The Concept of Parallel Input/Output Processing for An Electron Linac

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Abstract

The instrumentation of and the control system for the PNC 10MeV CW electron linac are described. A new concept of parallel input/output processing for the linac has been introduced. It is based on a substantial number of input/output processors(IOP) using beam control and diagnostics. The flexibility and simplicity of hardware/software are significant advantages with this scheme.

1. Introduction

Recently much progress has been made in one of the methods called parallel architecture.[1] Today parallel architecture, which uses RISC (Reduced Instruction Set Computer) processors, advance in processor-to-processor communication schemes, solid support from mainstream vendors, and parallel processing, can be found not only in academic or large supercomputing facilities but also in the main stream of commercial computing[2].

However, such a parallel processing is constructed mainly for computation-intensive applications such as supercomputers which tackle with complex scientific problems. The benefits of parallel architecture are also applied to control a large number of peripheral devices in a short period of time and new approach to control. This new concept is called parallel input/output processor (PIOP) in this paper. In general, a conventional mainframe computer input/output control scheme has been used to reduce central processing unit(CPU) overhead with dedicated processors for each peripherals, which are called IOP (input/output processor). Even mini/micro computers have this configuration by downsizing of computer hardware. A conventional mini/micro computer system has interface circuits instead of IOPs. The IOP scheme seems to be parallel processor architecture but input/output data and memory can not be shared and processed simultaneously because of a shared-bus system. In other words, PIOP consists of a large number of IOPs which have unique high-speed communication bus between each IOPs, considerable fast computation power, and dedicate memory.

This paper reviews a new concept of a prospective PIOP control system for a PNC electron linac facility.

2. Outline of the system configuration

The distributed-memory MIMD or SIMD systems and loosely-coupled hypercube architecture are chosen to the configuration of PIOP architecture. The system diagram (Figure. 1) shows that the PIOP system operates in association with a conventional computer, which is called the front-end computer (or host), and a few ten of processors which are called nodes. The front-end computer and each node are connected with two

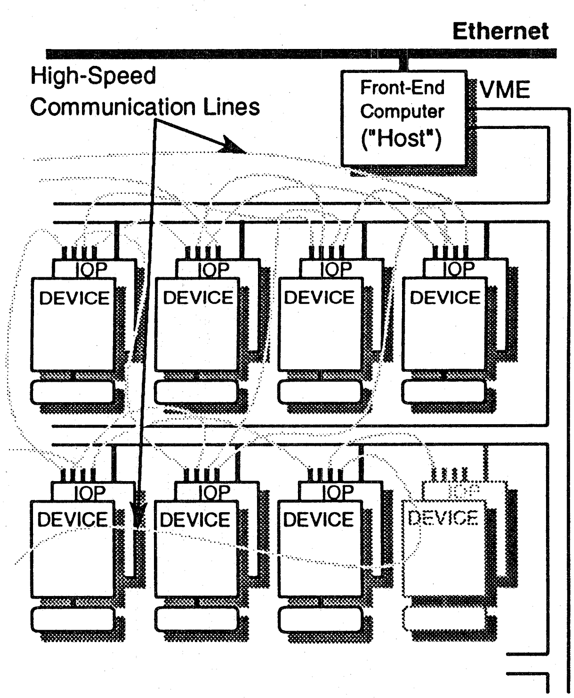

Figure. 1 The PIOP system diagram.

different communication lines. One is a conventional VME bus-based system that all processors must shear the same bus to access to the other processors one by one at a time. However, the VME bus is an industrial standard bus system, which has the advantages of many variety of hardware and software products. The other communication line is a high speed communication line (massage-passing network, loosely-coupled hypercube communication line) that supports message traffic between nodes. Messages can convey information between nodes, and also synchronize node activities. Messages containing data or code are copies of information resident on the sending node. They are sent through the message-passing network and delivered to other nodes. In general, the time required to pass messages is dependent on the speed of the hardware and the way the network is interconnected. A balanced system will exhibit message-passing performance that is comparable to computational performance.

3. PIOP nodes

Each PIOP node (Figure. 2) consists of a processor, distributed memory, high-speed communication ports, VME bus interface, and peripheral interface such as A/D and D/A converters. A digital signal processor(DSP) is a candidate for

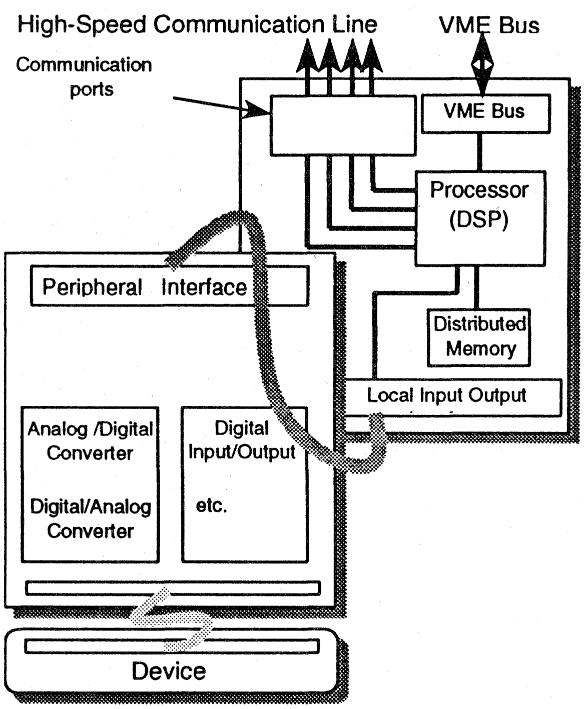

Figure. 2 The PIOP node diagram.

PIOP node processor because any application for analog electronic circuitry can be duplicated using DSP with the flexibility and simplicity of the analogy part of hardware. For parallel processing system, the processor should have both a floating-point CPU and parallel inter-processing communication channel ports which allow direct processor to processor communication over a point to point. That high speed communication ports are important components of the PIOP node to achieve the loosely coupled hypercube communication lines.

4. Discussion

The PIOP system will be applied to a beam control for an electron linac. The beam control contains controls and status displays for each individual linac equipment (an electron gun, an injection system, a beam transport system, and a beam dump, etc). The beam control is classified as part of a central control system which can be divided into five parts; the beam control, a operator's console, utility equipment for water-cooling, radiation monitor systems, and gas processing equipment. These systems are connected with the standard communication network(Ethernet with the TCP/IP protocol). The communication network is supervised by the system control processors which also manage the whole electron linac operation. Those processors are responsible for not crucial operations from the response time point of view because the processors manage the operations console and utility equipment.

The PIOP system (served as the beam control system) is interfaced with the linac equipment and each PIOP node connected with VME-bus and the high speed communication lines. Each PIOP node is connected with high speed communication lines as horizontally (or hypercube shape), which makes each node communicate with another node a short time as compared with shared bus system. A combination with high speed communication lines and the DSP (as node processor) makes fast data processing system for large number input parameters simultaneously. That data processing could not be achieved in conventional system. Such examples as beam current signals from each accelerator tube section are digitized by DSP and A/D converter and processed in each node processor at the same time.

5. Conclusion

The new concept of PIOP for the electron linac has been introduced. A substantial number of input/output processors are connected with high speeed communication networks as hypercube shape. The PIOP system is used to provide function which could not be obtained through the conventional data processing system.

The designing of PIOP system hardware and software for the electron linac is in progress.

References

[1] B. M. Boghosian, **COMPUTER IN PHYSICS** JAN/FEB 4-1 (1990) 14.

[2] D. Pountain and J. Bryan, **BYTE** August 17-8 (1992) 112.