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An Efficient Reduction of Are In MultistandardTransform Core Sharing Using Common Sharing Distributed Arithmetic

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ABSTRACT

This paper proposes a low-cost high-throughputmultistandard transform (MST) core, which can support MPEG-1/2/4 (8 × 8), H.264 (8 × 8, 4 × 4), and VC-1 (8 × 8, 8 × 4,4×8, 4×4) transforms. Common sharing distributed arithmetic(CSDA) combines factor sharing and distributed arithmetic sharingtechniques, efficiently reducing the number of adders for highhardware-sharing capability. This achieves a 44.5% reductionin adders in the proposed MST, compared with the directimplementation method. With eight parallel computation paths,the proposed MST core has an eightfold operation frequencythroughput rate. Measurements show that the proposed CSDAMSTcore achieves a high-throughput rate of 1.28 G-pels/s,supporting the (4928×2048@24 Hz) digital cinema or ultrahighresolution format. This is possible only with 30k gate countswhen implemented in a TSMC 0.18-μm CMOS process. TheCSDA-MST core thus achieves a high-throughput rate supportingmultistandard transformationsat low cost.

1.1Introduction:

Transforms are widely used in video and image applications. Several groups, such as The International Organization for Standardization (ISO), International Telecommunication Union Telecommunication Standardization Sector (ITU-T), and Microsoft Corporation, have developed various transform dimensions and coefficients, corresponding to different applications. Numerous researchers have worked on transform core designs, including discrete cosine transform (DCT) and integer transform, using distributed arithmetic (DA) factor sharing (FS) and matrix decomposition methods to reduce hardware cost. The inner product can be implemented using ROMs and accumulators instead of multipliers to reduce the area cost. Yu and Swartzlander present an efficient method for reducing ROMs size with recursive DCT algorithms. Although ROMs are likely to scale much better than other circuits with shrinking technology nodes, several ROM-free DA architectures have recently emerged. Shams et al. employ a bit-level sharing scheme to construct the adder-based butterfly matrix, called new DA (NEDA). To improve the throughput rate of the NEDA method, high-throughput adder trees are introduced in. Chang et aloes a delta matrix to share hardware resources using the FS method. They derive matrices for multi standards as linear combinations from the same matrix and delta matrix, and show that the coefficients in the same matrix can share the same hardware resources by factorization To further reduce the area, Qi et al. present optimization strategies for FS and adder sharing (AS) for multistandard (MST) applications. Fan and Su use the matrix decomposition method to establish the sharing circuit. Matrices for VC-1 transformations can be decomposed into several small matrices, a number of which are identical for different points transforms. Hardware resources can be shared. Moreover, other pervious works on hardware resource sharing are presented. Recently, reconfigurable architectures have been presented as a solution to achieve a good flexibility of processors in field-programmable gate array (FPGA) platform or application-specific integrated circuit (ASIC), such as AsAP, Ambric , MORA , and Smart Cell . Although these reconfigurable architectures have the feature of flexibility, the pure ASIC design can be recommended for a fixed customer application suitably. Because of the same properties in DCT and integer transform

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applied to Moving Picture Experts Group (MPEG) and Windows Media Video 9 (WMV-9/VC-1) , many MST cores are presented Hwangbo and Kyung introduce a fully supported transform core for the H.264 standard, including 8 × 8 and 4 × 4 transforms.

1.2 Literature Survey:

S. Uramoto, Y. Inoue, A. Takabatake, J. Takeda, Y. Yamashita, H. Terane, are proposed A 100-MHz two-dimensional discrete cosine transform (DCT) core processor applicable to the real-time processing of HDTV signals is described. An excellent architecture utilizing a fast DCT algorithm and multiplier accumulators based on distributed arithmetic have contributed to reducing the hardware amount and to enhancing the speed performance. A layout scheme with a column-interleaved memory and a new ROM circuit are introduced for the efficient implementation of memory-based signal processing circuits. Furthermore, mean values of errors generated in the core were minimized to enhance the computational accuracy with the word-length constraints. Consequently, it features the fastest operating speed and the smallest area with sufficient accuracy to satisfy the specifications in CCITT recommendation H.261. The core integrates about 102 K transistors and occupies 21 mm^2 using 0.8-μm double-metal CMOS technology.S. Yu and E. E. Swartzlander are proposed an efficient method for implementing the Discrete Cosine Transform (DCT) with distributed arithmetic. While conventional approaches use the original DCT algorithm or the even-odd frequency decomposition of the DCT algorithm, the proposed architecture uses the recursive DCT algorithm and requires less area than the conventional approaches, regardless of the memory reduction techniques employed in the ROM Accumulators (RACs). An efficient architecture for implementing the scaled DCT with distributed arithmetic is also proposed. The new architecture requires even less area while keeping the same structural regularity for an easy VLSI implementation. A comparison of synthesized DCT processors shows that the proposed method reduces the hardware area of regular and scaled DCT processors by 17 percent and 23 percent, respectively, relative to a conventional design. With the row-column decomposition method, the proposed architectures can be easily extended to compute the two-dimensional DCT required in many image compression applications such as HDTV. M. Butts, is proposed Programming MPPAs for complex real-time embedded applications is difficult with conventional multiprogramming models, which usually treat communication and synchronization separately. Based on a programming model for massively parallel embedded computing that is reasonable and productive for software developers, we developed a scalable MPPA chip architecture that delivers tera-ops performance with very good energy efficiency in an ordinary 130-nm ASIC. This MPPA's architecture is based on the structural object programming model, which composes strictly encapsulated processing and memory objects in a structure of self-synchronizing channels. Small RISC CPUs and memories execute the objects.Y. J. Yu and Y. C. Lim, are proposed A popular technique in the design of multiplierless FIR filters explores the common subexpression sharing when the filter coefficients are optimized. In these techniques, the coefficient multiplier are realized as a multiplier block (MB) with shared shifters and adders. Many researches showed that the power consumption of a MB is often not simply proportional to the number of adders but is rather very much dependent on the adder depth of every coefficient. In this paper, an optimization technique is proposed to design the MB with constrained adder depth to achieve low power consumption. Numerical examples show that the proposed algorithm generates filters using less adders with low adder depth.

CHAPTER 2

2.1 Introduction to MPEG-4:

MPEG-1 is a standard for lossy compression of video and audio. It is designed to compress VHS-quality raw digital video and CD audio down to 1.5 Mbit/s (26:1 and 6:1 compression ratios respectively) without excessive quality loss, making video CDs, digital

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cable/satellite TV and digital audio broadcasting (DAB) possible. Today, MPEG-1 has become the most widely compatible lossy audio/video format in the world, and is used in a large number of products and technologies. Perhaps the best-known part of the MPEG-1 standard is the MP3 audio format it introduced. The MPEG-1 standard is published as ISO/IEC 11172 – Information technology Coding of moving pictures and associated audio for digital storage media at up to about 1.5 Mbit/s. The standard consists of the following five Parts:

1. Systems (storage and synchronization of video, audio, and other data together)

2. Video (compressed video content)

3. Audio (compressed audio content)

4. Conformance testing (testing the correctness of implementations of the standard)

5. Reference software (example software showing how to encode and decode according to the standard).

2.2 Moving Picture Experts Group:

Modeled on the successful collaborative approach and the compression technologies developed by the Joint Photographic Experts Group and CCITT's Experts Group on Telephony (creators of the JPEG image compression standard and the H.261 standard for video conferencing respectively) the Moving Picture Experts Group (MPEG) working group was established in January 1988. MPEG was formed to address the need for standard video and audio formats, and build on H.261 to get better quality through the use of more complex encoding methods.Development of the MPEG-1 standard began in May 1988. 14 video and 14 audio codec proposals were submitted by individual companies and institutions for evaluation. The codecs were extensively tested for computational complexity and subjective (human perceived) quality, at data rates of 1.5 Mbit/s. This specific bitrate was chosen for transmission over T-1/E-1 lines and as the approximate data rate of audio CDs. The codes that excelled in this testing were utilized as the basis for the standard and refined further, with additional features and other improvements being incorporated in the process. After 20 meetings of the full group in various cities around the world, and 4½ years of development and testing, the final standard (for parts 1–3) was approved in early November 1992 and published a few months later. The reported completion date of the MPEG-1 standard, varies greatly: a largely complete draft standard was produced in September 1990, and from that point on, only minor changes were introduced.The draft standard was publicly available for purchase.

Part 1: Systems:

Part 1 of the MPEG-1 standard covers systems, and is defined in ISO/IEC-11172-1.MPEG-1 Systems specifies the logical layout and methods used to store the encoded audio, video, and other data into a standard bit stream, and to maintain synchronization between the different contents. This file format is specifically designed for storage on media, and transmission over data channels that are considered relatively reliable. Only limited error protection is defined by the standard, and small errors in the bit stream may cause noticeable defects.

2.4 Multiplexing:

To generate the PS, the multiplexer will interleave the (two or more) packetized elementary streams. This is done so the packets of the simultaneous streams can be transferred over the same channel and are guaranteed to both arrive at the decoder at precisely the same time. This is a case of time-division multiplexing. Determining how much data from each stream should be in each interleaved segment (the size of the interleave) is complicated, yet an important requirement. Improper interleaving will result in buffer underflows or overflows, as the receiver gets more of one stream than it can store (eg. audio), before it gets enough data to decode the other simultaneous stream (eg. video). The MPEG Video Buffering Verifier (VBV) assists in determining if a multiplexed PS can be decoded by a device with a specified data

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throughput rate and buffer size. This offers feedback to the muxer and the encoder, so that they can change the mux size or adjust bitrates as needed for compliance.

Part 2: Video:

Part 2 of the MPEG-1 standard covers video and is defined in **ISO/IEC-11172-2**. The design was heavily influenced by H.261.MPEG-1 Video exploits perceptual compression methods to significantly reduce the data rate required by a video stream. It reduces or completely discards information in certain frequencies and areas of the picture that the human eye has limited ability to fully perceive. It also exploits temporal (over time) and spatial (across a picture) redundancy common in video to achieve better data compression than would be possible otherwise. (See: Video compression)

2.5 Color space:

Before encoding video to MPEG-1, the color-space is transformed to Y'CbCr (Y'=Luma, Cb=Chroma Blue, Cr=Chroma Red). Luma (brightness, resolution) is stored separately from chroma (color, hue, phase) and even further separated into red and blue components. The chroma is also subsampled to 4:2:0, meaning it is reduced by one half vertically and one half horizontally, to just one quarter the resolution of the video.This software algorithm also has analogies in hardware, such as the output from a Bayer pattern filter, common in digital colour

2.5.1 Resolution/Bitrate:

MPEG-1 supports resolutions up to 4095×4095 (12-bits), and bitrates up to 100 Mbit/s.MPEG-1 videos are most commonly seen using Source Input Format (SIF) resolution: 352x240, 352x288, or 320x240. These low resolutions, combined with a bit rate less than 1.5 Mbit/s, make up what is known as a constrained parameters bit stream (CPB), later renamed the "Low Level" (LL) profile in MPEG-Cameras.

2. This is the minimum video specifications any decoder should be able to handle, to be considered MPEG-1 compliant. This was selected to provide a good balance between quality and performance, allowing the use of reasonably inexpensive hardware of the time.

2.5.2 Frame/picture/block types:

MPEG-1 has several frame/picture types that serve different purposes. The most important, yet simplest, is I-frame. I-frames I-frame is an abbreviation for Intra-frame, so-called because they can be decoded independently of any other frames. They may also be known as I-pictures, or key frames due to their somewhat similar function to the key frames used in animation. I-frames can be considered effectively identical to baseline JPEG images. High-speed seeking through an MPEG-1 video is only possible to the nearest I-frame. When cutting a video it is not possible to start playback of a segment of video before the first I-frame in the segment (at least not without computationally intensive re-encoding). For this reason, I-frame-only MPEG videos are used in editing applications.

2.5.3 P-frames:

P-frame is an abbreviation for Predicted-frame. They may also be called forward-predicted frames, or inter-frames (B-frames are also inter-frames). P-frames exist to improve compression by exploiting the temporal (over time) redundancy in a video. P-frames store only the difference in image from the frame (either an I-frame or P-frame) immediately preceding it (this reference frame is also called the anchor frame).

2.5.4 B-frames:

B-frame stands for bidirectional-frame. They may also be known as backwards-predicted frames or B-pictures. B-frames are quite similar to P-frames, except they can make predictions using both the previous and future frames

2.5.5 D-frames:

MPEG-1 has a unique frame type not found in later video standards. D-frames or DC-pictures are independent images (intra-frames) that have been

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encoded DC-only (AC coefficients are removed—see DCT below) and hence are very low quality. D-frames are never referenced by I-, P- or B- frames. D-frames are only used for fast previews of video, for instance when seeking through a video at high speed. **MPEG-4** is a method of defining compression of audio and visual (AV) digital data. It was introduced in late 1998 and designated a standard for a group of audio and video coding formats and related technology agreed upon by the ISO/IEC Moving Picture Experts Group (MPEG) (ISO/IEC JTC1/SC29/WG11) under the formal standard ISO/IEC 14496 – Coding of audio-visual objects. Uses of MPEG-4 include compression of AV data for web (streaming media) and CD distribution, voice (telephone, videophone) and broadcast television applications.

2.6 INFORMATION ON MPEG-4:

MPEG-4 absorbs many of the features of MPEG-1 and MPEG-2 and other related standards, adding new features such as (extended) VRML support for 3D rendering, object-oriented composite files (including audio, video and VRML objects), support for externally-specified Digital Rights Management and various types of interactivity. AAC (Advanced Audio Coding) was standardized as an adjunct to MPEG-2 (as Part 7) before MPEG-4 was issued.MPEG-4 is still a developing standard and is divided into a number of parts. Companies promoting MPEG-4compatibility do not always clearly state which "part" level compatibility they are referring to. The key parts to be aware of are MPEG-4 part 2 (including Advanced Simple Profile, used by codecs such as DivX, Xvid, Nero Digital and 3ivx and by Quicktime 6) and MPEG-4 part 10 (MPEG-4 AVC/H.264 or Advanced Video Coding, used by the x264 encoder, by Nero Digital AVC, by Quick time 7, and by high-definition video media like Blu-ray Disc).Most of the features included in MPEG-4 are left to individual developers to decide whether to implement them. This means that there are probably no complete implementations of the entire MPEG-4 set of standards. To deal with this, the standard includes the concept of "profiles" and "levels", allowing a specific set of capabilities to be defined in a manner appropriate for a subset of applications. Initially, MPEG-4 was aimed primarily at low bit-rate video communications; however, its scope as a multimedia coding standard was later expanded. MPEG-4 is efficient across a variety of bit-rates ranging from a few kilobits per second to tens of megabits per second. MPEG-4 provides the following functions:

2.6.1 MPEG-4:

MPEG-4 provides a series of technologies for developers, for various service-providers and for end users:MPEG-4 enables different software and hardware developers to create multimedia objects possessing better abilities of adaptability and flexibility to improve the quality of such services and technologies as digital television, animation graphics, the World Wide Web and their extensions. Data network providers can use MPEG-4 for data transparency. With the help of standard procedures, MPEG-4 data can be interpreted and transformed into other signal types compatible with any available network. The MPEG-4 format provides end users with a wide range of interaction with various animated objects.Standardized Digital Rights Management signaling, otherwise known in the MPEG community as Intellectual Property Management and Protection (IPMPThe MPEG-4 format can perform various functions, among which might be the following:Multiplexes and synchronizes data, associated with media objects, in such a way that they can be efficiently transported further via network channels.Interaction with the audio-visual scene, which is formed on the side of the receiverMPEG-4 provides a large and rich set of tools for encoding. Subsets of the MPEG-4 tool sets have been provided for use in specific applications. These subsets, called 'Profiles', limit the size of the tool set a decoder is required to implement. In order to restrict computational complexity, one or more 'Levels' are set for each Profile. A Profile and Level combination allows: A codec builder to implement only the subset of the standard needed, while maintaining interworking with other MPEG-4 devices that implement the same combination.Checking whether MPEG-4 devices comply with the standard, referred to as conformance testing.

2.6.2 Advanced Video Coding (AVC) :

H.264/MPEG-4 Part 10 or AVC (Advanced Video Coding) is a standard for video compression, and is currently one of the most commonly used formats for the recording, compression, and distribution of high definition video. The final drafting work on the first version of the standard was completed in May 2003.H.264/MPEG-4 AVC is a block-oriented motion-compensation-based codec standard developed by the ITU-TVideo Coding Experts Group (VCEG) together with the International Organization for Standardization (ISO)/International Electro technical Commission (IEC) Moving Picture Experts Group (MPEG). It was the product of a partnership effort known as the Joint Video Team (JVT). The ITU-T H.264 standard and the ISO/IEC MPEG-4 AVC standard (formally, ISO/IEC 14496-10 – MPEG-4 Part 10, Advanced Video Coding) are jointly maintained so that they have identical technical content.H.264 is perhaps best known as being one of the codec standards for Blu-ray Discs; all Blu-ray Disc players must be able to decode H.264. It is also widely used by streaming internet sources, such as videos from Vimeo, YouTube, and the iTunes Store, web software such as the Adobe Flash Player and Microsoft Silver light, broadcast services for DVB and SBTVD, direct-broadcast satellite television services, cable television services, and real-time videoconferencing. The intent of the H.264/AVC project was to create a standard capable of providing good video quality at substantially lower bit rates than previous standards (i.e., half or less the bit rate of MPEG-2, H.263, or MPEG-4 Part 2), without increasing the complexity of design so much that it would be impractical or excessively expensive to implement. An additional goal was to provide enough flexibility to allow the standard to be applied to a wide variety of applications on a wide variety of networks and systems, including low and high bit rates, low and high resolution video, broadcast, DVD storage, RTP/IP packet networks, and ITU-T multimedia telephonysystems.The H.264 standard can be viewed as a "family of standards", the members of which are the profiles described below. A specific decoder decodes at least one, but not necessarily all profiles. The decoder specification describes which of the profiles can be decoded.The H.264 name follows the ITU-T naming convention, where the standard is a member of the H.26x line of VCEG video coding standards; the MPEG-4 AVC name relates to the naming convention in ISO/IECMPEG, where the standard is part 10 of ISO/IEC 14496, which is the suite of standards known as MPEG-4. The standard was developed jointly in a partnership of VCEG and MPEG, after earlier development work in the ITU-T as a VCEG project called H.26L. It is thus common to refer to the standard with names such as H.264/AVC, AVC/H.264, H.264/MPEG-4 AVC, or MPEG-4/H.264 AVC, to emphasize the common heritage. Occasionally, it is also referred to as "the JVT codec", in reference to the Joint Video Team (JVT) organization that developed it. (Such partnership and multiple naming is not uncommon. For example, the video codec standard known as MPEG-2 also arose from the partnership between MPEG and the ITU-T, where MPEG-2 video is known to the ITU-T community as H.262.[1]) Some software programs (such as VLC media player) internally identify this standard as AVC1.

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