

The video compression standards of the future: VC-1 and H.264.

Two new video compression standards have emerged in recent years that significantly outperform older standards such as MPEG-1, MPEG-2 or MPEG-4(part 2). These new standards are H.264 and VC-1.

The H.264 standard was developed by the MPEG community in conjunction with ISO and was first officially published in 2003. VC-1 is an informal reference to the SMPTE-412M standard, originally developed by Microsoft, as part of their Windows Media Player toolset. VC-1 became officially and openly available under the auspices of the SMPTE in 2006. In the PC world, VC-1 is often referred to as WMV-HD, WMV9, WVC-1. Both VC-1 and H.264 have been officially adopted, along with MPEG-2, by the BlueRay consortium.

There are many objective benchmarks comparing the compression performance of VC-1 and H.264. The benchmarks consistently show that the two standards give very similar compression quality over a wide range of bitrates. It has, however, been argued that VC-1 performs slightly better when B-frames are not used and that H.264 performs slightly better when B-frames are used. In all cases VC-1 and H.264 compression has been shown to be much better than any of the older standards, especially for high definition video.

These new encoding standards achieve their level of performance by incorporating new coding tools that are not present in older standards. These tools include an advanced entropy coding system, variable size DCT transform, fractional pixel motion search, multiple motion vectors per macroblock, and an in-loop deblocking filter.

Advanced entropy coding in VC-1 is achieved via an adaptive Huffman based VLC table selection which allows the entropy coding algorithm to vary according to motion or bitrate variations. In H.264, a computationally more complex Context Adaptive Binary Arithmetic Coder (CABAC) is used to improve entropy coding.

The H.264 and VC-1 standards have a variable DCT transform size feature. VC-1 supports multiple DCT block sizes including 8x8, 8x4, 4x8 and 4x4 while H.264 supports 8x8 and 4x4. This feature helps to improve coding quality for video that contains very fine objects/details.

Both standards have quarter pixel motion search precision that allows for further reduction of residual data on macroblock matching. H.264 implements a 6-tap filter for $\frac{1}{2}$ pel interpolation and successive bilinear interpolation for quarter pel while VC-1 implements a bicubic filter for $\frac{1}{4}$ pel interpolation and separate bilinear interpolation for $\frac{1}{2}$ pel pixels.

Up to 4 motion vectors per macroblock are available in both standards. These multiple motion vectors allow for more precise motion estimation of low granularity moving objects and provide improved macroblock matching for this detail.

An in-loop deblocking filter is present in both standards and reduces blocking artifacts at macroblock/block boundaries especially at low bitrates. The in-loop filter also reduces the bitrate due to its low pass filter behavior.

H.264 proposes spatial predictive coding, in addition to a temporal predictive coding mode. This further reduces bitrate in homogeneous image regions of I-frames.

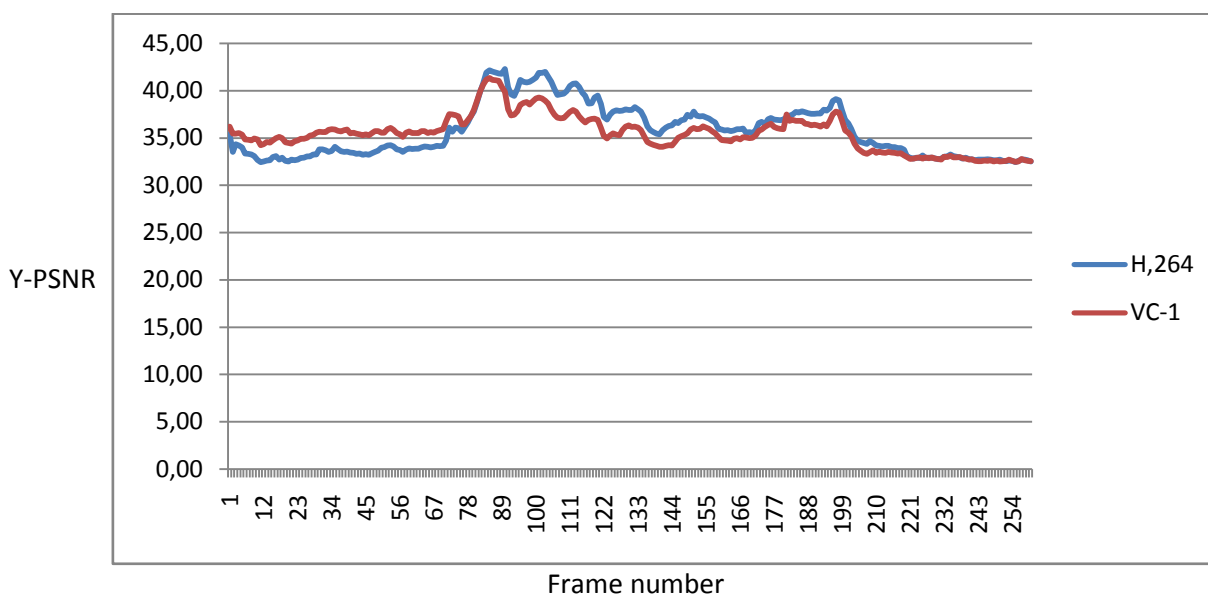
Not all of these afore mentioned tools need to be used to see the performance advantages of H.264 and VC-1 over the older standards. In fact, many practical H.264 and VC-1 encoder solutions only use a subset of the tools to reduce processing cost but still achieve very good performance.

VC-1/H.264 benchmark result

The chart bellow shows a typical PSNR performance of a VC-1 and an H.264 codec with similar tool sets enabled. The well known football sequence (resolution 720x480) was used and 260 frames were encoded. The bitrate was set to 1,3Mbits/s for both encoders.

Average Y-PSNR for VC-1 encoder: 35.08dB

Average Y-PSNR for H.264 encoder: 34.98dB



References

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