**COMPRESSION**

## A Brief Summary & Guide to Image, Audio & Video Compression

**By Bapusaheb Patil**

* Why Is Compression Important?

Because it saves space. It enables you to save more of your selfies, more funny cat videos, more Game of Thrones episodes, more Eminem or Martin Garrix or Taylor Swift songs (or whatever musician you fancy), more of anything else you wish on your laptop/PC or phone.

And it is faster and more cost-efficient to send a compressed image/video/audio file because high speed internet connections are not always available in all locations.

The following paper comprises of a detailed description of how image, audio and video files are generated, encoded, or ripped and how they can be compressed further to optimize space whilst maintaining the integrity of the files and keeping a minimal margin of quality loss.

* Image Compression

There are many formats of image files, like JPG/JPEG, PNG, GIF, TGA, BMP.

Several factors attribute to the size of an image file. But first, let’s clear some of the common misconceptions that people have over what properties affect the size of pictures.

1. Saturation:
   1. The amount of hues that are in an image has very little to do with the size of the image.
   2. They are merely represent the RGB color spaces/CMYK color spaces that are present in the picture.
   3. “Desaturating” an image file (removing all the colour or reducing the RGB values) does not significantly reduce the space taken up by the picture.
2. Resolution:
   1. Actually, resolution does have a considerable impact on the size, but you can have an image file with high resolution that is smaller in size than an image file with lower resolution.
   2. To explain this, let me take the example of two images:

Let us call the first image “Scenery” and the second image “Grass”.

* 1. “Scenery” captures more detail than “Grass”, meaning there are more number of sharper details and raster details in it than the latter.
  2. “Grass” largely comprises of shades of similar colours and doesn’t capture too many details.
  3. “Grass” is of a higher resolution than “Scenery”. But the file sizes indicate otherwise:
     1. Grass.jpg – 1.20MB
     2. Scenery.jpg – 2.64MB

1. Format:
   1. Various formats have different compression algorithms. There are two types of image file compression: lossless and lossy.
   2. JPEG, the most commonly used image format follows a lossy compression method.
   3. GIF, animated images, is a lossless compression-following format.
   4. PNG, the most used format on the internet, follows a lossless data compression.
2. Bit Depth:
   1. Images have a property called bit depth. That is the main property of any image that determines the size of the image.
   2. Bit depth is nothing but information regarding the colors stored in a picture.
   3. The higher the bit depth of the image, the higher the size of the image.
   4. This is because more colour information is stored in an image of higher bit depth.
   5. How to calculate the rough size of an image given it’s resolution and bit depth:

Consider an HD image file of resolution 1280x720 with 24-bit color (most common).

The size occupied by it would be: 1280 x 720 x 24 bits

= 2,21,18,400 bits

= 27,64,800 bytes

= 2,700 kB

HOW DO I COMPRESS IMAGES?

There are several ways in which we can compress images, but there is no method in which images can be compressed without any drawback. There are many sites and applications which compress images, but I will be only listing the ones I have found most efficient, keeping in mind a good quality to size ratio.

1. FILEminimizer Pictures – This is a free Windows software that is capable of compressing image files upto 98%. And the quality loss percentage is adjustable too. A 7MB photo is reduced to 0.15MB with only 10% loss in quality.

Link: http://goo.gl/MiZWuq

1. CompressNow – I have compared this site with other sites and it is a robust site for compressing images. The main feature is you can actually select the compression percentage and the site processes your image accordingly.

Link: www.compressnow.com

* Audio Compression

Two of the most commonly used audio formats include MP3 and M4A (also known as AAC).

Audio compression is the easiest to understand among the three types of compression discussed in this paper. These are the following factors that are in play while an audio file is created or encoded or ripped from a CD/DVD.

1. Bit Rate:
   1. This is amount of bits that are processed per second in an audio file when it is played or accessed otherwise.
   2. This is the main factor that determines the size of an audio file no matter what the format of the file is.
   3. Higher the bit rate, higher the size of the audio file.
   4. In the early 2000s, around the time when the first iPod launched, a bit rate of 128kbps was considered to be of high quality, but we even have 320kbps now, which offers better quality.
   5. A 320kbps MP3 file can be converted into a 128kbps MP3 file. Doing so would reduce the size of the file, but will hinder quality and may cause distortion in some cases. This may also corrupt parts of the audio file and render the audio file useless.
   6. But the main goal should be to use the best format to maintain an optimum bit rate, balancing both quality and size.
   7. This is further discussed in the “Format” section of this paper.
   8. But the key point to remember is, larger the file size, better will be the sound quality.
2. Format:
   1. As I previously mentioned, the most commonly used formats are M4A and MP3. FLAC is also used by music enthusiasts, because it is the most lossless audio format till date, but I won’t be going into that in detail.
   2. While converting/compressing an audio file, each format has certain boundaries regarding the bit rate of the final output file.
   3. MP3 files can only have 8, 16, 24, 32, 40, 48, 56, 64, 80, 96, 112, 128, 144, 160, 192, 224, 256, 320 kbps of bit rate. M4A files can have 8 to 529 kbps of bit rate.
   4. First off, M4A is a better audio format than MP3, but MP3 has better compatibility than M4A, meaning, it can be played on more devices than M4A. M4A was developed by Apple for the music sold on iTunes and for Apple devices like iPod, iPhone, etc.
   5. Why is M4A better than MP3 then? Because if we consider a M4A and a MP3 file of the same bit rate, the M4A file takes up lesser space and also offers a better quality than the same MP3 file.
   6. A 256kbps MP3 file is equivalent to a 192kbps M4A file with respect to the sound quality. And the M4A file will be smaller than the MP3 file.
   7. M4A files take up lesser space while providing better sound quality than MP3 files. All this happens even at a lower bit rate than MP3 files.
   8. So, ideally, a user should prefer an audio file of M4A format, at 192kbps. Here are the ideal bit rates for certain scenarios:
      1. 128kbps – For a smaller file size, if you need to save space.
      2. 192kbps – Ideal, balances both file size and sound quality. Most recommended.
      3. 256kbps – Superb sound quality, but file size will be high.

HOW DO I COMPRESS AUDIO?

I have tested the top audio converters to compress audio files with various formats, bit rates and sample rates, like AVS Audio Converter, Switch Audio Converter, Wondershare Converter Ultimate, Xilisoft Audio Converter and Audiozilla. But most of these softwares have drawbacks when it comes to functionality or ease-of-use. The following three applications provide a good GUI with good compression rates:

1. Switch Audio Converter – This is by far the most versatile software that I could find to convert my entire music library into a size-efficient M4A format. It also allows batch conversion and auto file-naming according to a qualifier that is preset by the user. It can also grab and convert files from audio CDs and compress them to the PC. Post compression, all the metadata of the music files is still saved as it was on the original input files.

Link: http://goo.gl/kBHmVQ

1. AVS Audio Converter – This is just a free alternative and while it is not as good as Switch Audio Converter, it does get the job done while providing a friendlier user interface. The main drawbacks of this are:
   1. It may render some audio files moot and/or may cause distortion during playback.
   2. All metadata is lost post compression.

Link: http://goo.gl/RLK5T4

1. Wondershare Video Converter Ultimate – This is technically a video converter, but you can also use it to convert and compress audio files. If you find the above two applications to be too complex to use, Wondershare offers a much more user-friendly interface and it has a large collection of input and output formats to choose from.

Link: http://goo.gl/pWzCvr

* Video Compression

This is probably the most important part of the paper because it has a huge impact on digital storage solutions, both personal and enterprise. And therefore, I have spent a lot of time finding better solutions to compress videos efficiently without making the picture blocky and with zero frame judders.

Video files have so many properties which can be tweaked in order to get the most efficient video output. The main properties of any video file are: Overall Bit Rate (or just, Bit Rate), Format, Codec, Bit Depth.

1. Format:
   1. When it comes to video, format doesn’t contribute to much of the file size.
   2. What is a “format”? It is just a container that encapsules multiple codecs for video, audio and other relevant information.
   3. What is a “codec”? Codec is a standard of compression that is used to compress video files when they are being encoded. The same video file is “decoded” by the video player during playback only if the video player supports that particular codec.
   4. Example:
      1. MKV, MP4, 3GP, AVI are all formats which contain different video and audio codecs.
      2. HEVC/H.265, H.264, AAC are different video and audio codecs.
   5. AVI was the most commonly used video format before but we have now moved on to better formats. AVI is not capable of containing better codecs like HEVC/H.265.
   6. 3GP was used in mobile phones to record videos and while it supported a good bunch of codecs, it compromised in video quality.
   7. MP4 is the most widely used video format today. It is used in all smartphones and is capable of holding a wide variety of both audio and video codecs. It even supports 4K video. It is the most compatible video format but it is not space-efficient and takes up more space when compared to MKV. This makes it the second-best video format.
   8. MKV is currently gaining a lot of traction and is being used to encode videos more often these past few years. It is capable of holding the latest video codec HEVC/H.265 and does so while maintaining a small file size at a very reasonable bit rate. It is probably the best format right now.
   9. To be noted: Not all formats will be supported by your video player.
2. Bit Rate:
   1. In a video file, bit rate comprises of both video bit rate and audio bit rate.
   2. Video Bit Rate + Audio Bit Rate = Overall Bit Rate
   3. The rule here is simple and same as the one for audio bit rate as discussed in the above section. The higher the bit rate, higher will be the file size, and better will be the video/audio quality.
   4. Usually, an overall bit rate of 700kbps is enough to encode a video of good quality.
3. Bit Depth:
   1. Currently, video files are encoded/decoded in two bit-depths: 8-bit and 10-bit.
   2. Higher the number of bits, higher is the colour information, and hence better is the picture.
   3. 8-bit is more frequently used, and while it is not that colour-detailed and sharp as 10-bit, it does take up lesser space than 10-bit.
   4. 10-bit is gaining popularity and is more rich in colour and is capable of capturing more details while recording the video and also while encoding/compressing the video later on.
4. Codec:
   1. Video formats contain both video and audio codecs, but I will be only covering video codecs in this part.
   2. Codecs are the most important part of any video file as they are solely responsible for the video file size and also for the quality of the output file.
   3. The commonly used video codecs are XVID, HEVC/H.265 (also x265), H.264 (also x264), DivX, FFMpeg.
   4. XVID is one of the oldest codecs in video encoding. It is best contained in an AVI format, followed by MKV and MP4 formats, although the latter formats are not that efficient in containing XVID format. I would not recommend anyone to use XVID codec as the file compression is terrible whilst also rendering an inferior quality output file.
   5. H.264 is also one of the older video codecs used and this is the second highest quality codec available (after HEVC/H.265). It is the most widely deployed and is compatible with almost all modern devices today. It also used to record videos on handheld devices. Even web browsers can play H.264 codecs. But in 2013, a new video codec called HEVC or H.265 or x265 was released for the public that was much more efficient than H.264. It also supports 4K video thanks to some improvements and development done in the last few years.
   6. HEVC is the successor of H.264 codec and it is the most highly recommended video codec because not only is it 40% more space-efficient than H.264 and more than 60% space-efficient than almost all other video codecs like XVID, FFMpeg, etc. One of the notable features of HEVC codec is that it supports 8K video, although 8K video is uncommon and is used mostly in film & studio level production. HEVC is a ground-breaking innovation in the field of video compression and it is the latest codec in use right now. Because of that, a huge team of developers are working on it to make it more efficient and more robust. Let me demonstrate how the essence of HEVC codec:

(The following data is actually experimental data collected from video files on my own personal laptop and all the information regarding the video properties is true and as follows)

* + 1. I have downloaded a 1080p video file (a movie) that is 1 hour 41 minutes long.
    2. The original source file is in H.264 codec and is contained in a MP4 format. Bit depth is 8-bit and Bit Rate is 1200kbps. This has resulted in a file size of 3.76GB.
    3. Using Handbrake (a video converter/encoder that is explained further in the later part of this paper), I compressed the file to 1.55GB WHILE MAINTAINING THE SAME QUALITY AS THE SOURCE FILE, HENCE A LOSSLESS COMPRESSION. The file was converted into HEVC codec.
    4. The details of my output video file are: 1080p resolution, 8-bit bit depth, 1200kbps bit rate, HEVC/H.265 codec. And a size of 1.55GB.
  1. So using HEVC codec, I could compress a video file to nearly 41% of its original size.
  2. It is worth mentioning that H.264 and HEVC codecs both support 3D video files.

HOW DO I GET INFORMATION/VIDEO PROPERTIES REGARDING VIDEO FILES?

Download and install **MediaInfo**, a software that displays a unified view of technical and tag data (or metadata) that is relevant to video and audio files, from:

www.mediaarea.net

After installing it, just Right-Click on the video/audio file you want information on, and click on ‘MediaInfo’ from the Explorer context menu.

HOW CAN I PLAY A VIDEO FILE OF ANY CODEC/FORMAT?

Install K-Lite Codec Pack from:

www.codecguide.com

After installation, it installs decoders that are capable of playing all the codecs regardless of the video player used, i.e. even Windows Media Player will be capable of playing HEVC and 3D video files.

Now let’s get to the important part:

HOW DO I COMPRESS VIDEO FILES?

A lot of applications have been released since different codecs were released and are being improved on. All you need to compress/convert a video file is a mid-range graphic card with a rating of at least 5 from Game-Debate.com, a mid-range processor and 2GB of RAM, apart from the video encoding software itself.

But let us focus on the ones that support HEVC encoding because that is the most essential codec and the application needs to support that as it will be the most commonly used codec in a few years, beating out H.264 and XVID. After installing these softwares, they will guide you on how to compress video files on first launch.

1. Handbrake – This is most widely used GUI-based video converter, mostly because it is open-source and supports a huge range of formats and codecs. It supports HEVC codec with 3D-HEVC as an additional option, for encoding 3D video files. Since a lot of developers are working on making Handbrake better, that makes it the best video encoder out there. It also multi-platform (Windows, Mac, Linux). You can also set the priority of the thread, what this does is it allows the system to allocate more resources and hence put more effort into converting the given video file. This results in a faster and a better quality output. You can also enable multi-thread processing so that all cores are used in the conversion of the file, although keep in mind that the graphic card has more to do with the conversion of the file than the processor.

Link: handbrake.fr

1. Wondershare Video Converter Ultimate – If you’re looking for a simpler looking and more user-friendly video transcoder than Handbrake, then Wondershare is a good alternative. It also supports conversion of audio files. One of the limitations is that it is not available for Linux, on which threads tend to run faster than Windows or Mac. But this a paid and premium application, unlike Handbrake, which is free and open-source. This has a collection of video and audio presets to choose from and does not allow the flexibility that Handbrake does, but it is faster than the latter in conversion rates. There is a small margin of quality loss while encoding videos with Wondershare, but this can be negligible in most cases.

Link: www.wondershare.com