NEW VIDEO CORPORATION

Everything You Ever Wanted to Know About Digital Video, but Didn't Know How to Ask & Competitive Analysis

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This primer will give you a basic, not-too-technical overview of digital video, compression algorithms, SuperMac's DigitalFilm board, and New Video's EyeQ.

It is important to know that there are 4 primary uses for digital video:

- On-line digital video editing for direct output to videotape
- Off-line digital video editing for preview and output of an EDL (edit decision list)
- Multimedia - for inclusion (digitally edited or not) in multimedia applications such as presentations, computer based training, educational programs, information kiosks, and content publishing
- Teleconferencing - digital video for transmission over phone lines

This paper will deal primarily with the first three uses only.

Whether you will eventually move your digital video from the computer back out to analog videotape or keep it in the computer in digital format, you are probably going to want to edit it. One of the more exciting reasons for digitizing analog videotape into the digital domain of the computer is for the random access that digital video offers.

EDITING OF DIGITAL VIDEO

Overview

Traditionally, a lot of time is wasted in an analog video environment, simply shuttling video tape back and forth among decks during the editing process. This is both a waste of time and money. Though, there are "traditional" video decks available which are digital (allowing for random access of any video frame on the tape), they unfortunately cost anywhere from $40K - 150K each. These high prices have limited their use to the very largest institutional producers of video material.

One important factor in the price of these high-end, Digital Video editing (DV editing) systems has been the very large, high-performance hard disks they require. Since one frame of video generally takes approximately one megabyte (MB) of storage; and since video tape runs at 30 frames-per-second (fps); one second of uncompressed video takes approximately 30MB of storage, and the disks have to be capable of writing and reading at sustained rates of 30MB per second or more. This has placed digital video out of the reach of most users.

Two important technology trends have been converging to help create lower cost solutions for DV editing. First, the cost of hard disk storage is coming down. Most professionals can easily afford a one gigabyte (1,000 MB) hard disk drive today. Therefore, they can store more video less expensively. Second, compression technology has developed to the point where video compression hardware and software can compress video at ratios from 25 - 200 to 1 while maintaining fairly good quality. This means that video can take much less storage space, and can be recorded to and played back from standard computer hard disks with average read/write rates in the 500KB to 1.5MB per second range. The combination of better compression technology and inexpensive mass storage devices has paved the way for low cost DV editing systems. Now, for under $4,500, you can purchase equipment to add to your Macintosh that can accomplish what traditionally would cost hundreds of thousands of dollars. In fact, these solutions allow you to do even more!

Traditional video editing is expensive and time consuming. DV editing dramatically cuts both the time and costs involved in editing. Instead of shuttling your video tape back and forth in search of a segment, DV editing allows the editor to jump directly to the proper video frame. DV editing makes it much easier to insert a new video segment, – it literally takes seconds. Traditional editing tools would require you to recompose the entire tape, which could take hours. DV editing also makes special effects easy and inexpensive. Special effects are one of the most expensive items to add in the traditional video editing process. DV editing not only makes adding effects easy, but it also makes new kinds of effects possible.

The question to now ask is, “how can we use this digital video?” As previously explained, there are primarily three ways to utilize digital video: on-line editing for analog videotape output (AVO), off-line editing, and multimedia usage.

On-line DV editing

On-line DV editing is the capability of editing digital video and outputting the end result directly to analog video tape. The goal is “broadcast” quality videotape output. What is actually possible, using todays personal computer-based DV editing systems, is slightly less than “broadcast” quality - a grade often referred to as “industrial quality.”

Of all of the characteristics of digital video, image quality is the overriding requirement for on-line editing. The on-line market will not mind buying larger storage devices for their digital video as long as the quality is high enough for analog videotape output. The comparative costs between larger storage devices and traditional video editing equipment more than cost justifies using a digital on-line system. Other important characteristics of digital video, such as file size, data rates (required for transmission and playback of the compressed data files), cross-platform compatibility, networkability, and inexpensive decompression and playback take a back seat to image quality for on-line editing.

Off-line DV editing

The quality possible with today’s “on-line” digital video technology cannot, at this time, result in “broadcast” quality video. However, today’s DV editing solutions will be acceptable for off-line editing. With products like Adobe Premier 2.0, you can output a SMPTE timecode compatible list called an edit decision list (EDL). An EDL records your edit decisions (which frames you want to include in your final tape and where you start and stop each section) and special effects into a simple text file that can be read by traditional EDL readers. This process allows you to use DV editing for off-line editing and previewing. The final high-quality broadcast tape can then be auto-assembled at a video post production facility, using the master tapes and the EDL produced on the DV editing off-line system.

Digital Video for Multimedia

Until recently, in order to incorporate video in a multimedia application (such as computer based training systems, information kiosks, or presentation) an attached analog video device, such as a

laserdisc, VCR or camcorder was required. In addition to an overlay video device, a video board capable of displaying analog video on the Mac screen was also required. Laserdisc had been the video device of choice because of its random access capability and quality.

There are important advantages in using digital video instead of analog video for multimedia. Digital video eliminates the need for having a separate video device attached to the Mac. The video files simply need to be loaded onto a hard disk or a networked server. This simplifies many aspects of system management and increases overall system reliability. Using digital video makes it easier and far less expensive to replace and update segments of video. Using traditional methods, an entirely new laserdisc or videotape had to be created every time any modification to the content were needed. Conversely, digital video kiosks, for example, can be updated with new material daily via a network download, and training materials can be kept up to date in even the most volatile industries.

The critical issues in the selection of a digital video product for use in multimedia applications are the file size per minute of video and the data rate required for video playback (which, incidentally, are the same), cross-platform compatibility of the video files, access to inexpensive playback on any personal computer, and of course, quality.

COMPRESSION ALGOTITHMS

A compression algorithm is a method for compressing data. Video compression algorithms are compression methods that are specifically geared for handling the data created by digitizing full-motion video. There are quite a few algorithms on the market, each one slightly different. New Video believes that there will not be one algorithm that meets every video compression requirement. Different algorithms are suited for different uses. Some are optimized for quality – at the expense of file size and data rate. Others are optimized to minimize file size and data rate – sometimes at the expense of quality.

Real-time (symmetrical) compression means that video is captured and compressed at full video frame rates (NTSC = 30 frames per second). This term has been badly misused by a number of companies selling video digitizing boards. Though these companies claim to digitize video in “real time,” they are only able to capture 1 frame of video in 1/30 of a second. That is still frame capture, not real time video digitizing. When referring to the capability of real time digitizing New Video means the capability of digitizing, compressing and storing video at 30 fps.

Video can also be compressed asymmetrically. Asymmetric compression means that the compression process is done in non-real time once the capture, or digitizing process has taken place. Asymmetric compression processes differ in their degree of asymmetry. This degree, or level, is usually referred to by a ratio like 150:1. A compression process with 150:1 asymmetry will take 150 minutes to compress 1 minute of video. A better way to measure asymmetry – because in the world of digital video, frame rate is one of the characteristics that can be allowed to vary – is by measuring how much time it takes to compress one frame of video. This is a more accurate measurement of the asymmetry of a particular algorithm.

The following is a brief description of some of the algorithms that are either currently shipping or are thought to be close to commercial release in some form:

• PLV 2.0: PLV (Production Level Video) provides extremely high-quality digital video at extremely low data rates. The average storage size of a PLV file is 9 MB per minute for full-screen, 30-fps video with 16-bit audio. PLV defies the norm for compressed video by providing extremely high image quality, at a data rate low enough to be played directly from a CD-ROM in real time. It is designed for large scale content publishing. PLV is currently cross-platform compatible with any system running a DVI-compatible board and will, in the future, be playable on personal computers

without special hardware. It requires an outside service bureau for compression. Compression services currently cost $250 per minute of video.

•"Motion" JPEG: Though JPEG is a CCITT/ISO standard for still image compression, "Motion" JPEG is not a standard for video compression. File format, audio compression, audio synchronization and system integration, all of which are vital to a motion video compression standard, are not defined in the JPEG standard. None of the many versions of "Motion" JPEG are compatible with one another. Some companies selling "Motion" JPEG based boards are claiming that it is the "successor" to DVI algorithms. Don't be fooled. "Motion" JPEG has nothing to do with DVI, nor does it have anything to do with MPEG. Though to give "Motion" JPEG its due, it is good at one thing at it's highest settings. It creates high quality digital video that some can use for low-end, industrial quality on-line DV editing for AVO. Of course, this quality comes at a price: 30 - 65 MB per minute for disk storage, plus recommended system configuration $20 - 28K. Certainly unacceptable for multimedia use.

• True Motion: Upon release, this will be the highest quality algorithm on the market. It is capable of both real time and asymmetric compression and is suitable for multimedia applications, off-line DV editing, as well as on-line DV editing for AVO. This algorithm represents a major advancement in the quality of digital video. True Motion comes one step closer to the "broadcast" quality sought by so many professional video people.

• Indeo: Indeo Video is a family of cross-platform, scalable compression algorithms for use on the desktop. The first member of the Indeo video family (available in Apple's next release of QuickTime) is a real-time compression scheme acceptable for on-line DV editing for AVO (with lower quality results than True Motion or Motion JPEG), fine for off-line video editing, and is optimized for multimedia. File sizes are small and are adjustable depending on the level of quality you choose. You have access to every frame–just like "Motion" JPEG. In addition, Indeo files can be played back with or without special hardware. Utilizing the Indeo software codec, any Mac running QuickTime 1.5 can play an Indeo file. In software it will play back at 15 - 20 fps in smaller windows and delivers approximately Compact Video (see below) results. With hardware acceleration, Indeo can also play back at 30 fps at up to a full-size window. Indeo is the only algorithm that can be played in both hardware-accelerated and software-only environments, and it is the only software-only playable video that can be compressed in real time. Indeo is also cross-platform compatible with any system running a DVI-compatible board, and can play back without hardware on any Windows based system running QuickTime for Windows or Video for Window.

• RTV (Real-Time Video): RTV is another real-time compression algorithm that runs on EyeQ. It is acceptable for on-line DV editing for AVO (with lower quality results than True Motion or Motion JPEG) fine for off-line DV editing, and is optimized for multimedia. File sizes are small and are adjustable depending on the level of quality you choose. You have access to every frame–just like "Motion" JPEG. RTV is cross-platform compatible with other DVI hardware on other platforms.

• Compact Video Compressor (CV): CV is a recent software-only algorithm, available with QuickTime 1.5. It provides larger window sizes and better frame rates and quality than Apple Video Compressor (see below). CV is 150:1 asymmetric at its higher quality settings (it requires 2 hours or more to compress 1 minute of video even on Quadra-class machines). It requires between 15 to 30 seconds per frame for compression depending on the quality selected. This high level of asymmetry makes CV most suitable for large scale distribution of video and for very small scale desktop projects. While it improves on AVC's image quality, it won't replace it. Average CV file sizes are very large as well. Expect 320x240 pixel windows at 15-24 fps to take about 30 Mb per minute of storage space, and approximately 5 hours to compress.

• Apple Video Compressor (AVC): This is the original software-only algorithm (Road Pizza). It will continue to be an option for software-only playback of video files under QuickTime. It is not nearly as asymmetric as CV (it's only 45:1 asymmetric) and will run on all Macintosh systems. Expect 160 x 120 pixel-sized windows running at 12-20 fps (depending on the type of Mac you are using) and about 25 Mb per minute of storage space.

• MPEG: As of November 24, 1992, MPEG has cleared the international standards committee as a Proposed International Standard, but is not yet an acclaimed international standard. Although you may encounter some claims about MPEG chips and boards, New Video believes that the MPEG boards expected within the next six months will be decompression only. Since MPEG, when compressing, is currently 150:1 asymmetric on a Sun Workstation (SPARC Station 4), and since it uses frame differencing, it will be relegated to the same class of use as PLV - multimedia at CD-ROM data rates. However, New Video is committed to supporting MPEG in the future and is currently working on solutions that will allow MPEG to decompress on EyeQ hardware. New Video believes that MPEG solutions are not practicable at this time, but will become a standard in the future that will be important to support.

Algorithm	Storage per 1 min (1800 frames) of video and audio	Compression Type	Primary Usage	Availability
True Motion*	15 - 30 MB	Real time and Asymmetric (10:1)	On-line AVO /Off-line DV editing and Multimedia	Unknown - will run on EyeQ
PLV 2.0*	8 - 12 MB	Asymmetric (Off-line)	Multimedia	Ships with EyeQ
Motion JPEG	30 - 65 MB	Real-time	On-line AVO /Off-line DV editing	Ships with DigitalFilm
Indeo*	5 - 30 MB	Real-time	Off-line DV editing and Multimedia	Ships with EyeQ (Q1 '93) & Next QuickTime Release
RTV*	5 - 30 MB	Real-time and Asymmetric (1.2:1)	Off-line DV editing and Multimedia	Ships with EyeQ
Compact Video (CV)	Variable	Asymmetric (150:1)	Multimedia	Ships with QuickTime 1.5
AVC	Variable	Asymmetric (45:1)	Multimedia	Ships with QuickTime 1.5
MPEG 1.0	Approx. 9 MB	Asymmetric (150:1) on Sun SPARC	Multimedia	Unknown

***indicates compression algorithms that currently or can run on New Video's EyeQ products.**

There are different algorithms for different applications. You must first determine your application requirements with regard to platform, image quality, symmetrical vs. asymmetrical compression, file size and data rate, in order to determine which compression algorithm you should use and ultimately which digital video board you should select.

COMPETITIVE ANALYSIS

DigitalFilm

Pros

The main use for SuperMac's DigitalFilm board is DV editing for AVO. Because "Motion" JPEG does only intraframe compression, and because the image quality is high, it is suited for editing files for AVO. DigitalFilm currently grabs video in real time at 320 x 240 pixels at 50:1 compression ratios resulting in file sizes of 30 - 45 MB per minute and uses pixel doubling to achieve 640 x 480 resolution. At their higher picture quality 25:1 compression ratio setting DigitalFilm is capturing a 640 x 240 window. In order to create a full-screen size DigitalFilm doubles lines to achieve the 480 line resolution of "full-screen" video. This results in file sizes of approximately 50 - 65 MB per minute of compressed video. The quality of the video output is good. It is not, however, "broadcast" quality. Most video professionals would not consider DigitalFilm files high enough quality to be considered for industrial usage.

Cons

DigitalFilm is based on the "hardwired" CL550B processor from C-Cube, and therefore, can run only one compression algorithm – "Motion" JPEG. The file sizes that DigitalFilm creates are very large. Generally speaking, their video files run between 35 and 65 MB per minute. This means files 2 to 4 times larger in size than files created by EyeQ. While this may be acceptable for some files used for digital video output, it is definitely not acceptable for use in multimedia.

Because "Motion" JPEG requires high data rates for playback, DigitalFilm cannot create files that play from CD-ROM or over a network in real time and at full screen. Even if a CD-ROM is not the delivery medium, using DigitalFilm will require four times as much hard disk storage space as a typical EyeQ file, for an equivalent amount of video.

The recommended, optimal configuration for DigitalFilm calls for a Quadra 950 with 64 MB RAM. To store at least 20 minutes of compressed video, you'll need a 1 - 4 GB, SCSI-2 hard disk array ($5000). In addition, you will need another large drive for your applications. Plan to buy an expensive disk array for every station that plays video. You will also need a $6,000 DigitalFilm board in every station, or you will have to settle for software-only play back (of course, if you are going to do that, why not buy a Video Spigot in the first place?).

SuperMac currently offers an editing solution, but has yet to ship a hardware playback-only solution. Their current playback solution is to convert DigitalFilm files to software-only (using CV), resulting in files that are limited to current software-only playback performance. As with any CV compression process, it requires approximately 2 hours to covert 1 minute of video. This makes DigitalFilm an expensive and unacceptable solution for multimedia.

So, a typical station for digital video playback of DigitalFilm files will cost $20,000 - 26,000. Because most multimedia applications, such as training and kiosks, require multiple systems, DigitalFilm is not a cost effective solution. It is therefore unacceptable for multimedia.

The bottom line on DigitalFilm is this: If you want a single purpose digital video board for on-line DV editing for AVO and you don't mind paying SuperMac's premium price for it, buy a DigitalFilm board. Remember, you will need a Quadra, a SCSI 2 hard disk drive, and a $6,000 DigitalFilm board for every station. However, read on if you are interested in a complete digital video solution for multimedia.

EyeQ

Pros

The EyeQ Authoring Solution is a complete digital video solution. Because it is based on programmable technology, it is able to compress and decompress video with a wide range of algorithms for a wide range of uses – making it very versatile. EyeQ can currently compress and decompress the Indeo and RTV video algorithms, and can decompress the PLV video algorithm. New Video is actively working on porting new algorithms to run on EyeQ. Our intention is to make EyeQ the only hardware accelerator for *every* compression algorithm available under QuickTime 1.5. Authors will be able to capture and compress video using most any QuickTime algorithm, and will be able to play that video back with or without hardware on any QuickTime platform. In addition, there are algorithms planned for teleconferencing and other specialized applications on the horizon. And since EyeQ is based on programmable technology, it will be upgradable via software.

Since EyeQ can use a variety of algorithms, it can create digital video files that can be used for multimedia or AVO. EyeQ can produce files for play back from CD-ROM at full screen and 30 fps. These same files can play over standard networks, and can also be played cross-platform on any system running a DVI compatible board. EyeQ will also produce files that are ideal for output to analog videotape.

- Algorithms for multimedia: PLV, RTV and Indeo
- Algorithms for AVO: New Video is currently working on solutions including True Motion

In addition, there is an EyeQ product for playing compressed video. If you want an entire classroom playing back EyeQ files at full-motion and 30 fps, you need only an EyeQ Playback Solution in each system. In fact, EyeQ's recommended configuration for the Playback (and Authoring) Solution is any MacII (except IIsi) or better, a 13" Apple Monitor, 8MB RAM, and a 200MB hard disk to store 20 minutes of compressed video. Including a $2495 EyeQ Playback board set, this configuration represents a $6000 - $7000 investment – a much more cost effective solution than DigitalFilm. If you need a software-only playback alternative, you can capture Indeo files with EyeQ and play them back without EyeQ hardware using the Indeo software codec, available in he next released of QuickTime. Furthermore, the same files will be playable on a PC under QuickTime for Windows. This cross-platform compatibility ensures that the file you create on you Mac with EyeQ can be played back by anyone with a Macintosh or PC (with Windows), with or without DVI hardware! Talk about compatibility.

Cons

PLV has been attacked for requiring off-line processing by a compression facility. Our competition would love for you to believe that there is only one of these, and that compression services are expensive and slow. In fact, there are now 11 licensed PLV compression facilities with more on the way. The current cost is $250 per minute of compressed video and turnaround time is generally one to two weeks. Although PLV is less convenient and often more expensive than desktop compression, it provides the optimum solution for video publishing. That is, files compressed using PLV result in very high quality video at low enough data rates to play from CD-ROM, at full-screen size and at 30 fps. PLV compression is to desktop compression what Linotronic printing is to LaserWriter printing. It is a final step in the production process that can be used to achieve the highest quality video files for

use in content publishing, training, kiosks, or any environment where high-quality video is needed with extremely low storage requirements.

RTV, our current algorithm for desktop compression, captures at lower resolutions than DigitalFilm. At a maximum of 320x240 capture it is roughly half the resolution of a DigitalFilm frame at its highest quality setting. RTV is an algorithm that is targeted for multimedia use and is generally not used for on-line DV editing for AVO. DigitalFilm would make a better choice at this time if all you want is on-line DV editing for AVO. However, the True Motion algorithm, which is now running on EyeQ, provides both higher resolution capture (768x240 and 60 field per second) and compression, providing the highest quality digital video available on the desktop.

Conclusion

Hopefully after reading this you will have a better understanding of current digital video technology. The determining factors which will help you decide which digital video product to purchase will be *how you use that digital video.* New Video believes that in providing you a flexible, software upgradable, multi-purpose digital video product, you will be able to accomplish all that you want to do – with EyeQ.

This is an "in process" draft of New Video's educational primer on digital video. We have tried to be fair to our competition in reporting what they are good at as well as what they are not. We are more than willing to correct any factual errors in this document in order to represent other products fairly. For more information or to provide corrections to any factual errors in this document, please feel free to contact:

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