Compressing Digital Video

Introduction and Significance

Full size, full motion video requires a computer to deliver data at 30 MB per second. Today's newer computers can handle this, but it results in video files in the gigabyte range for only a few minutes of video. Even if the computer can process the data, such large files are impractical for storage and transfer. This is especially important for files that will be transferred over the internet. Compression creates a new file that stores data in a format that requires less space. In some cases the compressed file can later be decompressed or expanded.

How Compression Works

Compression is achieved through the use of a codec: a compression – decompression algorithm that looks for redundancy in data files. For example, XXXYYYY could be reduced to 3X4Y. In this example, the compression is considered "lossless" because the file can be decompressed and restored to the original format without any loss of data. Video compression, however, is considered "lossy" because it results in a loss of data. When compressing video, codecs look for redundancy in areas where the human eye or ear cannot distinguish between differences. Since the human eye is less sensitive to color differences than to brightness, the color information (chrominance) is separated from the brightness information (luminance). The codec then averages the chrominance data for adjacent pixels, which reduces the volume of data. The luminance data is not changed. Normally, individuals cannot perceive the

differences caused by the lossy compression. However, when the image is enlarged, the data loss is obvious, and it will look blocky.

The algorithm of a codec achieves compression in other ways, such as by recording only the differences between frames. Since most of the information from frame to frame is the same, less data needs to recorded. Compression is also achieved by assigning short codes to frequently used characters while less frequently used characters are converted to longer codes.

The amount of compression that is achieved is known as the compression ratio. Compression ratios will vary according to the type of images in the video and how much the images change. A busy image with many colors will not compress as much as one with less colors.

Compression Formats for Video

MPEG is the acronym for Moving Picture Expert Group, and it is the standard for digital video. The different types of MPEG are used for different data rates and applications. MPEG 1 was developed first to encode video at data rates of less than 1.4 Mbps. This is the data transfer rate of a single-speed CD drive and allows for video CD format. MPEG 2 supports better quality video. It has a data rate of 10 Mbps and is the compression format for DVD, direct broadcast satellite, and digital cable. MPEG 4 has been developed for video transfer over the internet and thus has the lowest data rate at 64 kbits/s. Other types of MPEG for use in multimedia are being developed such as MPEG 7 and MPEG 21.

Recently, a start-up company known as Pulsent has unveiled their new video compression technique which they claim can shrink digital video to one fourth of the MPEG standard (Olsen and Hansen, 2002, March 24). This company seeks to use their technology for Video-On-Demand services provided by companies such as Disney and Century Fox that would deliver quality broadcast programming over the internet.

Choosing a Codec for Video Compression

Video producers can choose from a number of different codecs to compress their files based on their specific needs. Cinepak ($129) is a good choice for files that will be played on older computers. It compresses files for older versions of QuickTime; however, it does not compress as well as some newer codecs. Apple's QuickTime Pro ($30) will compress video files but with limited results. It comes with additional features that allow you to adjust colors, contrast, and apply special effects. Sorenson Squeeze ($299) is a popular, new codec that can compress video for web delivery while retaining quality. It also allows for variable bit rate, so files can be customized for delivery via a 56k modem or via cable/DSL. Cleaner 5 ($599) by Discreet has obtained the reputation for being the most powerful codec that provides the highest compression ratios without loss of video quality. It provides a full array of quality-optimizing features, though it is not as easy to use as Sorenson Squeeze (Heil, 2002, April 1).

Factors to Consider for Video File Size

1. Frame Rate: Raw video runs at 30 frames per second. However, the illusion of motion can still be generated with speeds as slow as 10 frames per second when there

is no fast moving items. Cutting the speed to 15 frames per second or less can cut the size of a file in half (or less than half) without sacrificing quality when there is only a moderate amount of motion.

2. Image Size: Full screen resolution is typically 640 x 480 pixels. Like frame rate, reducing the image size can significantly reduce file size. When reducing image size, a 4:3 aspect ratio should be retained. It may be possible to play back a 320 x 240 image sized video at double-size to become a full-screen movie with reasonably good results. A small video size would typically run at 192 x 144 pixels.

3. Color Depth: Normal digital video contains 24-bit color (millions of colors). Pulling down the color range to 16 bit (thousands of colors) will reduce file size by one third. Some codecs allow 8-bit color (256 colors) which might work only for animations. Tests should be done on the video file to determine which color depth is necessary because reducing color depth can greatly distort the image.

Summary

Since raw digital video produces enormous file sizes, the video file must be compressed so that it can be stored and transferred. File sizes need to be reduced so they can fit on a CD-ROM (700 MB) or DVD (4 GB) or transferred over the web at 1-2 Mbpm. File compression is achieved through a codec, a compression/decompression algorithm that reformats data so it takes up less space. Video compression is lossy compression that uses the MPEG format as the standard. A variety of different codecs are available which produce widely varying results, both in terms of compression ratios and in terms of image quality.

References

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Compression/Decompression FAQ. http://www.midl.co.jp/DLC/com_decom_E.htm

De Lancie, P. (2002, January 1). Shrink to Fit. Video Systems. Available online from Electric Library, www.elibrary.com

Heid, J. (2002, April 1). Sorenson Squeeze 1.0. MacWorld p. 39. Available online from Electric Library, www.elibrary.com

Olsen, S. and Hansen, E. (2002, March 24). Show Time for New Video Compression. CNET News.com. http://news.com.com/2100-1023-867490.html?tag=prntfr

Vaughan, T. (2001). Multimedia: Making it Work (5th ed.). Berkeley, CA: McGraw-Hill.

Websites for Additional Research

Codec Central: a listing and comparison of different codecs
http://www.siggraph.org/education/materials/HyperGraph/video/codecs/Default.htm

Compression Techniques (using Discrete Cleaner 5.0 and other compression tools)
http://wiscinfo.doit.wisc.edu/ltde/ORFI/avs/compress.htm

Data Compression Reference Center:
http://www.rasip.fer.hr/research/compress/index.html

MPEG-2 Video Compression Tutorial by P. N. Tudor
http://www.bbc.co.uk/rd/pubs/papers/paper_14/paper_14.html

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