DEVELOPMENT SYSTEM FOR DIGITAL SIGNAL PROCESSING APPLICATIONS

Victor P. P. Esteves, Guilherme F. Ribeiro, Fernando S. Schlindwein

Department of Electronic Engineering / EE
Biomedical Engineering Program / COPPE
Federal University of Rio de Janeiro

ABSTRACT

In this paper we describe a development station for projects based on the DSP TMS320C25 for real-time digital signal processing. The main purpose was the creation of a tool to help the development of solutions based on DSP, such as speech analyzer and synthesizers, fast digital controllers and Doppler ultrasound signal analyzers.

The station comprises four basic modules: a dedicated hardware which includes the TMS320C25, 32 kwords of data memory, 32 kwords of program memory and 16 bits audio band A/D-D/A converters; a host general-purpose microcomputer; the monitor/debugger software running both on the host computer and on the dedicated hardware, and a library containing a wide variety of DSP functions.

INTRODUCTION

With the spread of microcomputers the processing using dedicated hardware, such as the Word Slice Architeture of ADSP series (1), which performs specific functions, is no longer the only option for fast digital signal processing. The option to use boards with A/D and D/A converters in slots of the computer associated with software packages like ILS, DADiSP and LabWindows, has shown its versatility. It also speeds up the development of projects, with the corresponding cost reduction and commercial viability.

The option to use a general-purpose microcomputer associated with software packages brings in itself limitations such as low-speed processing, not allowing therefore real time processing of signals in the full audio band. Even using co-processors this structure is not capable of processing audio signals in real time. The development of single-chip DSPs has made that feasible. Due to the presence of hardware multipliers and a parallel structure of data and program the single-chip DSPs perform operations commonly used in signal processing, such as multiplying/accumulating with memory displacement, in a single machine cycle.

To sum it up: an FFT of 256 complex points takes 160 ms to run on an 8 MHz 80286, while on the 40 MHz TMS320C25 it takes 2.26 ms: a 70 times ratio.

DEVELOPMENT STATION

The development station consists basically of a PC compatible host computer and a dedicated hardware, based on the DSP TMS320C25.

Although some DSP boards are already available commercially in developed countries, in Brazil there are no such commercial boards. Also, most of these commercially available boards are intended to be "plug-in" boards for a personal computer, whilst our approach is that the DSP board is in itself the dedicated hardware/software solution, independent of the PC, which is only used during software development.

The serial connection of the microcomputer with the dedicated hardware was chosen to give the latter the option to operate in an autonomous way. The option to use "plug-in" boards, although providing a greater speed in data transmission, binds the operation of the DSP to the operation of the microcomputer.

FIGURE 1 - THE DEDICATED HARDWARE

The dedicated hardware, shown in figure 1 has 32 kwords of RAM program memory, 32 kwords of RAM data memory, an

analog to digital converter based on Burr-Brown's PCM75 (16 bits resolution and convertion time of 17 μs), a digital to analog converter based on Burr-Brown's PCM53-V (16 bits resolution , 3 μs settling time and slew rate of 10 V/μs), a keyboard and a display.

A monitor/debugger has been developed to act as the environment for developing small applications and debugging DSP programs in general. It is split in two programs: the first, written in TMS320 Assembly is stored in the 32 kword EPROM of the dedicate hardware. The other part, developed to run on the host computer, acts as the programing/debugging environment. The communication between the host computer and the DSP board is via a serial link.

The flowchart in figure 2 shows the development steps of a project using the station.

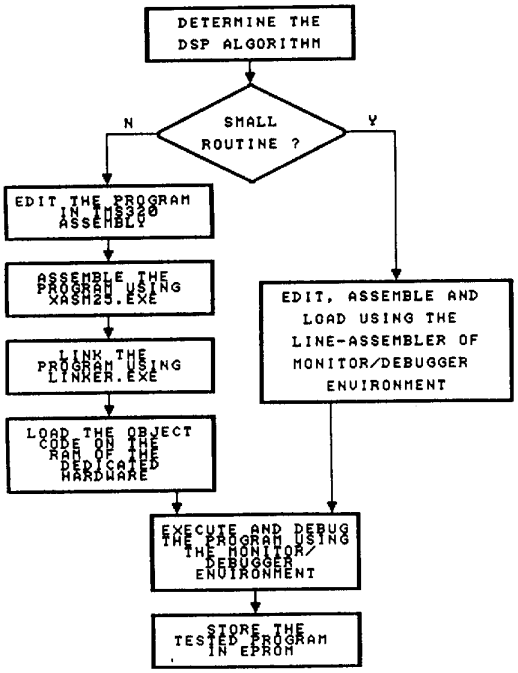

FIGURE 2 - DEVELOPMENT STEPS

The programs of digital signal processing to be executed by the TMS320C25 are developed on the host computer in TMS320 Assembly language and assembled using the Texas Instruments' XASM25.EXE assembler. A library of routines for DSP was developed, and the individual routines can be called by the application program and linked to it using the Texas Instruments' LINKER.EXE program.

Once the DSP program is assembled and linked, it may be loaded in RAM or stored in the EPROM of the dedicated hardware. As a matter of fact, the first form is an intermediate phase of the latter, namely, the application software is tested/debugged in RAM prior to storing it in EPROM, thus avoiding the need of reloading the application software every time the dedicated hardware is turned on. For some kinds of uses where one needs to change the application program in order to implement several applications using the same dedicated hardware, it may be necessary to keep monitor/debugger program in EPROM , loading each application on the RAM.

To test small routines a line-assembler was developed into the monitor /debugger environment. There is also a command to disassemble the code contained in the memory of the dedicated hardware, showing it in a mnemonic form. This command permits, among other things, a final visualization of a routine assembled and loaded by the line-assembler.

The execution of application programs on the monitor/debugger is realized by branching the execution to the beginning of the program to be tested. Software breakpoints are available and there is also the option to execute the program instruction by instruction showing the contents of internal register and/or memory positions previously set.

APPLICATION

To example one of several applications of developed station was implemented a real time audio signal spectrum analyzer, according to the diagram of figure 3.

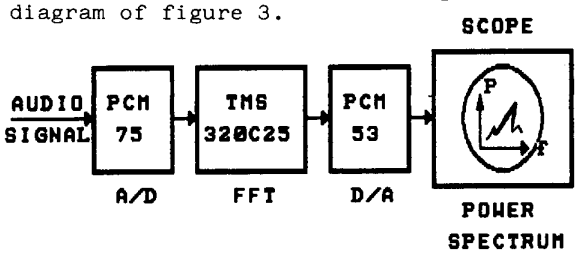

FIGURE 3 - AUDIO SPECTRUM ANALYZER

An audio signal is sampled (256 samples) and the TMS320C25 performs a Cooley-Turey 128 points, radix-2, DIF FFT (2). The result is the 128-points power spectrum which is showed on an oscilloscope.

REFERENCES

(1) AD,"Analog-Digital Convertion Handbook' pp.621-658: 1986.

(2) TI, "Digital Signal Processing Applications with the TMS320 Family", pp.69-170: 1986.

AUTHOR ADDRESS: Caixa Postal 68533
Rio de Janeiro-RJ-BRAZIL
CEP: 21.941
PHONE: (55) (21) 590 0788