Virtual Instrumentation Interface for SRRC Control system

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ABSTRACT

Virtual instrumentation system has been developed for the control system of SRRC. Almost of the measurement instruments are to provide IEEE-488 interface, they are distributed around the accelerator facilities, the virtual instrumentation system connects these instruments by local area network, Ethernet, to GPIB adapter. The man-machine interface developed by using LabVIEW, which is running at Sun's workstation. The workstation to be played as an instrument server, the operator can access remote instruments simply by point and click operation. The information provided by instruments can be analyzed and extracted the desire machine parameters at workstation. The main control system can access these parameters by standard network protocol. The major goals of the virtual instrumentation interface are to provide the automatic measurement of the machine parameters and to minimize the interlude of the machine physicists and operators. Machine parameters, such as tune, beam spectrum, filling pattern, bunch length, can be on-line displayed at main control panel or archived for various applications.

I. INTRODUCTION

A two-level hierarchical computer system is implemented for the control system of SRRC [1,2]. The control system can access any type of accelerator device. There are still missing link information sources, such as wave form as well as spectrum cannot be accessed from the control system at this moment. A few instruments support Ethernet interface, but most of them provide standard interface, such as GPIB, RS232,...etc. To fill this gap, the solution was to connect control system and variety instruments that have IEEE-488 interface to a control network (Ethernet) which is also distributed throughout the facility. Commercially available tool kit LabVIEW was used to develop the user interface that reduces large amount loading of programming [3,4,5]. LabVIEW provides an icon-based graphical programming environment that offers high productivity in development phase.

II. SYSTEM STRUCTURE

Almost of the measurement instruments provide IEEE-488 interface, they distributed around the accelerator facilities, the virtual instrumentation system connects these instruments by local area network via ethernet to GPIB adapter. Operator and machine physicist will have the flexibility to control the instruments from the computers in their offices. This system was built on standardized networking protocols and implemented with the measurement server concept. The system may configure to connect 8 GPIB-ENET adapters to drive GPIB devices. One GPIB-ENET adapter can drive 15 GPIB devices or expand to 31 devices. The man-machine interface is developed by using LabVIEW, which is running at Sun's workstation. The workstation is played as an instrument server, the operator can access remote instruments simply by point and click operation. The application programs executed on the workstaion analyze and extract the machine parameters from the information provided by the instruments. Users may access these parameters from control system through the standard network protocol.

The system configuration of the Ethernet-based virtual system is shown in figure 1. The figure shows there are two level computer systems connected by control network. The instrument's server is running on a Sun's SPARCstation.

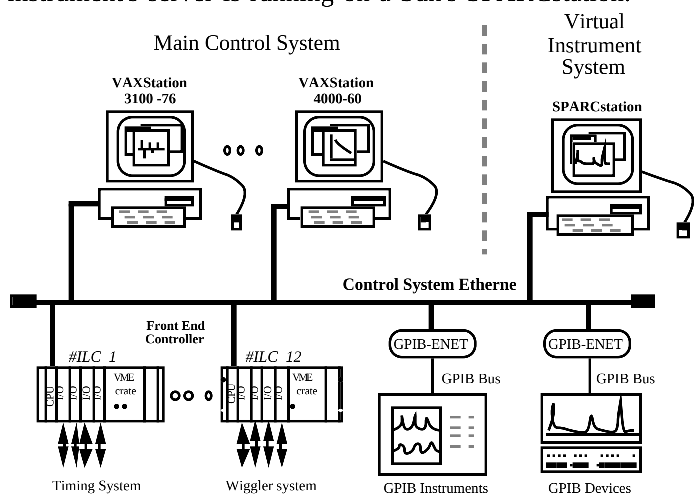

Figure 1. Ethernet based virtual instrumentetaion system

III. SOFTWARE STRUCTURE

According to our control system design [1,2], many workstations for control devices have the same configuration. The dynamic database and static database are the same on each computer. The main control system software was developed on VAX/VMS computer system. Relations between processes are shown in figure 2. A server process running on a control computer serves data access from non-database client. It can serve reading, setting requests, static database fields access and receive the results from some special measuring system then write into the part of dynamic database (DDB) that is not refreshed by ILC. ILCs upload their DDB at 10Hz, the dynamic data receiving process refreshes the console's DDB area. The refreshed area for each ILC was set to 1400 byes. But on console level computer we configured the size of dynamic database for each ILC to 1500 bytes. Then there are 100 bytes are not refreshed by the ILC. Those special measured results were written into 1400 to 1500 bytes' area. There is another process responds to broadcast those results or receive the broadcast data and write into the part of DDB to keep the consistency of control system. The device setting request is limited to the specified hosts that are listed in a file to provide security of control. The requests are built by string, it is simple for any computer system to communicate with each other that stands on UDP/IP protocol. The server creates the channel of data accessing between any computer system to main control system. By the channel, the measured results can be archived to files daily by an archiving process started on a specified computer that has large harddisk space. The same, they can be accessed by any control process from any control computer, they are base on the same database system. From the results we may understand more about the extracted machine parameters related to the effected devices, for example.

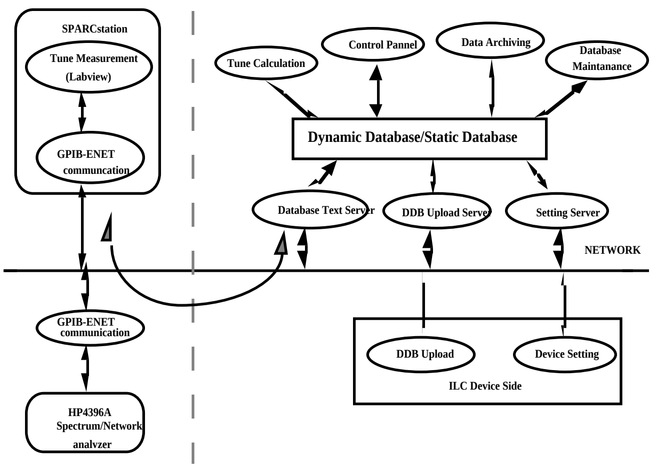

Figure 2. Relationship between processes

IV. USER AND CONTROL SYSTEM INTERFACE

The LabVIEW programming environment provides enough user-interface objects to build applications. The control program of LabVIEW is called Virtual Instrument. One VI program has two parts, control panel and diagram. The control panel provides user interface, the diagram is the execution body. It also supports Code Interface Nodes (CIN) function to link C program. It may be necessary if it is difficult to build functions by using LabVIEW objects. It should be careful to manipulate the passing variables to and from CIN functions. They are only passed by address, the data types of the variables cannot be checked, the error data type passing may cause fatal error at run time. During the command and data exchange between VI program and GPIB devices, the GPIB-ENET device translates the messages from Ethernet to GPIB bus signals that stands on TCP/IP protocol.

V. TYPICAL APPLICATIONS

We have developed several applications at this moment. The detailed of several applications are present here. These applications include spectrum analyzer interface, optical sampling oscilloscope interface and sampling oscilloscope interface, etc.

A. Spectrum Analyzer And Tune Measurement

The spectrum and tune are measure by using HP 4396A spectrum and network analyzer. To make the tune measurement simplified, two reference values of tunes are calculated by a tune calculation process on a control computer.

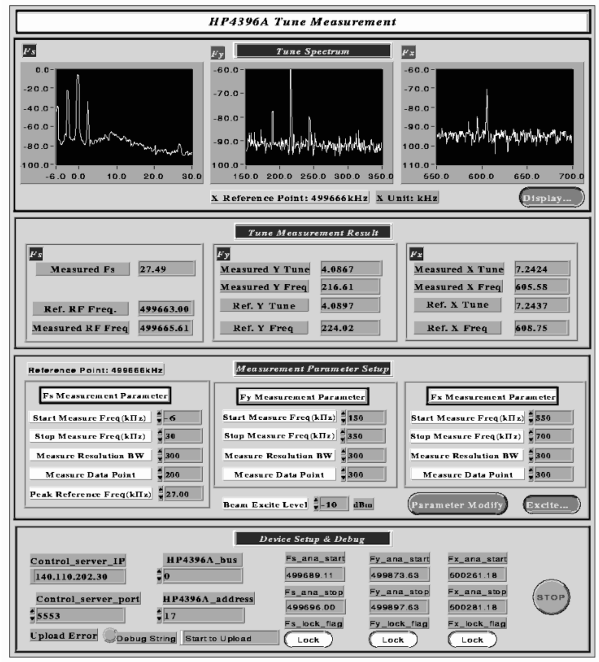

Figure 3. Tune measurement virtual instrument interface

The process calculates the tunes according to the machine lattice. Using the channel supported by the server, the reference values can be accessed and the measured results can be updated by the tune measuring process that is developed on a Sun UNIX computer. The tune measuring process uses the reference values to set analysis range to identify peaks. If the specified range cannot find tune peak then the analysis range of getting peaks will be set wider till the peak found or the range is set to the spectrum measuring boundary. If the tune is found the peak analysis range will be set to be close to the peak to avoid error locking. It also may excite the beam if the peak cannot be identified. The difference between measured tune and calculated tune value is about several kHz. HP4936A spectrum/network analyzer can be set to several sweeps ranges to do spectrum analysis. From our requirement it is set to 3 pieces of sweep range. The first is to get synchrotron frequency and the fundamental frequency to calculate tunes, the second is to get vertical tune ν_y and the third is to get horizontal tune ν_x. Then one sweep cycle we may get 4 peaks according to the peak analysis ranges.

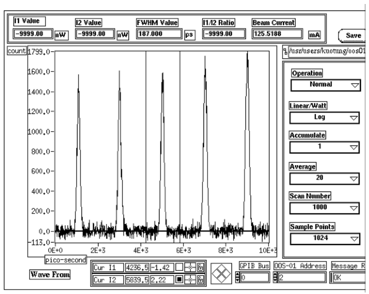

Figure 4. Optical sampling oscilloscope virtual instrument interface

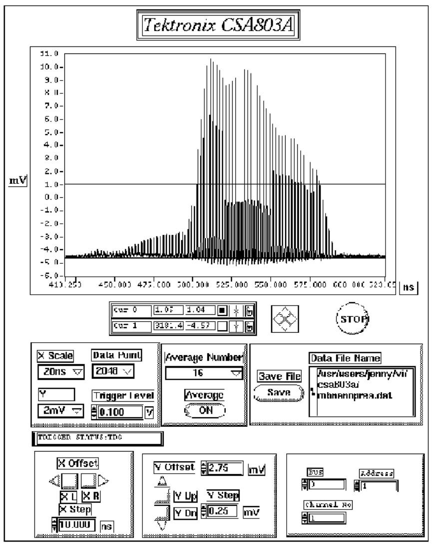

Figure 5. Oscilloscope virtual instrument interface

B. Optical sampling oscilloscope virtual interface

The averaged bunch length of the storage ring is measured by Hamamatsu OOS-01/VIS optical sampling oscilloscope that is located at synchrotron radiation diagnostic port, the location is about 150 meters far from control room. The device connects to Ethernet through GPIB-ENET adapter. The operator as well as machine physicists can access the bunch length on the control room on bunch length. The averaged bunch length is also stored on the machine database, it is valuable for analysis bunch length versus parameter of the machine. For example, beam intensity versus bunch length relation can be record automatically.

C. Oscilloscope Interface

Oscilloscopes are the most important instruments for the diagnostic and operate of the accelerator system. The virtual instrument system connects the oscilloscope through GPIB-ENET adapter. On the workstation, the operator can operate the oscilloscope as to the operate the real front panel of the oscilloscope.

VI. FUTURE PROSPECTIVE

The usability of the virtual instrument system has been demonstrated. But, present system is still in its infancy. There are many problems need to be solved. The major issue includes improve response time of the system, connect more equipment and find a batter way to bridge the virtual instrument system with the existing control system database. The trend of the future instrument systems will use standard computer network protocols. Bring instrument server concept [5] and updated virtual instrumentation system for the control system of SRRC is the major activity of the near future.

VII. ACKNOWLEDGMENTS

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