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Publishing on the WWW. Part 9 - Video codecs and decompressors

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Abstract

Digital video and audio produce very large and unwieldy files. Codecs are used to shrink files and them play back in reduced file size format. This article disusses the advantages, disadvantages and tradeoffs in using codes, and briefly reviews the most commonly used codecs.

MeSH: Computer Communication, Information, Internet, Networks/standards, Systems/standards

Introduction

Video, with or without accompanying sound, produces very large hard disk files, especially if uncompressed. Such files cannot be easily transported whether on a physical medium such as a compact disk (CDROM) or over the internet. This is where codecs come in. A codec is a technique of ‘compression/decompression’ and is used to shrink large video files to sizes that can be transported or downloaded with relative ease over the internet, such as in telemedicine applications,[1] or other file transfer methods. Many types of codec have been developed and may work through hardware, software or both, allowing video to be translated to a compressed format and back again in order to be viewed. Codecs are almost invariably designed to compress audio and/or video into as small a file size as possible without losing an excessive amount of quality.[2]Compression has been described as the art of throwing away as much data as possible while leaving an intelligible result. This involves different combinations and permutations of trade-offs, including compression speed, playback quality, small file size, and cross-platform playback portability. Compression techniques may be lossless where only truly redundant information is discarded or lossy. The latter type of

codec is commoner and discards information that it deems, will not be noticed, by the user. This is achieved by a complex mathematical encryption, reducing resolution, colour depth and frame rate. The higher the compression ratio set, the worse the result until finally, artifacts and noise appear.

Successive compression, editing and recompression concatenates artifacts and noise, so care must be taken to work in an uncompressed, lossless format and to only save the final output in a compressed lossy form. Personal computers have become progressively faster and cheaper, with larger hard disks for storage, so working with very large files is not the problem that it used to be.

It is important to note the distinction between codecs and file formats. A codec works within a file format (which displays the video) to compress and decompress the video and/or data. There are several video file formats in use today, and these formats can utilise a variety of codecs. Popular formats include Video for Windows (which uses the .AVI file extension), QuickTime (.MOV or .QT file extension), Microsoft Windows Media Video (.WMV or .ASF file extension), Digital Video (.DV file extension), and RealMedia (.RM or .RAM file extension).

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Type of Codecs

Audio Video Interleaved (AVI)

AVI was released by Microsoft (MS) in 1992 as an extension of Windows 3.1 called Microsoft Video-for-Windows (VfW). It enabled 386- and 486-based computers (prependium era) to play back a video without using any additional hardware i.e. through software alone, and could play back an incorporated soundtrack. This format permits many different compression methods, in real-time or not in real-time, and with or without hardware assistance. The original codecs included in VfW were MS Video 1, Indeo and Cinepak. The video quality depends on the codec used and compression ratio selected (Table 1). MPEG-4 video (see below) is also used in stand-alone, AVI files.

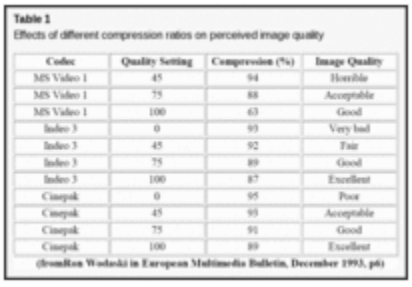

Table 1
Effects of different compression ratios on perceived image quality

Codec	Quality Setting	Compression (%)	Image Quality
MS Video 1	45	94	Horrible
MS Video 1	75	88	Acceptable
MS Video 1	100	63	Good
Indeo 3	0	93	Very bad
Indeo 3	45	92	Fair
Indeo 3	75	89	Good
Indeo 3	100	87	Excellent
Cinepak	0	95	Poor
Cinepak	45	93	Acceptable
Cinepak	75	91	Good
Cinepak	100	89	Excellent

(from Ron Wodaski in European Multimedia Bulletin, December 1993, p6)

Table 1
Effects of different compression ratios on perceived image quality

Microsoft Video 1

This codec comes from an era when a 256 colour display was considered good quality, so naturally, the codec suffers from this colour restriction. Image size is 240×180 pixels.

Cinepak

This codec was originally developed jointly by Apple and SuperMac and later acquired by Radius. It was intended to play small movies on 386-based computers from CDROM. Image size is 320x240 pixels at 15 to 30 frames per second. All Windows machines should be able to play back AVI video files encoded with Cinepak.

Indeo

Intel developed this codec in the 1980s. The original version 3.2 can be played back by all Windows versions but requires at least a Pentium based computer. Size was 320×240 at 15 frames per second on 486-based computers. Newer versions of Indeo are available and this codec is now owned by the Ligos Corporation. The more recent versions vary image quality according to computer processor power, with no dropping of frames.

Moving Picture Experts Group (MPEG)

MPEG was established in 1988 and is a working group in charge of the development of standards for coded representation of digital audio and video. This format combines two forms of compression. Intraframe (spatial) compression removes redundancy within each frame. Interframe (temporal) compression removes redundancy between video frames. MPEG video consists of sets of frames known as a GOP (group of pictures). Each group is eight to twenty-four frames long and has only one frame represented in full, known as an I frame, which is compressed using only intraframe compression. Around it are frames that only depict frame changes and not full frames. These may be P (predictive) frames that refer only to the previous frame, or B (bidirectional) frames that rely on both previous and subsequent frames.

The MPEG-1 codec is playable on virtually all platforms, including the Apple Mac. It was released in 1993 and works at 1.5 Mbit/s at a resolution of 352×240 pixels at 30 frames per second, with quality equivalent to VHS videotape. This format is interpolated and scaled. Interpolation blends adjacent pixels by interposing pixels with the codec's ‘best-guess’ colour value. Scaling means that one pixel on playback is scaled up to the size of four pixels, giving a somewhat blocky appearance.

MPEG-2 was designed for higher, broadcast quality digital audio and video, and is the format that Digital Versatile Disc (DVD) uses. This codec carries more information at a rate of up to 15 Mbit/s and a resolution of 704×480 pixels at 30 frames per second, four times greater than MPEG-1 and twice that of standard videotape. MPEG-3, intended for high definition television, was rolled into MPEG-2.

MPEG-4 is designed for high quality web streaming video and provides excellent quality at relatively low data rates. Microsoft has its own implementation in the Advanced System Format (ASF). This format provides standardised ways of representing units of audeo, video or audio-visual content, as discrete ‘media objects’, and also allows views to interact with such objects within a scene.

M-JPEG (motion JPEG) performs intraframe compression without any interframe compression. In effect, such a video stream is the equivalent of a sequence of I frames, and is naturally well suited to rapid scene changes.

DivX

This codec combines a variant of MPEG-4 video compression with MP3 sound compression, with a result that is almost as good as DVD quality in a very small file. Typically, a 5-6 gigabyte DVD movie can be compressed to 600 megabytes, and can therefore fit on a CDROM.

Sorenson

The Sorenson codec is used by Apple Computers QuickTime only and affords very good quality and compression ratios.

DICOM

Cardiology has moved into the world of digital image storage, and in common with the rest of the medical world, the DICOM (Digital Imaging and Communications in Medicine) standard has been adopted.[3]DICOM was created by the US National Electrical Manufacturers Association for the distribution and viewing of all kinds of medical images and specifies the exact way in which such images are exchanged. For example, in angiography, only grey-scale lossless sequences and images are permitted and only storage to CDROM is allowed.[4] Echocardiography produces larger files and therefore higher capacity media are permitted, such as re-writable magneto-optical disks, floppy disks, and CDROMs. Lossy compression is also allowed using a form of Joint Photographic Experts Group (JPEG) compression.

In conclusion, all of this allows a non professional video user to manipulate and produce video clips using a simple and humble, entry level home computer.

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