H.264/AVC
Encode Technology V0.8.0

H.264/AVC Standard Overview

H.264/AVC standard was published by the JVT group, which was co-founded by ITU-T VCEG and ISO/IEC MPEG, in 2003. By adopting new technologies in the video compression field, H.264/AVC outperforms its predecessor, MPEG-2, with its high performance and moderate compression complexity level. Now, it has already taken the place of MPEG-2 and become the most popular compression standard in the world.

Video Compression Performance

Rate-Distortion is typically used to judge the performance of compression algorithms. The Rate is the bit rate of the compressed video, with bps (bits per seconds) as its unit of measure. The Distortion measures the difference level between the compressed video and the original video. The Distortion is measured by Peak Signal to Noise Ratio (PSNR), with dB as its unit.

The diagram below depicts the improvements in compression performance from the initiating version TML1 to the published version JM6.1e, with a QCIF 10fps video as an example. It is part of a paper published by Thomas Wiegand and Gary J. Sullivan on CSVT, July 2003. The name of the paper is Overview of the H.264 / AVC Video Coding Standard.
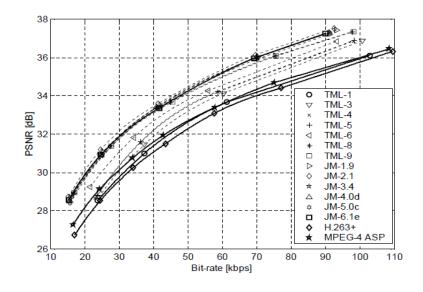

Diagram 1: An Example of H.264/AVC Compression Performance

There are two ways to compare two compression algorithms:

- Comparing PSNRs with fixed bit rate.

For example, in the above diagram, when the Bit-rate = 60kbps, the PSNR value of H.263+ is 2dB lower than that of JM-6.1e.

- Comparing bit rates with fixed PSNR.

For example, in the above diagram, when PSNR = 32dB, the bit rate of H.263+ is 18kbps higher than that of JM-6.1e, which means H.263+ needs 60% more bit rate than JM-6.1e to achieve the same video quality.

What needs to be pointed out is that the diagram above is the performance of JVT's official encoder. Not all H.264/AVC encoders from different manufactures have the same performance. Video compression standards, including H.264/AVC, actually define rules for how video streams should be organized, and how to resolve the video stream when decoding it. How to perform the encoding procedure is not covered in the standard. Hence, adopting an advanced compression standard doesn't imply better compression performance will be achieved. An appropriate analogy is that the standard is like a dictionary for the reader to refer. A better dictionary provides more accurate definition to reduce the possibility of misunderstanding, however, how the writer uses this dictionary in his writing, is not ensured and controlled by the dictionary.

Moreover, Rate-Distortion is an objective indicator for compression performance under an ideal hypothesis. In the real world, before we can have the compressed video, the original video needs to go through a complicated procedure. There are many other factors which impact video quality and compression is only a part of it.

H.264/AVC Profiles and Levels

The H.264/AVC standard defines three profiles, including Baseline, Main and High, and further classifies in levels ranging from 1 to 5.1. The Profile Mark in the video stream indicates the encoding technology tools applied, and the Level indicates the maximum resolution, Macro-block rate, bit rate, etc.
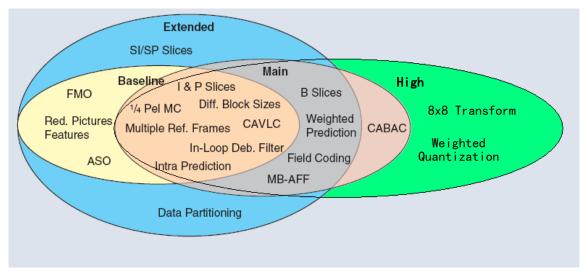
Figure 1 H.264/AVC Profiles and Encoding Technology Tools

A decoder can decide whether it supports the video stream or not by analyzing the Profile and Level content in the stream. Essentially, Profile and Level are the limitations of video stream supported by the decoder, not an encoder's maximum abilities. An encoder can use any Profile or Level, even when its abilities can not reach the same level. So, it is not reasonable to use Profile and Level to judge an encoder's performance.

Encoding Quality

Video quality observed by end users is not only influenced by encoding, but also sampling and processing before encoding. For example, the existence of noise changes the probability distribution of the image compression information and results in performance downgrade. High sharpness and brightness make bit rates rise dramatically. Nevertheless, this paper introduces three important factors that may influence encoding quality during the encoding process.

1)   Number of Macro-block encoding modes and performance of algorithm that select the encoding mode. The H.264/AVC standard defines several Macro-block encoding modes. Different parts of an image can select the most proper one, according to the characteristics of the corresponding part, for encoding. However, commercial encoders do not support all-prediction mode because of cost factors. Regarding real-time encoding, it is impossible for them to compare quality bit-rate ratios of different encoding modes as well. So, they have to estimate the situation and

select an encoding mode in advance by selecting some algorithms. The H.264/AVC standard doesn't define specific encoding modes and the selection of algorithms that must be supported. So, encoder manufacturers must design and implement the encoding modes and selection algorithms, which may vary greatly in performance.

2)   Inter Motion Estimation abilities.   Inter Motion Estimation is a major compression method used in video compression algorithms, including H.264/AVC. When Motion Estimation works, every part of the current image searches for the most similar reference in the previous image within a specific range, and the encoding process only compresses the residual data (differences between current image and previous image). Redundant information is greatly reduced in this way. The range and accuracy of Motion Estimation have key impacts on compression quality. The performance difference between algorithms is very huge, especially under dramatic motion scenarios.

3)   Encoding technology tools. Encoding technology tools are related to profile definitions, such as CABAC, B Slice and Field coding in Main Profile, and Transform and Weighted Quantization in High Profile, etc. These encoding technology tools make the H.264/AVC standard outstanding. By adopting these technologies properly during the encoding process, compression performance can be greatly improved. For example, CABAC (Context-based Adaptive Binary Arithmetic Coding) can improve compression ratio by10%-20%

Besides the above factors, there are many others. For example, bit rate control also affects encoding quality. A video with consistent quality is more pleasant to watch than a video with up and down performance, though the later may have a smaller file size.

Conclusion

To judge the encoding performance of an encoder, we can analyze its number of macro-block encoding modes, motion estimation ranges, and encoding technology tools. The best way of testing an encoder is to compare it with other similar products in real applications. This must be done in the same environment, with the same parameters, and with a comprehensive set of test cases.

Being the first company adopting H.264/AVC standard in the CCTV field, Hikvision is very experienced in video compression algorithms. With years of accumulated experience, Hikvision products achieve the best performance compared to the same level products from other suppliers. Hikvision megapixel products support multiple encoding technology tools under Baseline, Main and High Profiles. With dedicated design and development, Hikvision megapixel products generate video streams with fine image qualities while keep the bit rate at the lowest level. A 720P@30fps stream only requires 2Mbps while a 1080P@30fp stream requires 4Mbps. Because of this, the cost for bandwidth and storage are greatly reduced.

HIKVISION

About Us

Hikvision is the world's largest supplier of video surveillance products and solutions. The company specializes in video surveillance technology, as well as designing and manufacturing a full-line of innovative CCTV and video surveillance products. The product line ranges from cameras and DVRs to video management software. Since its inception in 2001, Hikvision has quickly achieved a leading worldwide market position in the security industry.

Hikvision possess the world's largest R&D team and state-of-art manufacturing facilities; both allow Hikvision's customers the benefit of world-class products that are designed with cutting-edge technology. As further commitment to its customers, Hikvision annually reinvests 7% of its revenue into R&D for continued product innovation and improvement.

Hikvision operates 31 domestic branches in China and 14 overseas regional branch offices, in conjunction with over 30,000 partners all over the world to achieve a truly global presence. Hikvision is now publicly listed on the Shenzhen Stock Exchange. For more information, please visit Hikvision's website at www.hikvision.com.