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The New Control System for TARN-2

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The new control system for the cooler-synchrotron, TARN-2, is described. The new control system consists of OPU's (work stations) and EXU (control computer) linked with the local area network. The text message is used to transfer the control commands and their results. The control program CSA90 at EXU decodes the text message and executes it with the aid of the interface and periodic control subroutines. Both subroutines use common sharable image composed of the status, values, parameters and so on. The CAMAC, GPIB and RS232C are standard interface at EXU.

Introduction

A heavy-ion synchrotron-cooler ring, TARN2 has been constructed at the Institute for Nuclear Study, University of Tokyo. It has a maximum magnetic rigidity of 6.2 Tm, corresponding to 1.1 GeV for protons and 0.37 GeV/u for ions of charge-to-mass ratio 1/2. Now the injector is a sector-focusing cyclotron with K=68. The aims of TARN2 are to study the acceleration, cooling and extraction of heavy ions and so on. Recently study of the weak beam monitoring and experiment of atomic physics is being continued. So the TARN2 control system must gives reliable control functions and monitoring required to direct the up-to-date complex operations associated with on site experiment.

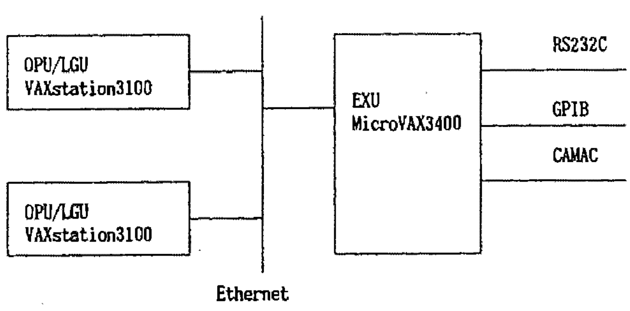

Fig.1 The new computer control system of TARN2

The present control system consists of the serial CAMAC, GPIB and microcomputers[1]. The serial CAMAC system covers static control system such as beam transport[2], injection, electron cooling[3] and a beam extraction system. On the other hand, dynamic control of both the RF acceleration and ring magnet system[4], is also performed with the dedicated microcomputers with external memory modules[5]. These systems well regulate TARN2 and now used without some troubles.

In 1990, basic design of the new computer control system was started and was authorized to combine the present I/O controllers. The present paper describes the new control system of TARN2 during the development phase.

Basic Architecture

In the new control system, the actual device control and man-machine communication is made by the separate units. The new system comprises OPU's (workstations) and EXU (control computer) linked with the local area network. The new computer control system of TARN2 is shown in Fig. 1.

The several kinds of workstations and PC's are used as OPU's. One is a VAXstation 3100. Another one is a microcomputer NEC-PC9801 with Ethernet board and DECnet-DOS. The uVAX 3400 is used as EXU and CAMAC, GPIB and RS232c are also available in the EXU.

The OPU and EXU execute task to task communications between them. Before the message transmission, OPU is linked with EXU. Then OPU and EXU transfer the text message to each other. The format of text message is formalized as shown in Fig.2.

At EXU, the received text message is stored into a buffer area by the interface process of control program CSA90[6]. Subsequently the buffered text message is taken by interface subroutine and then executed by a periodic subroutine after decoding the text message. Both subroutines use a common sharable image composed of the status, values, parameters and so on. Both subroutines are registered in the EXU and selectively called by the OPU using the subroutine number. The text message consists of this interface subroutine number and a command message associated with a control procedure of the target devices. So the central job at OPU is to generate the text message according to the associated control procedures. The interval of a periodic subroutine can be controlled by the associated control program CSA90. The minimum interval time is 50 msec and can be increased by 50 msec integrals.

The communication network 'INS-Ethernet' is a standard network in our institute, whereas other network system is used in our institute. The new control system

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is linked with the local area network which is in the TARN2 and cyclotron areas. Our network is also linked with 'INS-Ethernet'. On the other hand, the large scale computer system INS-M780 is also available through the associated local area network if we need any large computing power. In this case, TCP/IP protocol is used and terminal server with LAT-TCP/IP protocol is available in the network system.

The log-in by the off-site users will be expected through the network. To reject such a problem, physical cut off of the network will be expected during the actual operation phase, but general protection method is also employed.

function	input	output
get device information number	0:D<devnam>	0:n
get interface subroutine number	0:R<subrnam>	0:n
get periodic control subroutine number	0:K<subrnam>	0:n
get device information name	0:n	0:<devnam>
examine information	0:@Cn	0:<string>
	0:@In(,m)	0:x
	0:@En(,m)	0:x
modify information	0:@Cn=<string>	0:
	0:@In(,m)=x	0:
	0:@En(,m)=x	0:

() = optional
i = subroutine number
n = item number of device information
m = element number of array
x = data

Fig.2 Format of Text Message of OPU/EXU

Operator Console

The distributed operator consoles provide many kinds of operating functions. Up to 10 operator consoles could be joined with EXU to execute task to task communications. The main aim of task to task communication is to transfer the text message as described before. On the other hand, operator consoles as workstations provides us with the highest quality of visualization, man-machine communication and calculation speed. we have been considering several types of man-machine communications such as a touch panel, rotary encoder, mouse and so on.

The NEC-PC9801 with the resistive touch panel sheet and rotary encoder is chosen. The mouse system is also used in this OPU. The ON/OFF control and value setting are the main job of this system. The operating system of MS-DOS 3.3B and MS-C, MASM and turbo-C have been used to develop the application control program. DECnet-DOS is used in this system as the communication interface to EXU.

The VAXstation 3100 is used as OPU with VAX resources. The beam simulation program is available in this system. For instance, COD correction can be performed by the combination of OPU and EXU. The EXU sends measurement result of a beam orbit to OPU and receives back the command to change the correction current. The change of current is carried out by EXU.

Monitoring of the operating condition is an important facility. To discover the operating status, EXU periodically collects the operating status through the CAMAC system. The collected data is saved into a file and periodically refreshed by a timer process. The OPU assigned as a warning monitor refers the file in any time and executes appropriate fail-safe procedures.

Control Computer

The control program, CSA90, has been developed to execute the interface and periodic control process of EXU. The logical image of CSA90 is shown in Fig. 3.

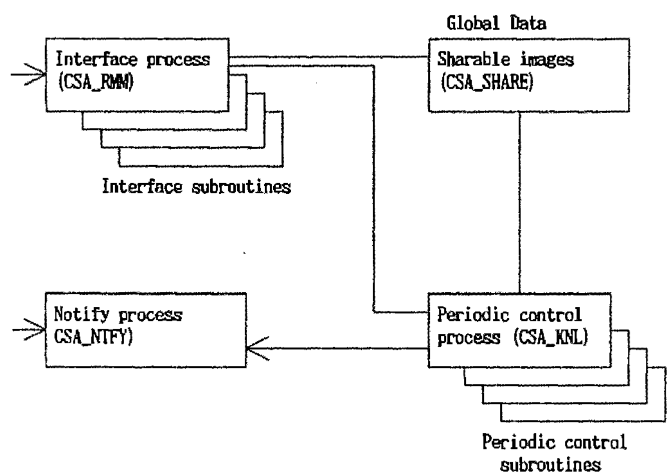

Fig.3 Logical image of control program CSA90

The CSA90 provides us with a flexible and expandable control system. This program has a basic program, device control programs, configuration definition files and a data generator. The device control programs are a set of subroutines and have no direct relation to each other. The basic program executes those subroutines according to a configuration program and requests from OPU. To make the configuration definition file easily, a data generation program is also provided.

By using CSA90, addition of new functions or modification of the control procedures are easily made by addition or modification of subroutines. Then the control sequence or configuration of the control system could be changed easily in according to the purpose of

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accelerator studies and so on.

The I/O interfaces are comprised of CAMAC, GPIB and RS232c. Presently the main CAMAC crate is alternatively controlled by either the Kinetic 3922 and EXU or Kinetic 3920 and an old existing microcomputers. The serial CAMAC driver housed in the main CAMAC crate is used commonly by either EXU or existing microcomputers through the above mentioned crate controller. Several kinds of local control devices with GPIB are located near the RF acceleration system, electron cooling and elsewhere. They are controlled by EXU through the fiber cable. The CAMAC control system also supports GPIB through the local CAMAC-GPIB converter.

Local intelligent Control Devices

The distributed control devices with an intelligent function have been used in the TARN2 control system. For instance, pattern generator to regulate the magnetic field of the ring has been used in the synchrotron magnet power supply system. Present pattern generator is composed of the microcomputers and is directory controlled by the terminal at the control room. To include such an individual intelligent controllers into the network system, we have been considered an up-grade of existing intelligent one to new one.

Though the add-on board of Ethernet system can be used in the present intelligent local control system, it is difficult to construct the network communication system because it is depend on the operating system of the central processor of local control system. For more any

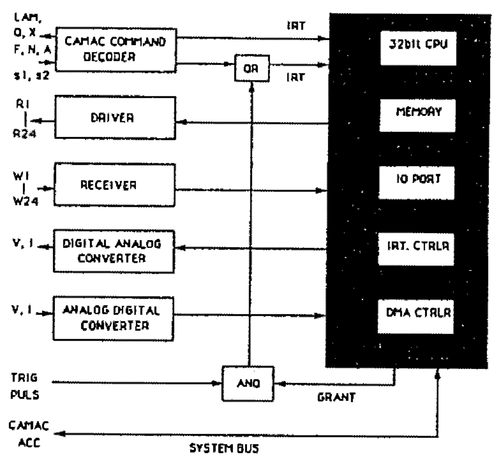

Fig.4 Proposed 32bit CAMAC board computer

unknown conditions, we have already considered that distributed local intelligent devices should be tied with the local area network. For instance, above mentioned pattern generators will be changed to a VME system with pattern memory system. The local CAMAC computer housed in the CAMAC crate is also considered as the candidate of distributed intelligent local control device. We have already been developed 8bit CAMAC module computer with a function of pattern signal generator, parallel bit signal input and output for any purpose. In this system, control program is stored as the ROM image and the RAM image. In Fig.4 the block diagram of proposed 32 bit CAMAC board computer is shown.

Conversion from present system to new one

The present microcomputer systems is written using an interpreted language such as INSBASIC with CP/M-86. To continue this approach with the present I/O control and the new control system, especially for OPU, a program converter has been developed from INSBASIC to QuickBASIC, which is used as the programming language for OPU. So the new control system will provide us with the user functions and subroutines associated with the present INSBASIC. Thus transparent programming can be performed in the new control system, especially for PC9801 as OPU.

For the FORTRAN system, such as the minicomputer U-400 or HP1000, the programs developed for CAMAC system will be implemented on the OPU and EXU. For instance, an existing program indicating the beam envelope of transport line will be reconstructed with MAGIC code in VAXstation 3100 and CAMAC handler in uvax 3400.

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