THE CRYOGENIC SUPERVISION SYSTEM IN NSRRC

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Abstract

The helium cryogenic system in NSRRC is a fully automatic system using the Siemens SIMATIC 300 PLC (Programable Logic Controller). Modularization in both hardware and software makes it easy in the program reading, the system modification and the problem debug. Based on the LabVIEW program we had developed a supervision system taking advantage of the Internet technology to get system's real-time information in any office. The functions of this supervision system include the real-time data accessing with more than 300 digital/analog signals, the data restore, the history trend display, and the human machine interface. The data is accessed via a Profibus line connecting the PLC system and the supervision system with a maximum baud rate 1.5 Mbit/s. Using this supervision system makes it easy to master the status of the cryogenic system within a short time and diagnose the problem.

INTRODUCTION

At NSRRC the installation of a helium cryogenic system, which is tailor-made for the cooling of the superconducting cavity, was finished at the end of October 2002[1]. The cryogenic system had finished its commission work at the end of October 2003. After system optimization, the liquid helium producing rate is 56 L/hrs without liquid nitrogen pre-cooling, and 124 L/hrs with liquid nitrogen pre-cooling. In early 2005 we had installed one distribution valve box and about 100 m long liquid helium transfer line (liquid helium, cold helium gas, liquid nitrogen). As indicated in Fig. 1 the distribution valve box is used to connect the first and the second helium refrigerator systems, the control valve box for superconducting cavity, and the liquid helium transfer system[2].

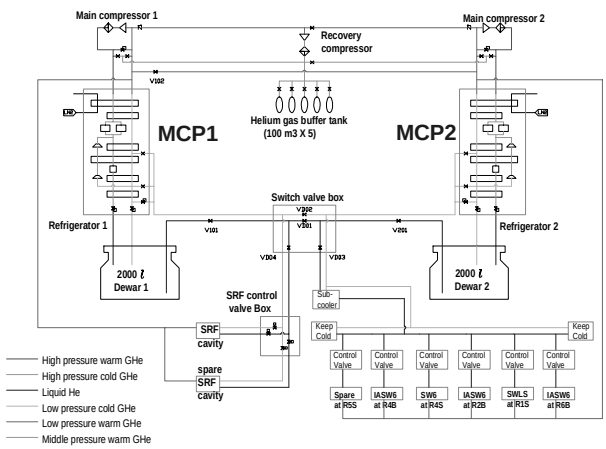

Figure 1: Configuration of the helium cryogenic system.

The second cryogenic system will be installed in early 2006.

The helium refrigerator system in NSRRC is a fully automatic PLC-controlled system developed by Air Liquide DTA. The hardware of the control system base on Siemens SIMATIC S7-300 PLC [3]. Using LabVIEW program we developed the supervision system. This paper describes the hardware and software of this cryogenic control system and the supervision system.

HARDWARE CONFIGURATION OF THE CRYOGENIC CONTROL SYSTEM

Figure 2 shows the hardware configuration of the whole control system. The PLC system was modularized in both hardware and software and thus it is easy in the program reading, the system modification and the problem debug. The engineering in Air Liquide France can modify this PLC program and its parameters through the modem. We can start the system through the internet network. But for safety reason the system only accepts commands from the local Siemens OP170B HMI control panel.

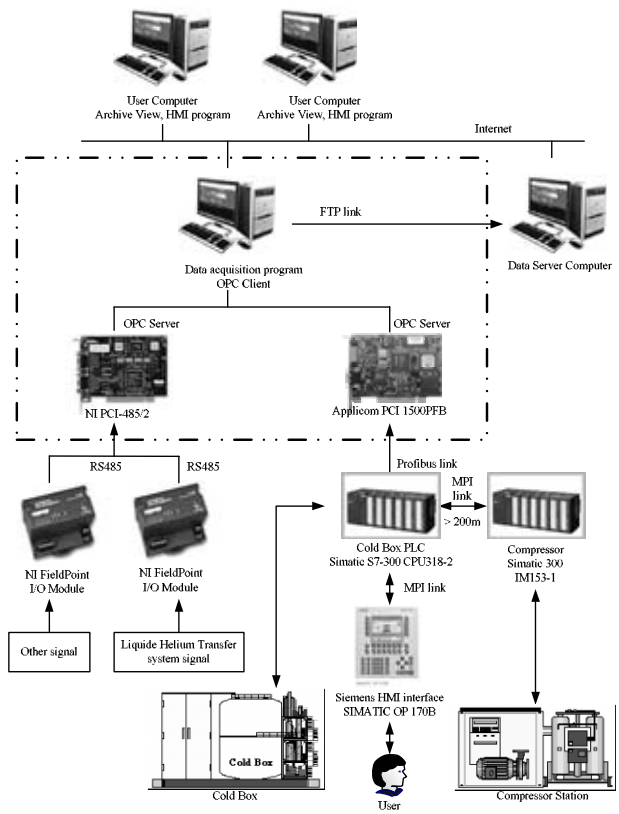

Figure 2: Hardware configuration of the cryogenic control system.

The signals from liquid helium transfer line and those from the utility equipments related to the cryogenic system are acquired by NI FieldPoint I/O Module. The Siemens PLC and NI FeildPoint module are located at different places and the server computers use the OPC (OLE for Process Control) protocol to communicate with them. The total number of digital/analog signals is more than 300 points. We developed a supervision program based on the LabVIEW environment, to assist the operator grasping all situations on the cryogenic system.

CRYOGENIC SUPERVISION SYSTEM

The supervision system includes three subprograms: the Data acquisition program, the HMI (Human machine interface) program, and the Archive view program. Figure 3 shows functions of all subprograms.

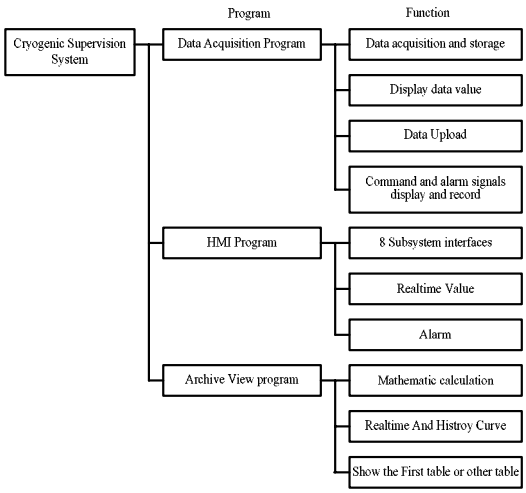

Figure 3: Architecture of the supervision system.

Data Acquisition Program

The data acquisition program has four functions: data acquisition and storage, display of data value, data upload, and commands and alarm signals display and record.

Data acquisition and storage: A server computer using an Applicom PCI 1500PFB card communicates with the Siemens PLC, another server computer using a NI RS485-2 card communicates with the NI FieldPoint I/O modules. The OPC protocol is the common communication protocol among the different I/O equipments and the supervision program. When the supervision system (OPC Client) acquires the data from two PCI interface cards (OPC Server), the supervision program checks the different data format and transforms the data to a format of floating point. The transformed data is then saved to a file with the acquired time. Each supervised signal occupies one file with accumulated daily records and the file is daily changed to different filename.

Display of data value: The acquired value refresh and display every two seconds. If the values exceed the high/low alarm range, the display interface will caution operator with the flash alarms.

Data upload: A data server computer manages all data from local servers at NSRRC and provides the data requested from Internet link. The using of data server computer also provides a better data security. Every ten minutes. the supervision program will upload all the data to the data server computer.

Commands and alarm signals display and record: All command orders and alarms during system operation are displayed and cataloged. This function helps one to trace the happened problems, improve the operation condition, and avoide the same mistake.

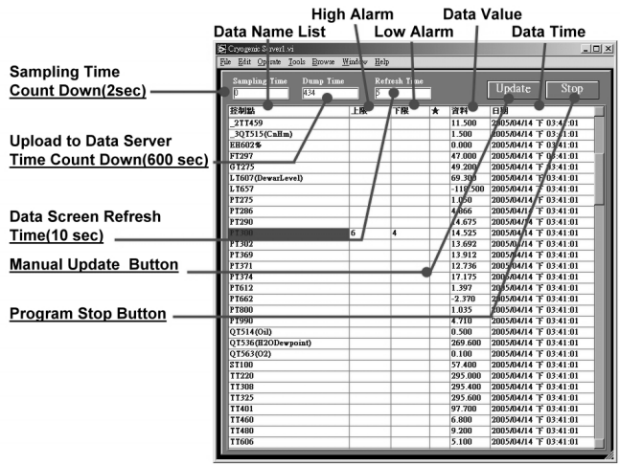

Figure 4: Data acquisition program.

HMI Program

We have measured more than 300 digital/analog signals in a cryogenic system. The number of signals will be doubled as the second cryogenic system in opearion. A HMI program was developed to rapidly monitor the status of the cryogenic system. Figure 5 shows the different parts of the cryogenic HMI program. The HMI program communicates to the server computers and accesses the real-time data through the Internet. The HMI program displays the real-time data at the icon of the associated equipment. One can set the high/low alarm value to notify the operator in the first time as an alarm happens.

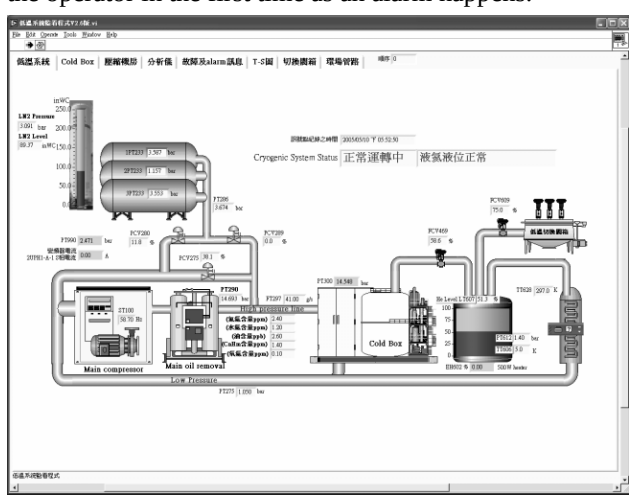

Figure 5(a): HMI program-Overall system.

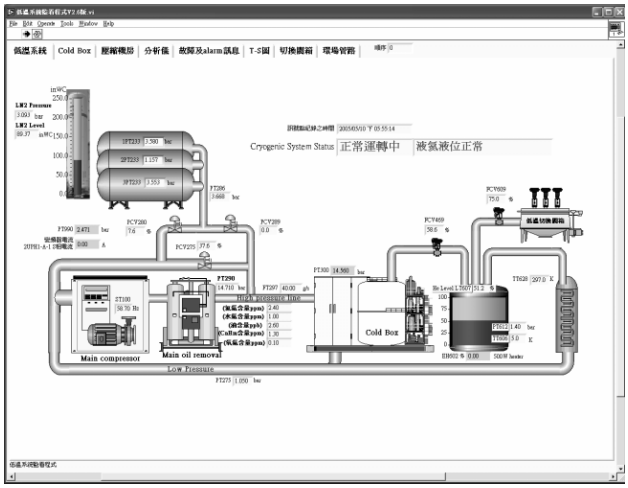

Figure 5(b): HMI program-Cold box.

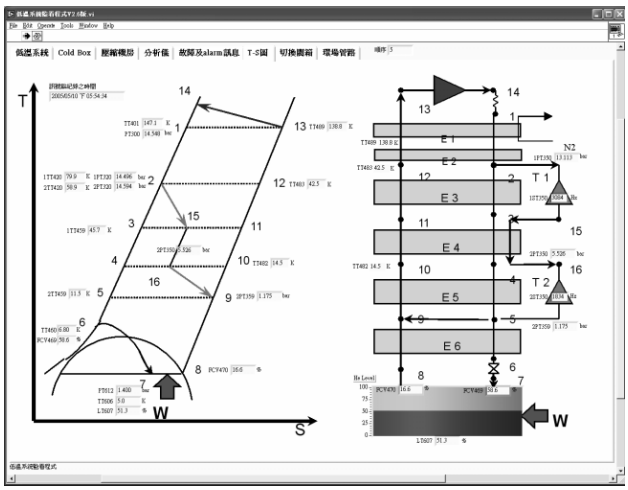

Figure 5(c): HMI program-T-S diagram.

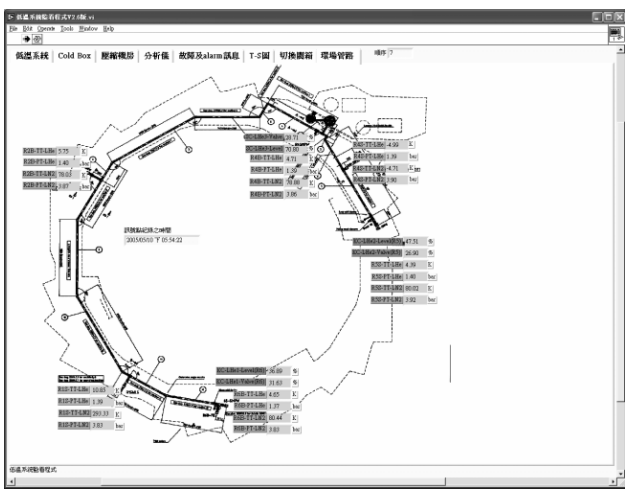

Figure 5(d): HMI program-Helium transfer system.

Archive View Program

Figure 6 shows the ”Archive View Program” which accesses the data through the Internet. This program have the functions: history trend curves for multi-days, multi-signal display up to eight curves, two-window display, dynamic display, auto/lock scale, zoom in/out, data transferred to .xls or .txt file, and mathematic calculation. Using this program one can easily find the abnormal condition of the cryogenic system by checking the trend curves.

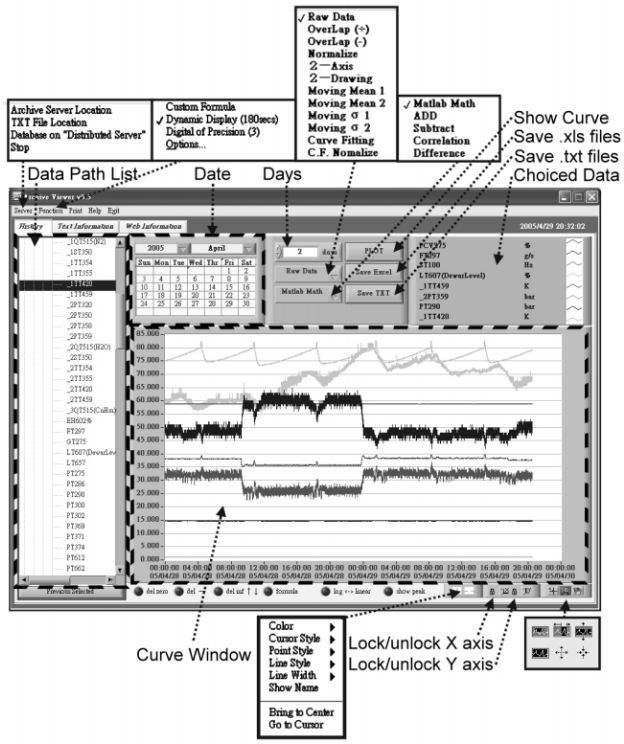

Figure 6: Archive View Program.

CONCLUSION

The paper describes the archietecture of the supervision system for the cryogenic system at NSRRC. The supervision system will be updated to a new version as the cryogenic system changes its configuration. The future goal is to integrate the “Expert System” into the program.

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[2] “Technical Specification: Helium Transfer System for the Six Supercondcuting Magnets at NSRRC,” NSRRC Technical Report, Oct. 15, 2003.

[3] A. Praud and B. Hilbert, “Technical Proposal: Helium Refrigerator System for SRRC,” Air Liquide DTA Technical Report (2001).