Digital Signal Processors

V Rajaraman

The fastest growing segment in microprocessors is the digital signal processor which is being integrated in devices such as cellular phones, modems and talking toys. In this article we look at their hardware architecture and describe how they differ from general purpose microprocessors.

Digital signal processors (DSP) are special purpose microprocessors which are optimized to process real-time signals (see Box 1) including audio and video signals. They are used nowadays in a variety of consumer products such as cellular phones, modems, audio systems and video game terminals, to cite a few. Their use is growing with the rising demand for high quality consumer products which process information in real-time. As they are widely used in cost sensitive consumer products their cost is a fraction of the cost of general purpose microprocessors such as Intel’s Pentium processors. A typical digital signal processor chip costs about Rs.400/- as opposed to a microprocessor used in PCs which cost around Rs.4000/-. In this article we will describe the hardware architecture of DSP chips and explain how they differ from the architecture of general purpose microprocessor chips.

Box 1. What is Real-time?

A telephone conversation between two persons is an example of a real-time process. Delay in reception of speech signals (even though not fatal) disturbs smooth flow of conversation. Another example of a real-time system is process control. A computer controlling the motion of a satellite should acquire signals from the satellite while it is in motion, compute corrections (if required) to the trajectory and send control signals back within a specified time for effective control. Delays may be fatal to the mission. Online systems are not necessarily real-time. For example, the systems used to reserve railway tickets is on-line as the work is done while the client is waiting but it is not real-time as clients can normally tolerate delays within reasonable bounds! A majority of DSP applications are real-time.
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In Figure 1 we give the block diagram of a digital signal processing system. Input signal to this system is analog, that is, it is a continuously varying signal such as music, an electrocardiogram or a continuous signal recorded by an instrument. The analog signal is sampled and digitized by the analog to digital converter and the digital information is input to the DSP. The DSP has a program which is used to process the digitized analog signal and give digital output (See Box 2).

The digital output is converted back to analog by a digital analog to converter (DAC). Conversion of the output to analog form is often necessary, for example, when music is replayed after noise is removed from the input by the DSP. One may wonder why an analog signal is converted to digital form, processed, and reconverted to analog form. The primary reason is noise immunity and the versatility of manipulating digital

Box 2  Programmability – A Boon to Designers

Signal Processing was earlier performed by hardware circuits specially designed for each application. The programmability of DSP allows a software-hardware solution to problems. Programmability allows the same DSP chip to be used in a large variety of applications – achieved by merely changing the stored program. Functionality of existing systems may be upgraded by just changing the program stored in the DSP’s memory. Many scientific instruments today use DSPs to enhance their performance and functionality.