DV Technology for video computer applications

By

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Abstract

The DV technology represent a new standard for video in consumer and professional applications. In this paper an overview of this technology is given in order to underline its main features. This video standard involves how to create, manage and store videos but not all the parts of this standard are explained here. The purpose is to give an overview of the DV image format and why DV represent a great advantage for video on computer system. No explanations about video cassettes and how to store DV on tape are given because it is not related to the purposes of this document, even if they represent an important part of DV technology. An overview of the main components of a DV based system is included, because it is an important characteristic of this standard.

Index:

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1. Introduction

DV format was born in 1995 from Sony, Panasonic, JVC, Canon, Sharp and some others company as a standard digital video format for consumer use. Now around 60 companies are involved in this project and also professional or industrial application have been developed. The DV technology

was initially intended as a standard for recording video in digital way on cassette. Now, thanks to the development of the IEEE 1394 high speed serial bus, DV is a digital video format used on digital tapes and disks, but also in computer based video applications. Because a lot of different companies are working on this technology and they have made different and concurrent products, a large number of names and acronyms have been created. All of them define particular implementations always very similar to DV but with differences. Sometimes these acronyms are used as synonyms but they are not! The result of this process is a big confusion about names and cross compatibility. For example there are DVCAM and DVCPRO. These two standards define two digital video formats very close to DV but they are specialized for different purposes and they have some improvements over DV. Sometimes DV is used as the name of the standard that include DVCAM and DVCPRO, but it is not true! The original DV format is often called miniDV, but originally miniDV was only the name of a cassette type! This is a real problem, and it is not simple to solve. In this paper only the characteristics of DV are considered, but all the the main features related with computer applications are almost the same for all formats of the "DV family".
This technology has two big advantages over analog video:

- This video format define an high resolution and quality video format, better than normal consumer video format, even better than some professional video system.
- You can get the video and audio directly in digital form from the camera or an Audio/Video device by the IEEE 1394 serial bus. A complete digital video system can be realized and it guarantee it's possible to copy video or manage it without any losses of quality.

The image characteristics of DV still depend on which standard TV system is used originally (NTSC or PAL/SECAM) for for showing the videos on the standard TV set. In the following sections, after an overview on analog video technology, the main DV features are showed.

2. Analog video technology.

In order to underline the main characteristics of the Digital Video (DV) technology, a short look to the traditional video system is necessary.
The normal video camera picks up the images and transform them in an analog signal. Different types of standards for analog video exist but all of them manage the information using the luminance/chrominance system. The images data are transformed in three analog signal: one represent the brightness and the other two the chrominance information. The video format is fixed by three main standards: NTSC, PAL and SECAM. These formats define the main characteristics of the video: resolution, brightness and color coding, refresh rate of the video. The main characteristics of NTSC and PAL (the main two standards) are showed below [1,2,11]:

NTSC:

- 525 scan lines per frame, 29.97 frames per second (33.37 msec/frame);
- interlaced, each frame is divided into 2 fields, 262.5 lines/field;
- 20 lines reserved for control information at the beginning of each field. It implies a maximum of 485 lines of visible data (Note 1)
- Use YIQ color system. From the RGB color system the relations to obtain the luminance (Y) signal and the two chrominance signals (I and Q) are:

$$Y = 0.30R + 0.59G + 0.14B ;$$
$$I = 0.74(R-Y) - 0.27(B-Y);$$
$$Q = 0.48(R-Y) + 0.41(B-Y).$$

PAL:

- 625 scan lines per frame, 25 frames per second (40 msec/frame) ;
- Interlaced, each frame is divided into 2 fields, 312.5 lines/field;
- 20 lines reserved for control information at the beginning of each field. It implies a maximum of 585 lines of visible data (Note 1).
- Use YUV color system. From the RGB color system the relations to obtain the luminance (Y) signal and the two chrominance signals (U and V) are:

$$Y = 0.30R + 0.59G + 0.11B;$$
$$U = 0.493(B-Y) ;$$
$$V = 0.877(R-Y) .$$

In all the standards TV the lines that are used to transmit the images information are less than maximum number of lines. The reason is that some lines are used for keeping in sync the transmitter (the camera) and the receiver (the TV set). In the same way, the first part of a line does not contain image information, but it is still used for retracing and synchronization. The result is that only a part of the video frame contains data about the image, this part is called the *active* part (see fig. 2.1). The modern video devices do not need all these sync and retrace data. Now these "non active" parts are use to transmit different information along with the video signal [1, 8].

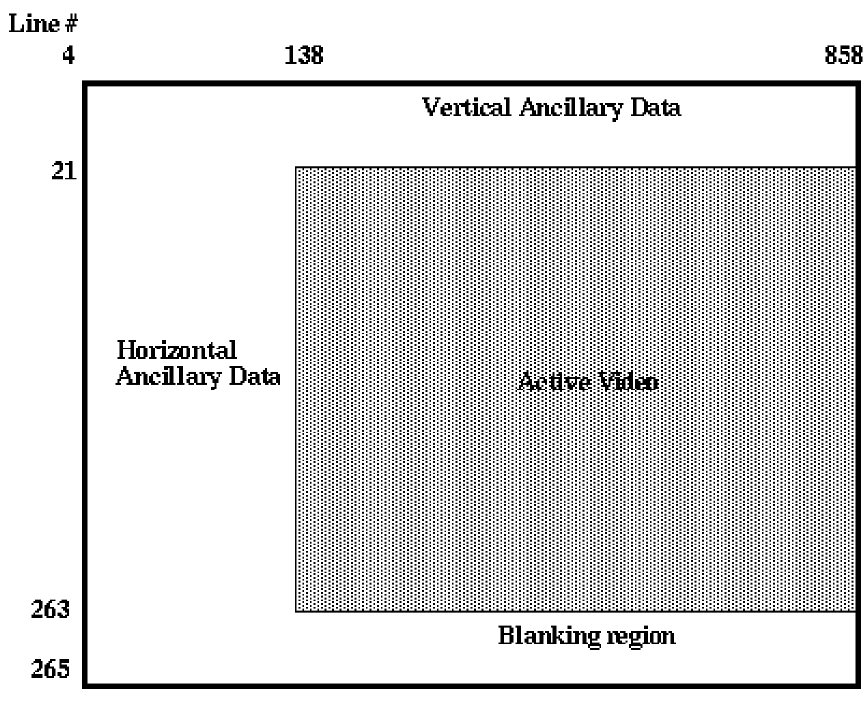

Fig 2.1: The analog video frame.

The main standards define only the maximum possible horizontal resolution of the image, the real resolution depends from the specific video format used. Also the analog encoding of the signals change with the video format used; there are three main possibilities [2]:

- In **composite** video, the color and luminance signals have been combined into one signal traveling over one wire and
- In **Y/C** or **S Video**, the color and luminance signals are transmitted on two different wires.
- In **component video**, the Luminance signal and the two color signals, or the three RGB

components, are sent on three separate wires.

The point about these standards is that all of them transmit and store video as analog signals. Each operation on a video clip causes a loss of quality because the new signal cannot be exactly the same of the original one due to noise and attenuation. If many operations are performed on the same video the result can be very poor quality images. To avoid this problem a possibility is to convert the video into a digital format. Using video in digital format no attenuation is possible. The noise can cause some bit errors, but error detection and correction systems are used to check and recover from errors. Different types of error detection and correction systems can be used. All of them add some redundant information to the original data stream, in order to rebuild the correct data when errors occur. The different systems used are out of the scope of this paper, but information can be found in [9] and the particular system that is used in DV is described in [4].
A frame grabber is used to convert the analog signal from the video camera, or VCR, into a digital representation. Problems remain if, after some operations on the digital version, the video is reconverted in analog form e. g. in order to be saved on a VHS or Betacam tape using one of the existing standard. The operations of analog-to-digital conversion, and vice versa, introduces errors and, at the end, the video is still in an analog form.
The analog to digital conversion of a video is regulated by the ITU-R BT.601 (CCIR 601) standard [1 ,3]. The maximum resolution, the frame rate and the color sampling, depend from the original format (NTSC or PAL/SECAM) of the video. A particular discussion is necessary about how the color information are managed. The human eyes are more sensitive to brightness than to color. Using this characteristic, it is possible to have good quality images with less data sampled from the chrominance signal than the luminance signal. There are different schemes used for sampling brightness and color; the main are: 4:2:2 , 4:1:1 and 4:2:0. A short explanation is necessary. The ITU-R BT.601 recommends that the luminance signal be sampled at 13.5 Mhz. 4:2:2 means that the two chrominance signals are sampled with a frequency that is 1/2 the sampling rate of the brightness signal. The first number represent the sample frequency of the luminance, the second and third numbers represent the sample frequency of the two chrominance signals. For 4 samples of the luminance signal there are 4 samples of chrominance, two for each type of signal. These samples are taken in the same time (see figure 2.1).

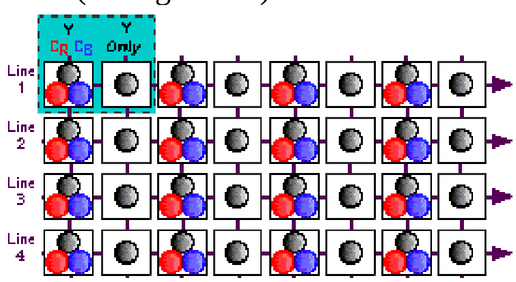

Fig 2.2: The 4:2:2 sampling scheme.

The 4:1:1 use the same idea but, the chrominance signals are sampled with a frequency that is 1/4 of the luminance signal sample rate (see figure 2.2). For 4 samples of the luminance signal there are two samples of chrominance, one for each type of signal.

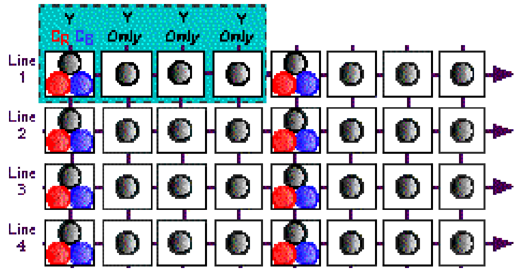

Fig 2.3: The 4:1:1 sampling scheme.

The last sample scheme is 4:2:0. That does not mean that only one chrominance signal is sampled. Instead, for each line only one of the two chrominance signals is sampled, following the scheme show in figure 2.2. Using this scheme you have the same horizontal and vertical color resolution.

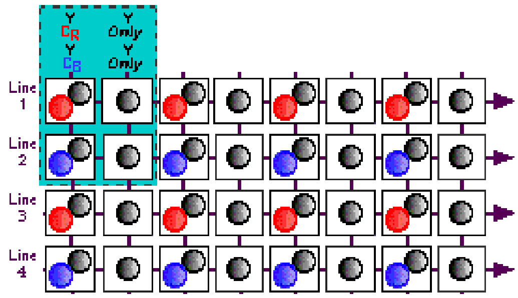

Fig 2.4: The 4:2:0 sampling scheme.

The frame rate of the video is still the frame rate of the TV standard used: 29.97 fps with NTSC and 25 fps with PAL/SECAM [1 ,11].
The digitized video produces an enormous quantity of data. This data cannot be handled by a computer system without any compression. For example, the video data rates of ITU-R BT.601 video are [1]:

- 485 active lines* 720 active samples per line * 29.97 frames per second * 8-bit YCbCr demands 251 Mbps.
- 4:2:2 - 167.5 Mbps
- 4:1:1 - 125.5 Mbps

During the digital to analog conversion all the analog video frame is sampled, but only the samples from the active part are kept. This is the reason because the terms "active lines" and "active samples" are used above. When a digital to analog operation is performed, also the "no active" part of the video frame must be rebuilt in order to have back a complete analog video frame [1,8].
A few minutes of video require an enormous quantity of storage that the computer system must manage. A common solution is to compress the digital video using a compression algorithm. There are a lot of codec systems (codecs stand for Compressor/Decompressor) based on different algorithms. Some of them are complete implemented in software, while some others are implemented in hardware. The speed of the codecs is important, some compression algorithms require a large amount of operations and so they are implemented using dedicate hardware. For other kinds of compression algorithms only software codecs is enough. In general, the bigger the compression ratio for given codec, the lower the quality of the compressed video. An explanation of the different codecs and compression algorithm is out of the scope of this paper.

3. Digital Video (DV)

3.1 DV based system

The main characteristic of the DV technology based systems is that they are completely digital. The camera picks up the images and it convert them directly into a digital form. The standard was born as a system to store the video on a tape in digital form. Thank to the development of the IEEE 1394 (Fire on Wire) high speed serial bus, now the video from the digital camera can be directly transmitted in a digital way to a computer system or a digital VCR or other devices. From the original images no signal deterioration is possible because of the digital format. The figure 3.1 give an example of DV system.

Fig. 3.1: SGI DVLink TM

All the links between the different devices are using the IEEE 1394 serial bus. This is a low-cost high-performance bidirectional serial bus that allows to transmit data from 100Mbps (megabits per second) to 400Mbps and the feature releases will be able to reach 1.2 Gbps. Connecting more devices with IEEE 1394, a system bus can be implemented. This bus is a "non-cycling network with finite branches". *Non cyclic* means that you cannot plug devices together so as create loops. Up to 16 cable hops are allowed between nodes, thus the term *finite branches*. Physical addresses are assigned on bridge power up (bus reset) and whenever a node is added or removed from the system, either by physical connection/disconnection or power up/down. No device ID switches are required and hot plugging of nodes is supported. Thus truly qualifies IEEE 1394 as a plug-and-play bus. The development of the IEEE 1394 has been very important for DV and at the same time the IEEE 1394 has been developed to satisfy the request of DV [5].
The result of this system is that it guarantees the quality of the video from the origin to the end. No deterioration is possible because of the digital format. It’s possible to copy a video and the copy is exactly the same of the master (this has caused some problems with copyrights) and it’s also possible to edit a video without any losses.

3.2 Audio/Video characteristics

The images, using DV format, are digitized using the ITU-R BT.601 standard. The image is picked up by the CCD (Charged Couple Device) in the camera which creates an analog representation of the image and this is immediately converted into a digital form. The final resolution and the color characteristics of the images depends on the TV standard used. The two DV formats for NTSC and PAL TV standards are [3]:

- NTSC: resolution 720 x 480, 29.97 frames/sec, sampling rate 4:1:1
- PAL: resolution 720 x 576, 25 frames/sec, sampling rate 4:2:0

The sampled video is compressed using a Discrete Cosine Transform (DCT), the same sort of compression used in motion-JPEG. The idea is similar but there are a lot of differences between DV compressor and the motion-JPEG compressor [3]. DV's DCT allows for more local optimization (of quantizing tables) within the frame than to JPEG compressors, allowing for higher quality at the nominal 5:1 compression factor than a JPEG frame would show. DV uses *intraframe* compression: each compressed frame depends entirely on itself, and not on any data from preceding or following frames. However, it also uses adaptive *interfield* compression; if the compressor detects little difference between the two interlaced fields of a frame, it will compress them together, freeing up some of the "bit budget" to allow for higher overall quality. In theory, this means that static areas of images will be more accurately represented than areas with a lot of motion; in practice, this can sometimes be observed as a slight degree of "blockiness" in the immediate vicinity of moving objects.
The most noticeable spatial artifacts are [3,6]:

- **Feathering or mosquito noise**: results from high-frequency data lost in the compression/decompression process. It is always within 8 pixels of a hard-to-compress edge or detail, and a common artifact in any DCT based compression such as DV, JPEG, or MPEG. Unfiltered titles on plain blue backgrounds make the clearest demo images, but these artifacts are also frequently found in DV image parts of dense clusters of leaves, sharp diagonal details, and the like, especially where the background image is itself quiescent and bright enough so that the noise isn't lost in the shadows. In this 72-pixel by 48-pixel detail (see figure 3.2), notice the noisy four rows of pixels above and adjacent to "1997" and the general lack of uniformity between the left edge of the image and the "1"

Fig 3.2 Mosquito noise

- **Quilting** shows up as discontinuities between adjacent DCT blocks in an between adjacent DCT blocks in an image. They are most noticeable in DV on straight diagonal lines that are slightly tilted from the horizontal or vertical. Quilting is also common to other DCT compressors like those used in JPEG and MPEG. Quilting is most often seen on DV footage as a "fixed pattern" distortion during slow pans or tilts. The 72-pixel by 48-pixel detail (see figure 3.3) of the larger scene shows quilting. The small arrows at the bottom of the image are aligned with the DCT block boundaries, every 8 pixels across the image.

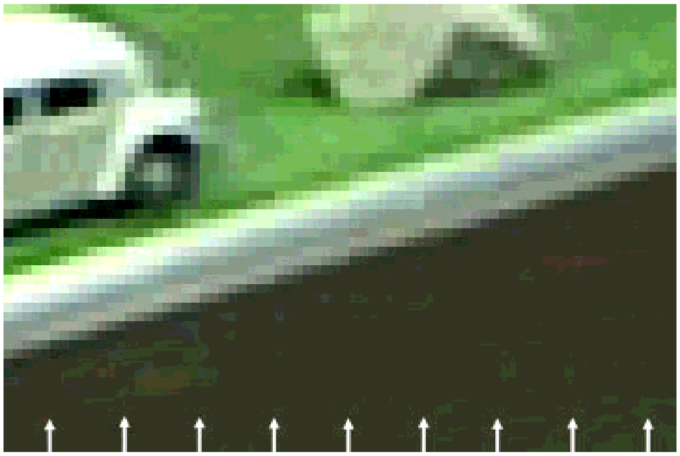

Fig 3.3 Quilting

- **Motion blocking** occurs when the two fields in a frame (or portions of the two fields) are too different for the DV codec to compress them together. The "bit budget" must be expended on compressing them separately, and as a result some fine detail is lost, showing up as a slight blockiness or coarseness of the image when compared to the same scene with no motion. Motion blocking is best observed in a lock down shot of a static scene through which objects are moving: in the immediate vicinity of the moving object (say, a car driving through the scene), some loss of detail is seen. This loss of detail travels with the object, always bounded by DCT block boundaries. No images have been found in order to explain this problem.

DV perform a 5:1 compression and video information are carried in a nominal 25Mbps data stream [ref 3, 4 and 6].
The audio information are included in DV format. Two different audio formats are supported and the user can choose the preferred one.
The standardized audio formats for DV are [3]:

- 2 channels, 48 kHz, 16 bits PCM linear coding;
- 2 channals 44.1 kHz, 16 bits PCM linear coding;
- 4 channels, 32 kHz, 12 bits PCM non-linear coding;

The maximum data stream for audio information is 1.536 Mbps, it is generated by the first and the last format. 44.1kHz format require a little smaller flow of data . This amount of data must be added to the 25 Mbps of video information to get the total bandwidth required for complete Audio/Video transmission.
The 44.1 kHz audio format is not usual used by all commerial DV video products, as video cameras and VCRs. These devices can playpack tape recorded using this format but the they cannot record audio in this way. The 44.1kHZ audio is used by NLE system and is often used when a video clip is converted in DV from a different format.
A notice is necessary about the synchronization between audio and video. In general two types of relationship between audio and video are implemented: *locked* audio and *unlocked* audio [3].
Locked audio is the theoretically better synchronization system. The audio sample clock is precisely locked to the video sample clock such that there is exactly the same number of audio samples recorded per frame. In the real life this is possible only with the PAL system, using NTSC the frame rate is such that the rate between video and audio is not entire. So it is possible to guarantee only that on 5 frames there is always the same number of audio samples.
In **unlocked audio**, the audio clock is allowed some imprecision. The phase locked loop (or other

slaving method) used to keep the audio sampling in sync with the video sampling can have a bit more slop in its lock up, with the audio sampling sometimes running a bit slower, sometimes a bit faster, but always staying in sync over the long run. The total amount of sync slippage allowed in unlocked audio is +/- 0.333 frame, so it’s not a real problem. In the real life sometimes the unlocked audio can give some problems. Some kinds of video camera seems to have completely independent video and audio sample clocks. In a long video sequence, it’s possible to notice some drift between the two. This is a problem of the device, not of the unlocked audio.
To realize a locked audio system is quite expensive because the locked audio clocks are expensive. Since DV was designed as a consumer format, unlocked audio was allowed as a cost-saving measure.

3.3 A short look to DVCAM and DVCPRO

Now we are ready to take, a short look on different video formats inside the "DV family". There are some types of standards that are nearly compatible with the DV format, except for some small differences. The main idea is the same, and their abilities are almost the same, but there is not a complete compatibility and there are different features.

- DVCAM: This standard have been developed from SONY and first was intended for professional and industrial applications. The video resolution and color sampling is the same of DV: 720x480, 4:1:1 for NTSC and 720x576, 4:2:0 for PAL. The compression system is the same of DV, 5:1 with a final video data stream of 25Mbps. Also the audio format is the same: 2 channels 48 kHz 16 bits and 4 channels 32 kHz 12 bits all unlocked (but it accept unlocked audio via IEEE 1394). Difference is how data is store on the video cassette [3].
- DVCPRO: These two standards have been developed by Panasonic, Philips, Ikegami and Hitachi for professional, industrial and broadcast applications. The two types of DVCPRO are: DVCPRO25 and DVCPRO50. In DVCPRO25 (simply called DVCPRO) the video resolution is the same as in DV, but it is different the color sampling for PAL. The video format is: 720x480 4:1:1 for NTSC and 720x576 4:1:1 for PAL. The compression system is the same of DV, 5:1 with final video data stream of 25Mbps. In DVCPRO50 the video resolution is the same as DVCPRO25 and DV, but the color sampling is 4:2:2 both NTSC and PAL. The compression system used by DVCPRO50 is based on the system used in DV and DVCPRO but with a compression ratio of 3.3:1 in order to increase the video quality. The video data stream for DVCPRO50 is 50Mbps. The audio is only 2 channels 48 kHz, 16 bit locked, plus one analog audio cue track both DVCPRO25 and DVCPRO50 [3,7].

Another standard, close to DV, is Digital8 from SONY. It has been developed to replace the old Video8 and Hi8 systems and it has more or less the same characteristics of DV, DVCAM and DVCPRO25 [3]. The main differences between the above standards are the design of the recording cassettes. Each of them defines a proprietary cassette format, and these different standards are not always cross compatible. About the video format, skipping DVCPRO50, the only problem is DVCPRO in PAL system. The PAL 4:2:0 DV and DVCAM playback on a DVCPRO have to be digitally resampled to generate a PAL 4:1:1 DVCPRO signal [3].

4 DV products

The DV format was designed for a specific commercial purpose. For this reason the technology was born already mature, that means was introduced directly implemented in commercial products. Nowadays a big number of different products have been developpped upon the DV technology, in order to soddisfy different necessities but always in the field of the video application and Non Linear Editing (NLE) .

An overview of the different type of products will be given below. The meaning of this part is to show which kind of products exist now, not what the current characteristics of these products are. The characteristics of the single devices are changing continuosly, it is possible to find the new products and releases features on web and some good start point will be given in the references [12,13].

4.1 Video cameras.

There are a lot of different models of cameras from different constructors. The bigger group of them are compact cameras for home-video purpuses, but there are also professional cameras for video production [12]. The difference between consumer and professional DV video cameras are mainly about the quality of the lens and the image capture part. The video format is always the same, DV is a very rigid and well defined format, no differencies are allowed in the compression system. Using better lens and better CCD devices you can obtain better images than using comsumer staff, because it is already better the optical image projected inside the camera and more sensitive are the CCDs. Professional video cameras offer also more capabilities for setting up the camera and to handle the video data as a set of edit commands.
All the video cameras have inside an hardware codec that can, in real-time, convert the analog signal from the internal image capture devices to the DV format. All the video cameras have the possibility to transmit the DV on a IEEE 1394 serial bus, but the really cheaper and bad quality ones. They have also different analog output and sometimes also input ports (S-video and/or composite video plus audio in). The inside hardware codec gives the possibility to convert in real time the video and audio format, from the analog formats to DV and vice versa.
Last common feature is the VCR capabilities. The DV camera nowadays in commerce usually store the video on DV cassettes (here there are the bigger differences between DV format and other type of DV like formats) and they give the capabilities to store and playback the video in digital format on cassettes. Nothing prevent from realising simply DV camera with only image capture devices and IEEE 1394 interface for computer focused applications. I have not found this type of camera yet, because now there is not a commercial interests on this type of device.

4.2 DV-VCR.

These kind of devices perform the usual operations of a common VCR using DV format on DV cassettes. DV-VCR have not less than one IEEE 1394 port to be linked with DV cameras or other DV devices and they have always input and output analog video and audio ports. Inside the DV-VCR there is the same kind of hardware codec that is used in DV cameras. This codec is used to store in DV format original analog input video or to send a DV video to a traditional TV set or some other type of analog video device. It is usually possible to use a DV-VCR to convert in real-time DV video to analog video and vice versa, that means DV-VCR can be used as a bridge to connect different subsystems based on DV and analog formats.

4.3 DV interfaces for Computer systems.

To handle DV on a computer not a really specific DV hardware is strictly necessary. The only absolute needed device is an IEEE 1394 interface, but this is a pretty standard device that can be used for different purposes. Using this type of hardware all the handling on DV is done by software system. In this case there is the maximun flexibility with the minimum cost for the hardware. The problem is in the computer system load to manage a so big ammount of data.
Different commercial boards are available now. These have different characteristics and are designed for different computer platforms. The trend now is to realise boards for PC and MAC platform, because the consumer focus of current DV technology. To have a better and update list of

the DV/IEEE 1394 boards for PC and MAC see [13].
Although the strictly reletionships between the current hardware technology, the differents computers platforms and the implementation of the IEEE1394/DV boards, some general considerations are possible. The general applications of this systems is focused on NLE. For this reason some devices include not only IEEE 1394 ports, but also analog audio/video ports in order to be able to manage DV and analog video on the same hardware device. The main differences between boards are about the DV codec system that is implemented. The main trade off is between hardware and software DV codec. Software DV codec makes simpler and cheaper the hardware device and more flexible the system, but it loads the CPU and it requires a very optimized software. Nowadays complete software solution is used by SGI on O2 workstation [14]. SGI defined a standard IEEE 1394 hardware interface and handle the specific DV data stream by software. There is a software library that contains utilities to handle data from IEEE1394 and DV data in particular [14].
Using an hardware DV codec (it is the same kind of chip used inside DV cameras and DV-VCR) it is possible to handle DV without overload the CPU. Using this solution the problem is to handle the enormous amount of data that is the uncompress video coming from the hardware codec. The CPU must not perform the codec related operations, the main difference is that the system bus connecting peripherals to CPU must carry at least 125.5Mbps (NTSC 4:1:1 video without the audio and control data) against the 25Mbps of the compress DV. This type of solution is used for foucused application on DV and NLE.
Nowaday there is not the best solution, a lot of variables are involved and so it is impossible to define a clear and general winner between systems based on hardware or software codecs. For example with the current PC systems using software codec the bottleneck results the CPU, but using hardware codecs the bottleneck results the PCI bus and there are not big differences of performance. A good example comes from the features of a current commercial NLE system for PC platforms, the DVRex-M1 by Canopus Corporation. In this NLE system there is an hardware codec on the hardware board (the SONY DVBK-1) and in the software system is implemented a software DV codec. The reason is that with the current PC technology the hardware codec gives better performans with not very fast CPU but with last generation CPUs, the software codec gives better result (this data are from Canopus Corporation web pages about DVRex-M1, August 1999).
More considerations are possible over the different implementations of NLE systems and DV computer applications, but these are related to the current technology and performance of the computer system, so it change very fast and are too application oriented for the purpos of this paper. More information about this problems are in [10,12,13].

4.4 Other types of DV devices.

There are some particular devices used to solve specific problems that cames using DV based systems. This part does not want to be an exaustive and complete list of all the devices that can be used on DV technology. The idea is to give just an overview of the most interesting devices that I have found and that can be useful in a DV system.

- *Media converter*. This type of devices convert analog audio and video into DV and vice versa in real time. It's based upon an hardware codec and can be use as an interface between a analog audio/video system and a DV system. It is a cheap solution for interfacing problems. The same operation can be performed by DV-VCR or some type of computer DV boards, but if the problem is only to convert the audio/video formats, this is the better solution.
- *IEEE 1394 hub*. This type of device is not a really DV device, it can be used for all the application of IEEE 1394 included DV. The purpose is to link together different IEEE 1394 devices in order to create a bus. The hub acts just like a "repeater" in that it replicates the data being sent from one device to all other devices attached to the hub.

- *IEEE 1394 data storage*. In order to store þe data that an IEEE 1394 can transmit, particular devices have been developped. There are devices that store the data from the IEEE1394 on different type of media: magnetic disks (as normal hard disk), digital tape and optical rewritable disk. The input/output of data is perform over the IEEE 1394 and they are controlled by the same bus. Nowadays not all the different IEEE 1394 data storage devices can handle the data rate products by DV and the amount of memory is big but not enough for large DV database. In the near future there will be probably devices with better characteristic useful for DV applications.

5. DV applications and tools

5.1 Video Editors

Video Editors are the main computer applications for video so far. Two main type of editor exist: Linear Editor and Non Linear Editor.
Linear editing is the traditional way to edit a video using analog video tapes. With the old analog video systems, it was only possible to access the video frames in a sequential way. In the early days of linear editing, frame accuracy was not possible, latest the idea of recording a unique code on every frame enabled edit controllers to reference an exact frame on the tape. Then it was possible to find a particular point in the video and perform cut and paste operations among others. With a digital video system it's possible to improve the performance of the linear editors, but this kind of editor is still used also with digitized video. DV format has a timecode that is different from the SMPTE 12M-1995, but some DVCAM and DVCPRO decks offer standard timecode I/O port for back compatibility with linear editor systems.
Non-linear Editing (NLE) is editing using random-access video storage. Nowadays, this almost always mean computer-based editing. Using this system the video is transferred from tapes to an hard disk and you assemble the final video by arranging the clips along a timeline on the computer screen. It is not any more necessary to move on the different videos in a sequential way, as it was used with linear editors. Finally, the video is transferred back on a tape. Today there are a lot of different NLE systems on market and you can find solutions for all type of computer platforms. This type of editing is not possible only with DV formats but you can have better result with this standard. In fact DV can be stored and manipulated in native form; no transcoding to JPEG, MPEG or other formats is required. The same high quality seen on DV tape (that is exactly the same of DV camera) is maintained in the computer. DV is compressed just enough to be able to stream into and out of current day PCs and Macs (not more expensive computer platforms are necessary to manage DV). More, using only DV devices no codecs are necessary, the video remain in the same format from the video camera to the final tape.

5.2 DV software tools

Nowadays there are different software tools in order to manage DV on computer systems. Because of the purposes of this technology, the main part of the software is for PCs (Window 95 and NT) and Mac platforms, and are related with editing. Skipping this big group of application there are software tools for the following fields:

- Utilities to play DV video on your computer;
- DV on IEEE 1394: tools for sending and receiving DV on the IEEE 1394 high speed serial bus and
- DV on IP: this a new field; some software has been developed in order to send DV on high speed IP based networks.

Different SDKs are available to handle DV format. Mainly all the Operating system support or are going to support the IEEE 1394 serial bus. With the FireWire interface, software tools are available to handle DV basically a software codec and a interface to dialogue with the external DV devices. This type of SDK is available for Winodw 98 and for te new system Window 2000. SGI gives this type of tools for O2 workstations and for system running IRIX and also Macintosh has specific tools. Mainy DV format is now supported by the two most important software system for multimedia audio/video application for PC and MAC: QuikTime and Window multimedia (AVI). Using this system is possible to handle DV clips for editing or other purposes.

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Images Index

1. Fig 2.1 is from Tobias Öbrink, Presentation at NUCCC 1999.
2. Fig 2.2, 2.3, 2.4 and 3.2, 3.3 are from Adam J. Wilt, "The DV, DVCAM and DVCPRO formats", web page created 1998, last updated June 1999.
3. Fig 3.1 is from "DVlink datasheet", SGI web pages.

Created by Enrico Pelletta at 1999-07-02

Last update 1999-10-02.

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