and upper bounds of all parameters. In case of a flaw, it changes a database error entry. Periodically, the HMI checks this entry and alerts the operator accordingly.

A communication check between the Stations and the Host is also performed. If the link is broken, and a Station remains more than a few seconds without receiving a token from the Host, its software shuts down the electron gun and several power supplies.

The software was written in C language, also using the Labwindows/CVI tool under Windows NT, to be compatible with the software in the user interface layer.

I/O DEVICE LAYER

The I/O device layer is the lowest layer, connected directly to the accelerator devices, like steering magnets and vacuum gauges. It is composed by several kinds of instruments divided in three categories: the box enclosed devices, like vacuum gauges controllers and microwave power meters, that share their data through RS232 or GPIB interfaces; the ADCs, DACs and digital I/O boards,

directly connected to the Stations buses (PCI or ISA); and homemade interfaces and microcontroller boards, like the electron gun control system [3].

Although there is a lack of standardization in this layer, the cost of using a standard bus (VME or CAMAC) would be too high for the relatively small density of control devices.

4 CONCLUSION

A PC-based control system has been developed, with focus on simplicity and low cost. Several tests were performed on some devices already installed (power supplies, temperature monitors, microwave and vacuum instrumentation) and the results show that the initial assertion on the use of PCs was correct. Nevertheless, more tests are needed to warrant the robustness and reliability of the system.

Both the host computer and the operational system have been through major upgrades since the first tests of the system. No significant problems were found in the process, showing a good degree of upgradability.

The control system is flexible enough to evolve with the accelerator, so some minor changes are expected when new subsystems are introduced.

ACKNOWLEDGMENTS

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