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APPLICATION OF TRANSPUTERS IN THE DATA ACQUISITION SYSTEM OF THE INESS-ALPHA SPECTROMETER*

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The paper describes the application of transputers in the DAQ system of the INESS-ALPHA spectrometer used in investigations of polarization phenomena in a few-nucleon systems under relativistic energies. The system has multiprocessor structure according to a scheme: main IBM PC plus add-on transputer-based boards. The system comprises three sub-systems interconnected by message transmission. The HW of the system and characteristic properties of application of transputers are under consideration, some promises of 'transputer-like' microprocessors using in DAQ systems are mentioned. The SW for the system is described in [1].

The investigation has been performed at the Laboratory of High Energies, JINR.

Применение транспьютеров в системе сбора данных спектрометра ИНЕСС-АЛЬФА

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В работе описано применение транспьютеров в системе сбора данных спектрометра ИНЕСС-АЛЬФА, используемого в исследованиях поляризационных явлений в малонуклонных системах при релятивистских энергиях. Система имеет многопроцессорную структуру в соответствии со схемой: основная ЭВМ IBM PC плюс дополнительные транспьютерные платы. Система состоит из трех подсистем, связанных механизмом передачи сообщений. Рассмотрены аппаратное обеспечение системы и особенности применения транспьютеров, кратко упомянуты перспективы применения транспьютероподобных микропроцессоров в системах сбора данных. Программное обеспечение системы описано в работе [1].

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

1. Introduction

In 1993 according to the research program of investigations of polarization phenomena in a few nucleon systems under relativistic energies experiments were begun using polarized deuteron beams of JINR

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synchrophasotron and INESS-ALPHA set-up [2,3]. The two-arm magnet spectrometer INESS-ALPHA incorporates 2000 channels of coordinate and spectrometric information, front-end electronics is located in seven crates of a standard CAMAC parallel branch highway [4,5]. The existed DAQ system of the set-up has not met new requirements, therefore a new DAQ system has been developed. As this was done the front-end electronics has not been changed. It was required, among other things, to enlarge a number of accepted events, to provide recording of the extracted beam data and accelerator parameters from remote control system of the accelerator and perform analysis of the experimental data during run. Under conditions of very limited expenditure some basic principles of the DAQ system development were formulated: low initial expenditure, use of standard means, possibility of modular extension.

2. The Application of Transputers

If the DAQ system for the spectrometer had been implemented, using single computer the unexeptable expenditure and complicated system would have been needed. So the system has multiprocessor structure: main computer plus add-on boards installed in its I/O slot. To provide an acceptable expenditure/performance ratio the IBM PC as the main computer and transputer-based add-on boards were selected. The advantages of the PC are well known: accessibility, low cost, it is provided with many HW and SW add-on's and good service.

Transputers are intended to serve as building blocks for real-time parallel systems [6]. Transputer (processor) compared to common microprocessor additionally contains in silicon internal RAM, timers, links and OS kernel. Members of the transputer product family are interconnected by their links — high speed serial duplex lines. There are processors, link adapters and programmable links commutators in the transputer family. The link adapter converts between serial link and parallel bus, link commutator provides a full crossbar switch between 32 link inputs and 32 link outputs.

To build a microcomputer using transputers one needs less additional ICs. A transputer gives to the system the following features:

— enlargement of data processing power;

— highly reliable interconnections;

— first-rate performance to stand-alone devices.

In accordance with the requirements during preparation and running the experiment the DAQ system comprises the following subsystems (Figure):

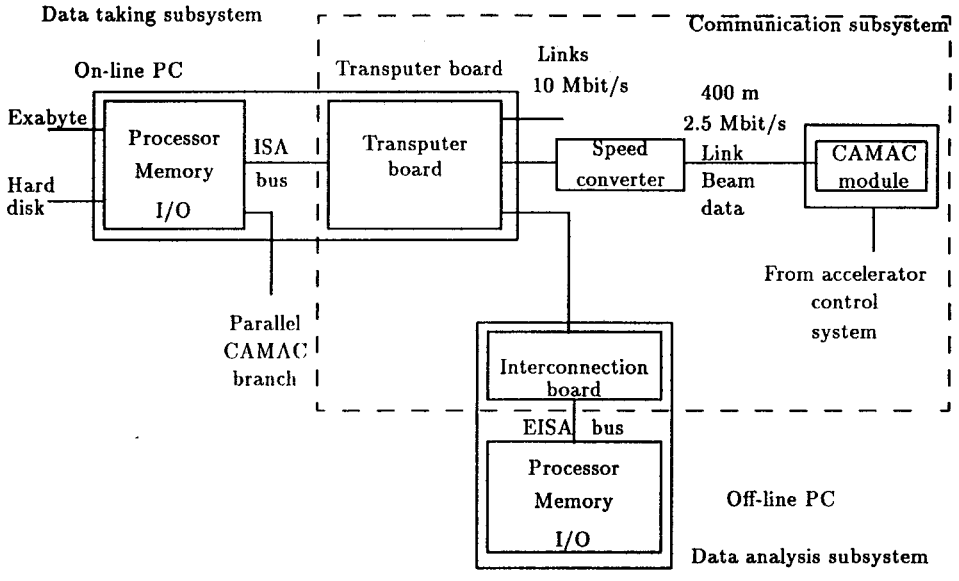

Figure. Structure diagram of the DAQ system

— data taking and on-line processing (consists of the on-line PC and transputer board);

— communication (transputer and interconnection boards, speed converter);

— data analysis during run (off-line PC).

The on-line PC reads data from the CAMAC branch, preprocesses them, builds the file and writes it to the hard disk. Between the accelerator cycles the data from the disk buffer are written to Exabyte tape and transmitted to the off-line PC for data analysis during the run.

The transputer board in the on-line PC uses transputer links to accept the data transferred from the accelerator control system and to synchronize processes in the subsystems. The transputer board incorporates processor T414, 1 Mbyte RAM and the interface of ISA-bus program channel implemented using the first transputer link and Link Adapter C011 [7]. Via the second transputer link the data describing the extracted beam and accelerator tuning from the accelerator control computer spaced at 400 meters are accepted. This data are transmitted by CAMAC module based on Link Adapter. The speed of a type transmission is 2.5 Mbit/sec. Thus the Link Adapter is used beyond the specification but no errors during the data transmission were detected. A speed converter implemented using two Link Adapters converts the bit speed after the receiver up to a standard for the transputer family value 10 Mbit/sec and transmits the byte to the transputer

board. The transputer transmits the data in the data file of events using interrupts in the on-line PC. The third link of the transputer is used to transmit data to the off-line PC via an add-on board with C011 placed in an I/O slot of the PC. For communication between the subsystems the message transmission mechanism is used.

During three runs in 1993—94 about 1.5 gigabyte of experimental data were stored to Exabyte tape. Different PCs were used in the course of the experiments: PC/386 ISA, 486 EISA, 486 ISA.

3. Promising Transputer-Like Microprocessors for DAQ systems

An intrinsic parallelism which has data acquisition and triggering usage and specific features of transputers made possible application of them in these systems [8]. A DAQ system for the general-purpose detector ZEUS at the HERA collider comprises 640 transputers [9].

New generation of Inmos transputer family offers increased computer power and higher speed links [10]. New generation components for HEP applications based on this ICs were developed [11]. A number of large experiments in HEP being planned (for example STAR) and those which have used transputers yet (for example ZEUS) consider them among other microprocessors as a promising means to use in the DAQ system. The most interesting for DAQ systems in HEP is the Inmos message routing chip C104.

Transputer had influence on microprocessor development. Large firms designed and produce transputer-like microprocessors, which are intended for multiprocessor systems development and furnished with communication channels (Texas Instruments TMS320C40, Motorola DSP96002, Analog Devices ADSP-21060). Quite a lot of new designs for trigger systems use C40, Motorola DSP96002 is also used. The new ADSP-21060 shows promise for the applications under consideration. The emergency of the Power PC with features well like a workstation but the cost much less gives an opportunity to develop DAQ systems having good performance/cost ratio on the base of the PC in conjunction with these new microprocessors.

4. Conclusions

The application of transputers in conjuction with IBM PC provided for the DAQ system a reliable means for a communication and a high-speed data processing power. The system reads up to 500 events per cycle (event

length is about 300 bytes), that gives the speed of data taking 150 Kbyte/sec. The system structure makes it possible autonomous debugging of the subsystems, data analysis during the run and modular extension of the system. In three runs 1.5 gigabyte of experimental data have been stored to Exabyte tape. The results of some experiments have been published [12,13]. New generation transputers and transputer-like microprocessors integrally with Power PC hold great promise for new DAQ systems of new experiments.

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