THE BUNCHER NB1 CONTROL IN HIRFL

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Abstract

There are some bunchers of FR system in HIFRL. They are very important for improving the beam quality. NB1, a new buncher, was designed in 1999. The control for the buncher was raised in last year. The NB1 control system is consisting of two parts, RF emitter control and moving system control. The NB1 moving system had been finished in Nanjing in 2000 and the emitter control system is going to be used in this year. The NB1 control system is based on CPCI. CAN bus, one sort of the famous field buses, is used to control the stepping motors in moving system. A CPCI/CAN bus converter is located in the CPCI crate. The software designing has been completed and tested. The GUI with windows style is handed to use. Whole control system will be introduced in this paper.
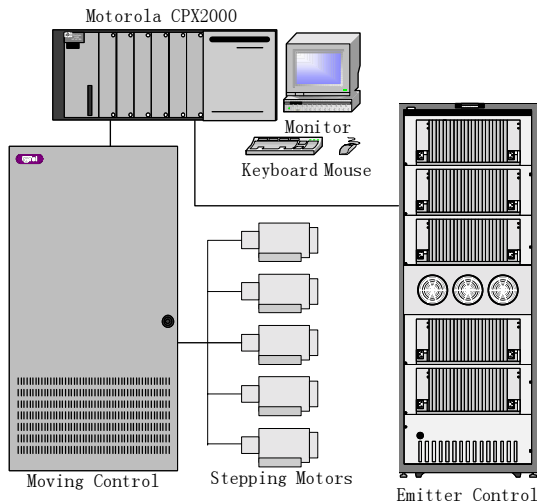
1 INTRODUCTION

Fig.1 The NB1 control system architecture

In the beam transport line between injector SFC and main cyclotron SSC, there were two bunchers named B1 and B2, which are expectable to squeeze the beam in the longitudinal so that the beam could be acceptable by the acceleration phase width of RF in SSC. Unfortunately, the bunchers were not working well because of some troubles in the designing and fabrication process, at the same time the control system of bunchers have not been suited for the needs of workers. So we decided to rebuild a new B1 instead of the old one, and a high-quality bus control will be introduced into the NB1 control system instead of CAMAC.

The NB1 control system is consisting of two parts, RF emitter control and moving system control. An industrial computer, the Motorola CPX2000 which is based on CompactPCI(Compact Peripheral Component Interconnect), that is CPCI, is used to administer the two parts. The CompactPCI specification was developed by the PICMG(PCI Industrial Computer Manufacturer's Group) and defines a ruggedized version of PCI to be used in industrial and embedded applications. With regards to electrical, logical and software functionality, it is 100% compatible with the PCI standard. The cards are rack mounted and use standard 3U or 6U Eurocard packaging. CompactPCI has the following features: HD(High-Density) 2mm pin-and-socket connectors, vertical card-orientation to ensure adequate cooling, positive card retention mechanism, optimized for maximum high shock and/or vibration environment, staged power pins to facilitate hot swap cards and eight card slots per chassis(versus four in the typical PC platform). The operation system in CPX2000 is Windows NT4.0 Workstation, whose performance is very good, and the program language is Visual C++ 6.0.

2 RF EMITTER CONTROL

To make the NB1 work well, there are some important steps in open/close the emitter. At first, before the emitter is opened, the operator must supplies voltage or current step by step to the emitter to protect the components in the emitter, and when the operator is going to close the emitter, the contrary steps will be used. On the emitter control cabinet there are some buttons and some indicator lights, and the indicator lights consist of two kinds, the alarm and the state. When some button is push down, the corresponding voltage or current will be supplied to the emitter, meanwhile, the value of voltage or current will be acquired back and displayed on the emitter control cabinet, only when the alarm light is not on and the state light is right, can the operator do the next step.

In the CPX2000 crate there are two 6U and single-width CompactPCI cards, the CPCI-200A and the Tpmc501, which are kind of IndustryPack carrier board. The CPCI-200A provides four IndustryPack slots, and the Tpmc501 provides two ones. The two cards can communicate with the emitter control cabinet via SCSI cable. There is a switch on the emitter control cabinet, when the switch is placed at the "local", the operator can only operate those buttons manually, while the switch is

placed at the "remote", both manual and computer control are manipulable.

Because the price of the CPCI-200A driver is very high, it is not purchased. So we have to write this driver in DriverStudio, which is thinked more prevail than other driver development tools, such as DDK and WinDriver, and now the driver has been finished and works well.

Fig.2 The interface of the computer control of RF Emitter

3 MOVING SYSTEM CONTROL

In the NB1 there are many capacitance boards, which are used to change the frequency of electric field in the NB1, so that the beam can be held in the pipeline. These capacitance boards are drove by the stepping motors. The moving control cabinet has an industrial control computer in which there is a card, and the card has two CAN(Controller Area Network) interfaces, one is used to transfer the control information to PLC(Program Logic Controller), and the PLC decode the control information and drive the five stepping motors, the other is used to communicate with the CPX2000 by CAN bus. So in the CPX2000 there is a CP350 card which is 3U and single-width.
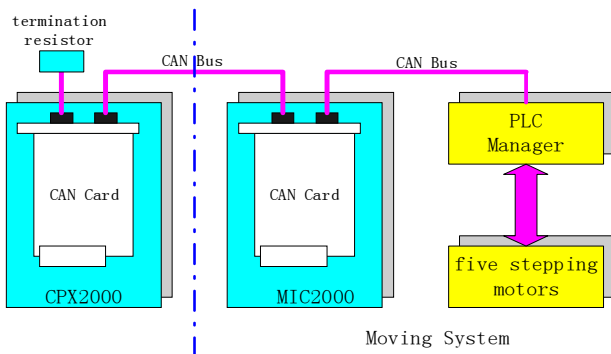

Fig.3 The architecture of CAN bus connect

CAN is a common, small area network solution that supports distributed product and distributed system architectures. The CAN bus is used to interconnect a network of electronic nodes or modules. Typically, a two wire, twisted pair cable is used for the network interconnection. CAN is implemented by a large number of industries including automotive, truck, bus, agriculture, marine, construction, medical, factory automation, textile, and many others. CAN has the following features: allows real time control with high level security, a network taking into account especially severe environmental temperature, electromagnetic radiance and vibration, a multimaster serial, normalised, flexible and modular network (ISO 11519-1 and ISO 11898), a network with priority message notion and a distinction between temporary and permanent errors, a network with messages up to 8 data bytes protected by a 15 bits CRC, CAN is able to work up to 1 Mbits/s and a network with a development and maintenance environment. The moving control cabinet has a control panel on which there are some state lights to indicate the status of the five stepping motors and some buttons to select the control objects and styles, the relative position of the five stepping motors are displayed on the control panel too. So when the position of some stepping motor is out of the limited, the operator must be careful at this time, or the stepping motor could be damaged. Obviously this belongs to manual operation, of course you can control these objects by computer, similarly there is a local/remote switch on the control panel.
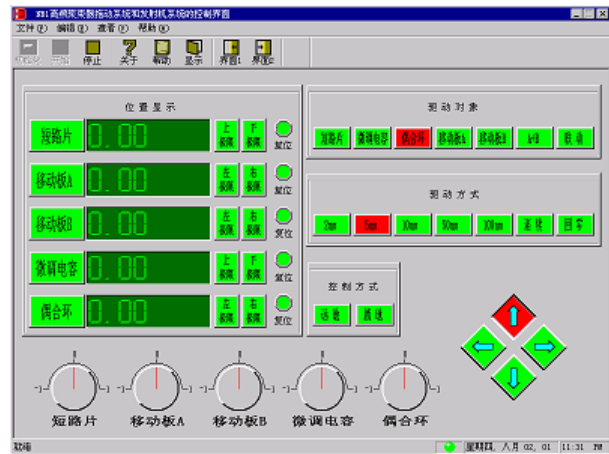

Fig.4 The interface of the computer control of Moving System

4 SOFTWARE ARCHITECTURE

The program running in the CPX2000 is writed in Visual C++6.0, which is very good OOP(Orient Object Program) language. The main features of the OOP are inherit, encapsulation and multiplicity. Since there are many control systems, such as moving control system and emitter control system, each control system consists of many named devices too, such as position monitor and

stepping motor, each named device are composed of properties(position, current, voltage)and operations on properties(get, set, read, write). The tree architecture can be described in class, that is, a control system has a corresponding class, every class has own variables (properties) and functions (operations). So if there are many similar devices and a lot of repeated operations, you had better use the OOP, because it's very convenient to maintain the application program.
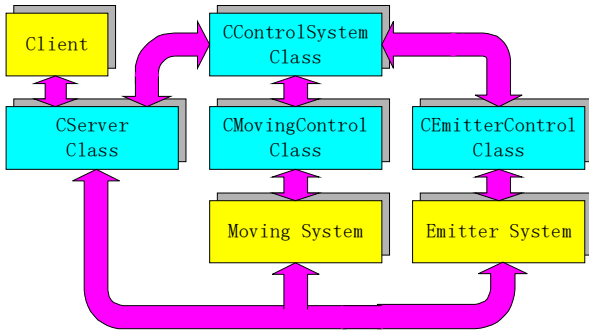

Fig.5 The relationship of four classes

There are four defined classes, CMovingControl, CEmitterControl, CControlSystem and CServer. CMovingControl is assigned to control the moving system and CEmitterControl that to control the emitter system. CControlSystem is a public class, including variables and functions offered to CMovingControl and CEmitterControl. That means CControlSystem does not directly control the devices. The responsibility of CServer is communication with the Client by Ethernet.

5 CONCLUSION

The software running in CPX2000 has been finished, and it is used to communicate with the RF emitter control system and the moving system. There is another important point, that is, when the local/remote switch is placed at "remote", the operator still manually manipulate those buttons on the control cabinet. The NB1 moving system had been finished in Nanjing in 2000 and the emitter control system is going to be used in this year. Now the NB1 RF cavity is being machined in Shanghai, once this part is finished, the whole NB1 will be tested, including the emitter control testing and the moving system control testing, if the testing passes, the next step must be done is that the CPX2000 will be introduced into the local area network, at that time, the CPX2000 will work as Server, and other computers that connect with the CPX2000 by Ethernet will work as Client, that is C/S architecture. The Client can control the RF emitter and the moving system via Server, of course a password could be needed when a Client try to connect the Server, otherwise the control of NB1 will be in a state of confusion.
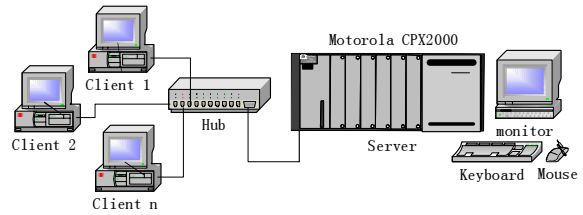

Fig.6 The LAN of NB1 control

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