AMD
Smarter Choice

ATI Avivo™ HD

Technology Brief (July 2008)

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INTRODUCTION

High Definition (HD) content is gaining in popularity among consumers looking for an immersive entertainment experience, thanks to the increasing availability and affordability of HD capable TVs and displays, in combination with a faster pace of releases of movie titles on both HD DVD and Blu-ray Discs.

Given that the PC has been the vehicle of choice for delivery of different types of digital content, PC manufacturers started providing an ecosystem of components for HD playback like new optical drives. However, upgrading current PCs with new Blu-ray and/or HD DVD optical drives does not guarantee that the rest of the PC components will have sufficient processing capability for fully featured and acceptable HD content playback that presents many challenges, including: large quantities of data processing (up to 6 times the rendering required for SD), computational complexity of algorithms for decode (e.g. CABAC), post processing and power consumption in software (CPU) or GPU assisted decoding scenarios.

Here we aim to look at the challenges of HD playback on the PC and the dedicated set of technologies implemented by AMD on GPUs in order to help provide efficient and high quality HD playback. This set of video and display technologies is named ATI Avivo™ HD.

SEAMLESS & EFFICIENT HD PLAYBACK

Unified Video Decoder (UVD)

In order to enable full HD video decode on a complete range of PC graphics solutions, AMD introduced the Unified Video Decoder, or UVD, commencing with ATI Radeon™ HD 2600 and ATI Radeon™ HD 2400 family of products, and continuing with later ATI Radeon™ HD 3000 series. UVD is a dedicated video decoding block that facilitates the full, bit accurate, decoding of VC-1 or H.264/AVC encoded video. Figure 1 shows a functional diagram of the decoding stages of UVD.

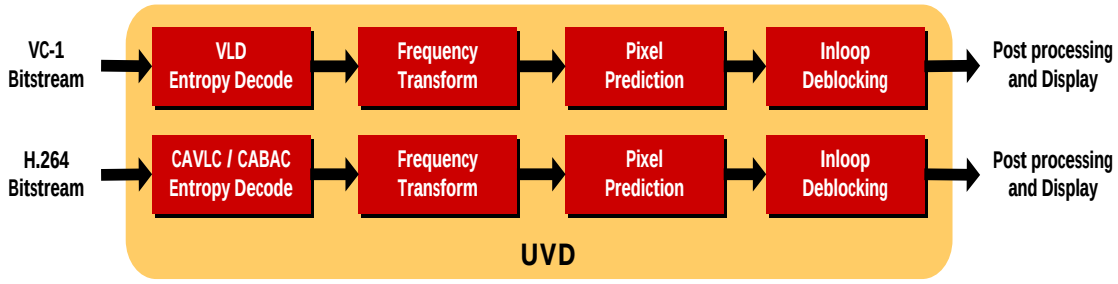
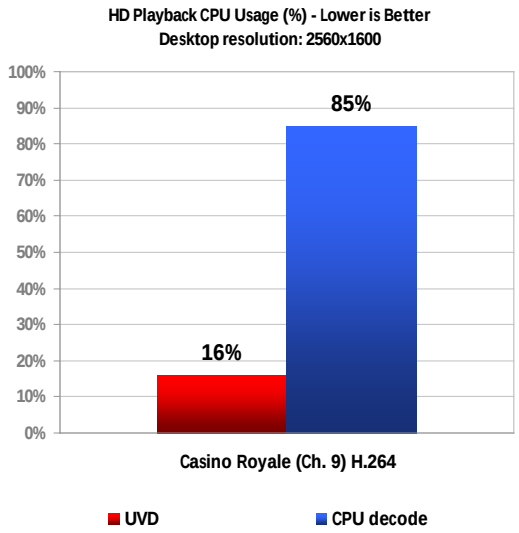


Figure 1: AMD's Unified Video Decoder

By utilizing dedicated hardware for the decoding of VC-1 and H.264 with UVD, the CPU is completely alleviated from the video decoding process, including the CPU intensive entropy decoding stage. The net result of removing the entire decoding process off of the CPU to the graphics processor is that it frees up significant CPU cycles.



System: AMD Athlon 64 X2 6400+ 3.2 GHz 2GB RAM
Windows Vista® Ultimate

Figure 2: Example of CPU utilization during H.264 playback

In Figure 2, CPU utilization is measured during playback of chapter 9 of the movie Casino Royale[1], encoded in H.264 at 1080p. UVD decoding sends the CPU utilization to very low levels, in this case there is only 16% utilization – equating to a removal of approximately 70% of the CPU cycles that would have been spent decoding the video under the CPU decode case. In fact, of the remaining 16% CPU utilization is the OS and application overhead required when playing back from an HD optical source. With UVD, VC-1 decoding benefits as well from the same low CPU utilization.

One consequence of switching processing from a CPU based software decoding to a dedicated processing solution on the GPU is that of lower overall system power utilization. An area where this can be of particular benefit is in a notebook PC with HD playback processing placing a greater burden on the battery. For desktop computers used as Home Theater PCs (HTPCs) this means lower CPU fans rotations, and a quieter environment during video playback.

2nd generation: UVD 2

In November 2007, the Blu-ray Disc Association (BDA) approved additional requirements for Blu-ray Discs, known as profile 1.1. The main change was the introduction of dual stream playback requirement with picture-in-picture, also known as *Bonus View* feature on Blu-ray Discs. Adding decode of a second stream represents an additional challenge for the CPU, especially for movies encoded in H.264 format. As new Blu-ray titles started to be released with this feature since the beginning of 2008, it has become important to enable dual stream decode for smooth playback of Blu-ray Discs.

With the ATI Radeon™ HD 4800 series, the UVD block has been redesigned to answer this new playback requirement. Second generation UVD 2 offloads the CPU from decoding two video streams; they will then be composited by the GPU's stream processing units to generate a picture-in-picture image on the display (Figure 3). With UVD 2, three codecs are decoded by hardware: VC-1, H.264 and MPEG-2.

[1] Casino Royale © 2006 Metro-Goldwyn-Mayer Inc.

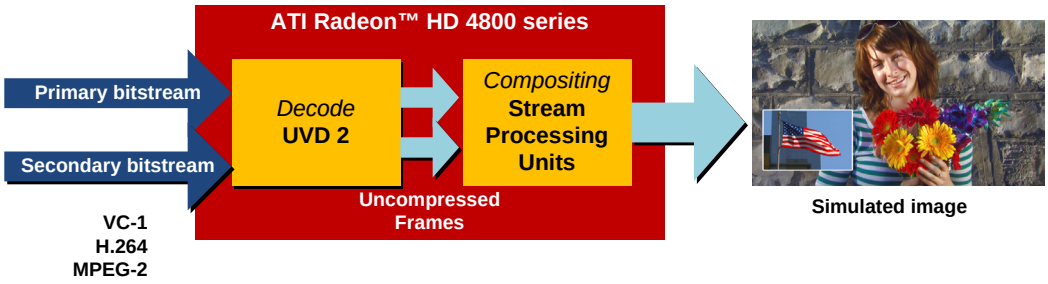


Figure 3: Dual stream (picture-in-picture) playback with UVD 2

CLEAR & CRISP IMAGE QUALITY

ATI Avivo™ HD post processing

The video frames decoded from a video stream can go through post processing in order to improve the image quality and correct visual artifacts from the source video during production or editing; artifacts introduced by the compression or broadcast of the content or simply by the scaling process when the source video is encoded at a lower resolution than the display.

Each user can have a preference for a different set of visual controls like colors or sharpness. ATI Avivo™ HD features different video quality enhancements and controls to provide users with a superior visual experience during playback, independently from the source of the video, HD as well as SD.

We expose in the following the main video quality features of ATI Avivo™ HD:

Advanced De-interlacing and Inverse Telecine

HD content on optical discs is usually encoded as series of full progressive frames, mainly in 1080p resolution. However, interlaced video remains dominant today as most broadcast video (SD and HD) is interlaced as well as standard DVD discs. Playback of interlaced video on progressive displays requires the conversion of the content from interlaced – two fields representing half the vertical resolution each, to a full vertical resolution progressive frame; this process is called de-interlacing.

Figure 4: De-interlacing algorithms

There are different algorithms to de-interlace video; the most basic ones are replication of lines a field ("weave") and averaging of lines of a field ("bob"). ATI Avivo™ HD includes advanced de-interlacing algorithms that take into account the temporal element of the video improving dramatically the visual quality of the picture (Figure 4).

Inverse Telecine, also known as "pulldown detection", is another sophisticated post-processing needed for a seamless and smooth playback of movie titles encoded in interlaced format. This is important to get the best image quality with titles created originally on film at 24 frames per second (fps) progressive, but encoded as interlaced video at 30 fps on optical discs like DVDs. At encode time, 6 intermediate frames are duplicated to achieve 30fps from 24fps; this group of frames is called pulldown sequence. There are several types of pulldown sequences; the most common for film is 3:2 pulldown.

Playback of such interlaced video on progressive monitors requires the detection of the type of pulldown sequence to remove it and playback only the original frames in order to deliver seamless playback with superior visual quality. This is achieved by Inverse Telecine post processing, another advanced post-processing feature in ATI Avivo™ HD.

Enhanced DVD upscaling

High resolution displays for PCs, like dual-link monitors, are becoming more available and affordable. These monitors support resolutions higher than 1080p, up to 2560x1600. This represents a challenge for playback of HD as well as SD videos because scaling up the video to the display resolution will have an amplifying effect on any artifacts existing in the source video, and most likely to introduce aliasing artifacts on the picture.

ATI Avivo™ HD display engine enables high quality scaling of video to high resolutions with ATI Radeon™ HD 4800 series[2] for an immersive entertainment experience. This will have more impact during playback of standard DVD videos. Figure 5 shows screen captures of a standard NTSC video (720x480 resolution) during playback on an HD monitor (1920x1200 resolution), with ATI Avivo HD upscaling showing more details on the building compared to the default scaling of the player application[3].

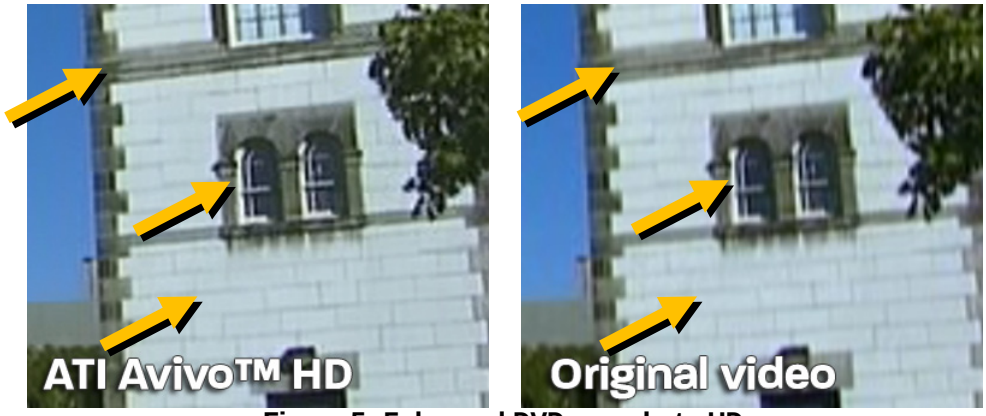


Figure 5: Enhanced DVD upscale to HD

[2] Supported resolutions may vary per product. For details on supported resolutions refer to the specific product page online at www.amd.com
[3] PowerDVD 7.3.4109

Dynamic Contrast Adjustment

One of the image characteristics that have an impact on the perception of details is contrast. A low contrast image will usually look less sharp, and details in some areas of the picture can be less visible because of lighting conditions at the time of shooting of the video and the nature of the scene.

Inspired by user controls on TV sets, most video playback applications today on PCs allow users to adjust image contrast manually; but the settings selected for a given scene (e.g. daylight) may not be suitable for a different scene (e.g. night scene).

Introduced with ATI Radeon HD 4800 series is the ATI Avivo HD automatic and dynamic contrast adjustment. Developed in collaboration with AMD's Digital TV group, this post-processing algorithm adjusts the image contrast automatically, without the user's assistance, and adapts dynamically to scene changes during the playback, enhancing visibility of details and perception of image sharpness, as shown on Figure 6.

Figure 6: Dynamic Contrast Adjustment

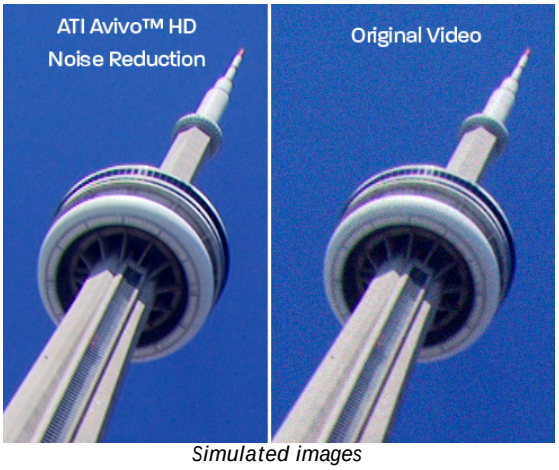
Color Vibrancy and Adjustments

ATI Avivo™ HD display engine processes data at 10-bits per color (30-bits total) enabling over 1 billion colors on 10-bit capable displays.

For video playback, ATI Avivo™ HD exposes advanced color controls, allowing users to adjust color saturation and vibrancy for vivid colors in the video, while preserving the natural look of human skin through an advanced "fleshtone" post-processing during video playback. Figure 7 illustrates the result of color vibrancy adjustment on a video with ATI Avivo™ HD post processing.

Simulated images

Figure 7: Color vibrancy adjustments



Simulated images

Figure 8: Noise reduction example

Noise Reduction and Edge Enhancement

Noise reduction is a post processing operation performed on video to remove noise artifacts introduced by the camera during the shooting or during transfer or compression of the video.

Noise reduction introduces specific challenges: detecting true noise pixels from valid ones, preserving details in the picture and avoiding common "ghosting" artifacts in sophisticated algorithms like Temporal Noise Reduction (TNR).

The ATI Avivo™ HD approach to noise reduction is advanced, using TNR to lower risk of removing valid pixels, and also balanced in the strength of noise reduction to eliminate "ghosting" artifacts while preserving details of the picture. Figure 8 shows the original video with noise in the source, easily noticeable in the blue sky, and the video with ATI Avivo™ HD noise reduction, with details on the tower preserved.

SUMMARY

The challenges of video playback go beyond simple decode to include video quality challenges, especially on high resolution displays. ATI Avivo™ HD is a comprehensive set of video and display technologies designed by AMD to enable seamless video playback, power efficiency with high visual quality on ATI Radeon™ HD graphics, to truly provide users with The Ultimate Visual Experience™.

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