DSP 技术原理与应用

Techniques And Applications *Of* DSP Chips

● 关华　胡秀蒙　庄华伟　著

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By

Guan Hua　Hu XiuMeng　Zhuang HuaWei

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Preface

About This Book

The term DSP stands for Digital Signal Processing, or the term DSPs stands for Digital Signal Processors.

Digital signal processing is one of the brightest spots in the semiconductor business today, and one of the few deserving the title "breakthrough." Like earlier advances in microprocessors and computer memories, digital signal processing is a foundation technology with the power to transform broad areas of the electronics industry. Its impact is being felt in applications as diverse as stereo systems, cars, personal computers, and cellular phones. In the next few years, digital signal processing will give rise to hundreds of new products and change what people expect from technology.

Digital Signal Processing is a technique that converts signals from real world sources (usually in analog form) into digital data that can then be analyzed.

A Digital Signal Processor is a special-purpose CPU (Central Processing Unit) that provides ultra-fast instruction sequences, such as shift and add, and multiply and add, which are commonly used in math-intensive signal processing applications.

The introduction of the microprocessor in the late 1970's and early 1980's made it possible for DSP techniques to be used in a much wider range of applications. DSP chips are used in sound cards, fax machines, modems, cellular phones, high-capacity hard disks and digital TVs. Among the numerous manufacturers, Texas Instruments (TI) is one of the major providers of DSPs.

The DSPs, the specifically designed microprocessors for handling Digital Signal Processing tasks, have some special features. This book is designed to introduce you to the common features, the architectures characteristics and applications of these devices, the DSPs. The TMS320C6000 platform from TI will be taken in this book as examples to do analysis and descriptions on the DSPs' applications.

In the first part of this book, which contains chapter 1 and 2, we give an overview on the Digital Signal Processing (DSP) and Digital Signal Processors (DSPs). The evolution and miscellaneous aspects on DSPs have also been described in details in this part. Part two of this book gives a detailed description on the DSPs' features and architectures. Taking the TMS320C6000 platform as an example, we make a thorough analysis and descriptions on every aspect of DSP devices in chapter 3 to 9, such as the CPU architecture, memory, peripherals, instruction set, pipeline operations and interrupts.

Part three of this book, chapter 10 to 14, may be served as a reference book for DSP design and applications. This part presents descriptions on the DSP developing tools and summarizes the DSPs' developing experiences undergone by the research team to which the authors belong. Specifically, this part complements the DSP knowledge by providing information to assist managers and hardware/software engineers in application development. It includes example code, hardware connections, design examples and schemes for various applications. It also defines the principles involved in many applications for instructional purposes.

This book was written for scientists and engineers in the field of DSP applications. The goal is to present practical techniques. Much of the information and data for TMS320 DSP was come from the TI's data books and data sheets. For more detailed information on these data, please refer to the original materials provided by Texas Instruments Incorporated.

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Special thanks go to the many reviewers who provided comments and suggestions on this book, and to the many technical staff members of TI and TI's distributor in Engineering and Marketing who provided invaluable materials and information during this project. Thanks are also due research team to which the authors belong for providing valuable materials and suggestions.

Authors of this book
Oct. 2006

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Part One

Overview

Digital signal processing is one of the brightest spots in the semiconductor business today, and one of the few deserving the title "breakthrough." Like earlier advances in microprocessors and computer memories, digital signal processing is a foundation technology with the power to transform broad areas of the electronics industry. Its impact is being felt in applications as diverse as stereo systems, cars, personal computers, and cellular phones. In the next few years, digital signal processing will give rise to hundreds of new products and change what people expect from technology.

Chapter 1

A Beginner's Guide to DSP

Have you noticed how everything is becoming digital these days – DSP filters, DSP modems, DSP transcievers and more – and for good reason. Digital representation of signals has many advantages over their analog counterparts:

- Fewer components;
- Stable, deterministic performance;
- Wide range of applications;
- No filter adjustments;
- Filters with much closer tolerances;
- Adaptive filters easily implemented.

Digital Signal Processing is so pervasive in everything, an amateur radio operator does and it is becoming an important tool. The part one of this book is designed to introduce you to DSP.

1.1 What is DSP?

The term DSP stands for Digital Signal Processing, or the term DSPs stands for Digital Signal Processors.

1.1.1 Digital Signal Processing

Digital Signal Processing is a technique that converts signals from real world sources (usually in analog form) into digital data that can then be analyzed. Analysis is performed in digital form because once a signal has been reduced to numbers, its components can be isolated, analyzed and rearranged more easily than in analog form.

Eventually, when the DSP has finished its work, the digital data can be turned back into an analog signal, with improved quality. For example, a DSP can filter noise from a signal, remove interference, amplify frequencies and suppress others, encrypt information, or analyze a complex wave form into its spectral components.

This process must be handled in real-time – which is often very quickly. For instance. stereo equipment handles sound signals of up to 20 kilohertz (20,000 cycles per second), requiring a DSP to perform hundreds of millions of operations per second.

1.1.2 Digital Signal Processor

A Digital Signal Processor is a special-purpose CPU (Central Processing Unit) that provides ultra-fast instruction sequences, such as shift and add, and multiply and add, which are commonly used in math-intensive signal processing applications.

DSPs are not the same as typical microprocessors though. Microprocessors are typically general purpose devices that run large blocks of software. They are not often called upon for real-time computation and they work at a slower pace, choosing a course of action, then waiting to finish the present job before responding to the next user command. A DSP, on the other hand, is often used as a type of embedded controller or processor that is built into another piece of equipment and is dedicated to a single group of tasks. In this environment, the DSP assists the general purpose host microprocessor.

Digital signal processing takes real-time, high-speed information, such as radio, sound or video signals, and manipulates it for a variety of purposes. Digital signal processing can restore vintage jazz recordings to their original clarity, erase the static from long-distance phone lines and enable satellites to pick out terrestrial objects as small as a golf ball. In cars, Digital Signal Processors (DSPs) create digital audio "surround sound" and are responsible for active suspension systems that adjust automatically to road conditions. In cellular phones, digital signal processing helps