A Feedback Test Bench Equipped with Digital Signal Processor

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1. Introduction

Microprocessors are used for many feedback and feedforward systems. A new kind of board level microcomputer DSP (Digital Signal Processor) has been developed rapidly and becomes a key technology in 1990s'. Its outstanding advantage of fast floating point calculation capacity made it possible to be the driving force behind many technology products.

For the purpose of local bump feedback control of the beam orbit for SPring-8 storage ring or other real-time feedback systems in future, we made a feedback test bench employing a DSP and tested its performances.

2. DSP Control System

2-1 Hardware Configuration.

DSP control system consists of three CPUs: 80X86 (host computer), Motorola's MC68030 (MVME) and TMS320C31 (DSP) as shown in Fig.1. The whole block of MVME and DSP and I/O boards surrounded by a broken line in Fig. 1 is called EAGLE 8000 series which is supported by MTT company.

The host computer and the MVME communicate each other by Ethernet. In EAGLE 8000, the MVME and the DSP communicate by VME bus. MTT-LINK master is used as DSP local I/O bus connected with I/O boards such as A/D, DIO, filter and clock.

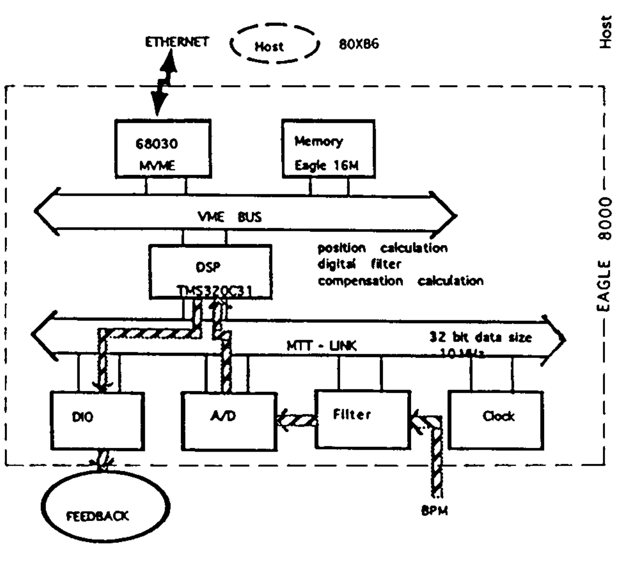

Fig. 1. The configuration of DSP system.

As shown in Fig.1, a filter is used as smoothing circuit of analog signal, for example, from beam position monitor (BPM). After the signal is changed into digital signal by A/D, the DSP calculates all the digital signals quickly according to the requirements from software and generates a feedback value to be written into DIO board which should drive the feedback loop.

2-2 Software Structure

Software structure of EAGLE 8000 is shown in Fig.2. There are three application softwares for Host, MVME and DSP, and two pairs of interface libraries between the host and the MVME, the MVME and the DSP. The interface libraries were provided by MTT Co.[1]. The host was equipped with compilers for three processors. The application softwares for three CPU's are written in C language and compiled to run on each processor. The programs are written to be bus independent.

Program for the host uses Microsoft C 6.0 development tools. Program for the DSP uses TI Company's (USA) developing tools. The MVME supports the communication between the host and the DSP.

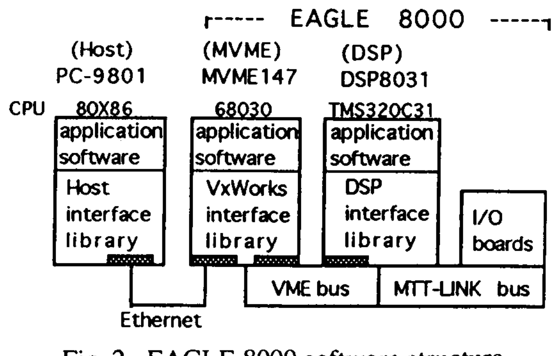

Fig. 2. EAGLE 8000 software structure

3. Feedback System and Test Principle

In the present experiment, instead of the beam orbit feedback, hall output voltage in the magnetic field was applied for controlled variable for the feedback control on the test bench as shown in Fig.3. A magnet, its power supply, a hall probe and its power supply were used as the devices for

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feedback test bench. The hall output voltage (controlled variable) is affected by the voltage of hall power supply (HPS) and also by the magnetic field (the current of magnet power supply).

Expected stabilization process in the test bench is as follows. When the change of the voltage of HPS is given as a disturbance, the DSP calculate the feedback value for magnet power supply, and the magnetic field changes if the feedback loop works. As the result, the hall output voltage (controlled variable) is expected to be stabilized.

I/O boards in Eagle 8000 series have the following specifications.

AI : input -1V - +1V, output 12 bits, resolution 0.5mV.
DO: output 12 bits. TTL level.
AO(home made DAC): input 0x800 - 0x7ff, 12 bits, output -4.0V - +4.0V.

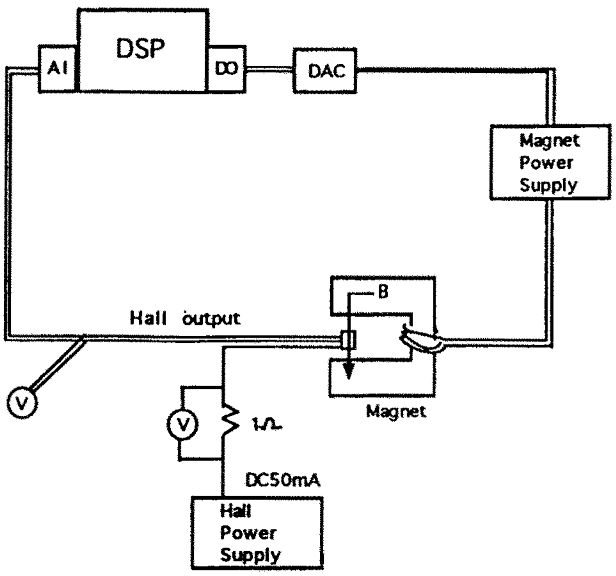

Fig. 3. The feedback test bench.

When AI is changed by the change of the voltage of HPS, DO is changed too. DO drives DAC to generate a corresponding output voltage which changes the current of magnet power supply. As the effects on the loop described above, AI value is stabilized.

The transfer function AI = f(DO) here is the simplest "P" mode and DSP calculates DO by:

$$DO = (REF-AI) * C + DO'$$

where

REF is a reference voltage.
DO is the current value of DO data register.
DO' is the previous value of DO register.
AI is the current value of AI data register.
C: Constant value

4. Test Result

Table 1 shows the voltage of HPS, AI and DO. The HPS was changed from 40.097 mV to 85.025 mV. The first part (40.097-45.091 mV) is no feedback region because of the saturation of DAC. Within the second part (50.082-85.025 mV), the feedback result is obvious. The experiment data shows that the voltage of HPS changed 41%, while the feedback result AI is almost stable (1% changed only) as shown in Fig.4.

Table 1.

	HPS(mV)	AI(mV)	DO(V)	
0	40.097	-7.7000	4.0000	saturated region
1	45.091	-8.6600	4.0000	
2	50.082	-9.5400	3.9000	linear region
3	55.074	-9.5400	3.6000	
4	60.066	-9.4900	3.2000	
5	65.059	-9.5700	2.9000	
6	70.049	-9.5100	2.7000	
7	75.038	-9.4700	2.4000	
8	80.034	-9.5000	2.4000	
9	85.025	-9.4700	2.2000	

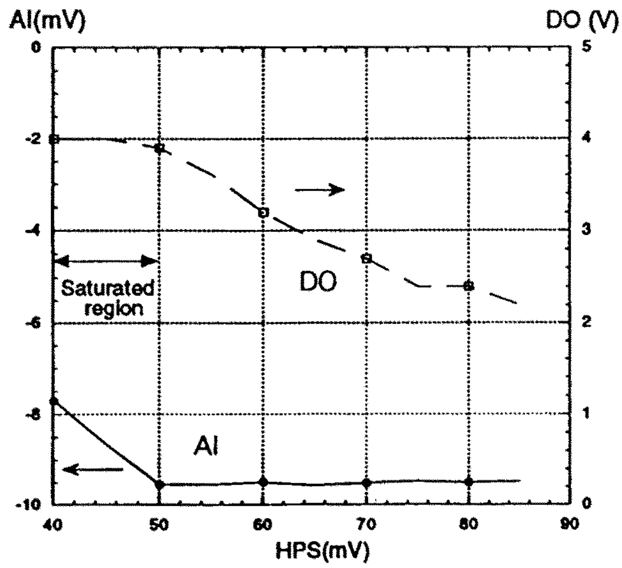

Fig. 4. Feedback result

5. Conclusion

The frame of hardware and software structure were almost completed. The test bench worked well. The feedback system we made is still in the beginning stage.

The feedback system with DSP will show more progresses by adding a FIR/IIR digital filter, modifying a feedback mode (PID or PI) and programming in assembly language.

Reference

[1] "EagleNet-Pc" interface library. Rev 1.11, MTT Co. Japan, (1993).