Architectural Approaches for Multimedia Processing

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Sethuraman (Panch) Panchanathan, Senior Member IEEE

Visual Computing and Communications Laboratory
Department of Computer Science and Engineering
Arizona State University
P.O. Box 875406, Tempe, AZ 85287-5406
E-mail: panch@asu.edu

Abstract. The recent advances in VLSI technology, high-speed processor designs, Internet/Intranet implementations, broadband networks (ATM and ISDN) and compression standards (JPEG, MPEG, H.261, H.263 and G.273) are leading to the popularity of multimedia applications. Examples include, video over the internet, interactive TV, distance learning, telemedicine, and digital libraries. Multimedia refers to a combination of various media types including text, audio, 2D and 3D graphics, animation, images and video. Visual media (image, video and graphics) proliferation in multimedia applications demands high-powered compute engines, large storage devices, and high bandwidth networks for processing, storage, and transport of image/video data. Visual media processing poses challenges from several perspectives, specifically from the points of view of real-time implementation and scalability. There has been several approaches to obtain speedups to meet the computing demands in multimedia processing ranging from media processors to special purpose implementations. Note that a variety of parallel processing strategies are adopted in these implementations in order to achieve the required speedups. The objective of this paper to present a summary of the various architectural alternatives that exist for multimedia processing.

1. Introduction

Multimedia processing is becoming increasingly important because of the wide variety of applications. A variety of media processing techniques are typically used in multimedia processing environments to capture, store, manipulate and transmit multimedia objects such as text, handwritten data, audio objects, still images, 2D/3D graphics, animation and full-motion video. Example techniques include speech analysis and synthesis, character recognition, audio compression, graphics animation, 3D rendering, image enhancement and restoration, image/video analysis and editing, and video transmission. Multimedia computing presents challenges from the perspectives of both hardware and software. Each media in a multimedia environment requires different processes, techniques, algorithms and hardware. Hence, it is crucial
to design processor architectures that meets the computing requirements of the various media types.

Visual media in a multimedia system contains a significant amount of information, and correspondingly involves a large volume of data in contrast to the other media types. Uncompressed digital video requires 250 Mb/s to support studio quality transmission of NTSC images (480 lines x 720 pixels/line x 24 bits/pixel x 30 frames/s). Even a simpler application such as video telephony (240 lines x 360 pixel/line x 16 bits/pixel x 10) requires 14 Mb/s to transmit the digital video signal in raw format. The bandwidth and storage requirements of visual information typically make it difficult to manage the data in its raw form. However, there is considerable redundancy in video data, both from an information theoretic view point as well as from the perspectives of structural content and human perception. A number of image and video compression standards, e.g., MPEG-1, MPEG-2 [1] and H.263[2] have been recently proposed to compress the visual data for a variety of transmission and/or storage applications. There is ongoing research and standardization efforts targeted towards future multimedia applications including MPEG-4 [3] and MPEG-7 [4] with the objective of integrating compression and content access functionality. These techniques and standards will involve execution of complex video processing tasks in real-time. The challenges can range from waveform coding implementations to scene modeling and understanding. For example, the principal objective of model-based image coding [5] or intelligent image coding is to understand the scene by modeling the objects to achieve a higher level representation. In addition, there is an increasing interest in 3-D image and stereoscopic video processing.

The complexity, variety of techniques and tools, and the high computation, storage and I/O bandwidths associated with visual processing pose several challenges, particularly from the point of view of real-time implementation. This is the principal reason for the slant of most media processor development towards visual processing. Several processing solutions ranging from multimedia extensions to general purpose processors such as the Intel MMX, programmable DSP architectures such as the TI-C6x series, Media processors like the Philips Trimedia processor, and special purpose architectures such as the C-Cube MPEG decoder chip-sets have been proposed to implement a variety of multimedia (particularly visual) processing operations.

The paper is organized as follows. The issues in multimedia hardware design is presented in section 2. The design trends in multimedia processor architectures are detailed in section 3. The conclusions are presented in section 4 followed by the references.

2. Issues in Multimedia Hardware Design

Multimedia applications require efficient VLSI implementations for various media processing algorithms. Emerging multimedia standards and algorithms will result in hardware systems of high complexity. In addition to recent advances in enabling VLSI technology for high density and fast circuit implementations, special