RECOMMENDATION ITU-R BT.1737

Use of the ITU-T Recommendation H.264 (MPEG-4/AVC) video source-coding method to transport high definition TV programme material

(Question ITU-R 12/6)

(2005)

Scope

This Recommendation specifies the use of the video source-coding method as per ITU-T Recommendation H.264 (ISO/IEC standard 14496-10), also known as MPEG-4/AVC, for the transport of high definition TV (HDTV) programme material for a variety of broadcasting applications.

The ITU Radiocommunication Assembly,

considering

a) that there are applications where it is desired to transport HDTV programme material in a virtually transparent fashion, i.e. introducing minimal visible artefacts, using a reduced bit rate;

b) that Recommendation ITU-R BT.709 Part 2 specifies the parameters for a family of HDTV video systems based on the use of a common image format of 1 080 active lines (interlaced and progressive) and 1 920 pixels per active line;

c) that ITU-T Recommendation H.264[1] specifies the algorithms for the advanced bit rate reduction coding method;

d) that the ITU-T Recommendation H.264 specifications are applicable to a variety of video systems, and they are increasingly used for various applications,

recommends

1 that when it is necessary to transport HDTV programme material in a virtually transparent fashion using a reduced bit rate, the 1 080 × 1 920 HDTV signal of Recommendation ITU-R BT.709 Part 2 (interlaced or progressive) should be source-coded in ITU-T Recommendation H.264, down to the bit rate available in the channel, with the parameters of levels 4 and 4.2 (the informative Appendix 1 provides an indication of the source-coding parameters and minimal tools for various members of the image systems in Recommendation ITU-R BT.709 Part 2; it also provides an indication of the bit rate for transport of the programme material so coded);

2 that, if the available bit rate is particularly low, the HDTV signal may be horizontally downsampled to 1 440 samples per active line prior to source coding.

NOTE 1 – Recommendation ITU-T H.264 is available in electronic form at the following address: http://www.itu.int/md/R03-SG06-C-0225/en.

[1] ISO/IEC Standard 14496-10, commonly called MPEG-4/AVC.

Annex 1

Example parameters and minimal tools to source-code various members of the image systems in Recommendation ITU-R BT.709 using ITU-T Recommendation H.264

This Annex shows example parameters and tools of the ITU-T Recommendation H.264 source-coding method that would be used to compress various members of the image systems specified in Recommendation ITU-R BT.709, Part 2. It also provides an indication of the bit rates for the transport of those signals when so source coded.

TABLE 1

Example parameters of ITU-T Recommendation H.264 source-coding for HDTV

Rec. ITU-R BT.709 family member	Level	Profile	Application	Bit rate (Mbit/s)
1 920 × 1 080 × 60/50i 1 920 × 1 080 × 24/25/30p	4	High 4:2:2	Contribution	20-30[(1)]
	4	High 4:2:2	Distribution	16-20
	4	High 10	SNG	10-15[(1)]
	4	High	Emission	8-12
1 920 × 1 080 × 60/50p	4.2	High 4:2:2	Contribution	30-40[(1)]
	4.2	High 4:2:2	Distribution	25-30[(1)]
	4.2	High 10	SNG	TBD
	4.2	High	Emission	TBD

(1) Bit rate indicated is tentative.

TABLE 2

Profiles and suggested coding tools

Coding tools	High	High 10	High 4:2:2	High 4:4:4
Main profile tools	X	X	X	X
4:2:0 chroma format	X	X	X	X
8-bit sample bit depth	X	X	X	X
8 × 8 vs. 4 × 4 transform adaptivity	X	X	X	X
Quantization scaling matrices	X	X	X	X
Separate C_b and C_r QP control	X	X	X	X
Monochrome video format	X	X	X	X
9- and 10-bit sample bit depth		X	X	X
4:2:2 chroma format			X	X
11- and 12-bit sample bit depth				X
4:4:4 chroma format				X
Residual colour transform				TBD
Predictive lossless coding				TBD

Annex 2
[Sullivan 2004]

ITU-T Recommendation H.264/MPEG-4 (Part 10) Advanced Video Coding (commonly referred to as H.264/AVC) is the newest entry in the series of international video coding standards. It is currently the most powerful and state-of-the-art standard, and was developed by a Joint Video Team (JVT) consisting of experts from ITU-T's Video Coding Experts Group (VCEG) and ISO/IEC's Moving Picture Experts Group (MPEG).

As has been the case with past standards, its design provides the most current balance between coding efficiency, implementation complexity and cost, based on the current state of VLSI design technology (CPUs, DSPs, ASICs, FPGAs, etc.).

In the process, a standard was created that improved coding efficiency by a factor of about two minimum (on average) over MPEG-2 while keeping the cost within an acceptable range.

In July 2004, a new amendment was added to this standard, called the Fidelity Range Extensions (FRExt, Amendment 1), which demonstrates even higher coding efficiency against MPEG-2, potentially attaining as much as 3:1 for some key applications.

While having a broad range of applications, the initial H.264/AVC standard (as it was completed in May 2003), was primarily focused on "entertainment-quality" video, based on 8-bits/sample, and 4:2:0 chroma sampling. Given its time constraints, it did not include support for use in the most demanding professional environments, and the design had not been focused on the highest video resolutions. For applications such as programme contribution, programme distribution, and studio editing and post-processing, it may be necessary to:

– use more than 8 bits per sample of source video accuracy;
– use a higher resolution for colour representation than is typical in consumer applications (i.e. to use 4:2:2 or 4:4:4 sampling as opposed to 4:2:0 chroma sampling format);
– perform source editing functions such as alpha blending (a process for blending of multiple video scenes, best known for use in weather reporting where it is used to key video of a newscaster over video of a map or weather-radar scene);
– use very high bit rates;
– use very high resolution;
– achieve very high fidelity – even representing some parts of the video losslessly;
– avoid colour-space transformation rounding error;
– use red, green and blue (RGB) colour representation.

The FRExt project produced a suite of four new profiles collectively called the *high profiles*:

1) the high profile (HP), supporting 8-bit video with 4:2:0 sampling, addressing high-end consumer use and other applications using high-resolution video without a need for extended chroma formats or extended sample accuracy;
2) the High 10 Profile (Hi10P), supporting 4:2:0 video with up to 10 bits of representation accuracy per sample;
3) the High 4:2:2 Profile (H422P), supporting up to 4:2:2 chroma sampling and up to 10 bits per sample, and
4) the High 4:4:4 Profile (H444P), supporting up to 4:4:4 chroma sampling, up to 12 bits per sample, and additionally supporting efficient lossless coding and an integer residual colour transform for coding RGB video while avoiding colour-space transformation errors.

As FREXt is still rather new, and as some of the benefits of FREXt are perceptual rather than objective, it is somewhat more difficult to measure its capability. One relevant data point is the result of a subjective quality evaluation done by the Blu-ray Disc Association (BDA). The summary results are reproduced in Fig. 1 below from the test report referenced in [Wedi and Kashiwagi, 2004].

This test, conducted on a 24 frame/s film program with 1 920 × 1 080 progressive-scanning, shows the following nominal results (which should not be considered rigorously statistically proven):

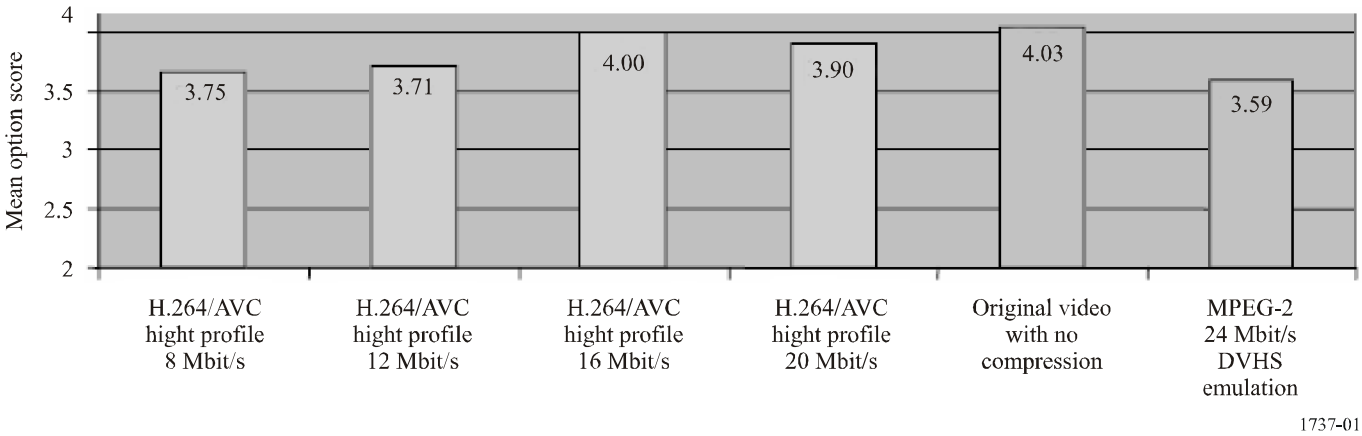
– The High Profile of FREXt produced nominally better video quality than MPEG-2 when using only one third as many bits (8 Mbit/s versus 24 Mbit/s).

– The High Profile of FREXt produced nominally transparent (i.e. difficult to distinguish from the original video without compression) video quality at only 16 Mbit/s.

The quality bar (3.0), considered adequate for use on high-definition packaged media in this organization, was significantly surpassed using only 8 Mbit/s. Again, there were sub-optimalities in the H.264/AVC coding method used in these tests. Thus, the bit rate can likely be reduced significantly below 8 Mbit/s while remaining above the 3.0 quality bar establishing a quality sufficient to call it "acceptable HD" in that demanding application.

FIGURE 1

Comparison of MPEG-2 to H.264

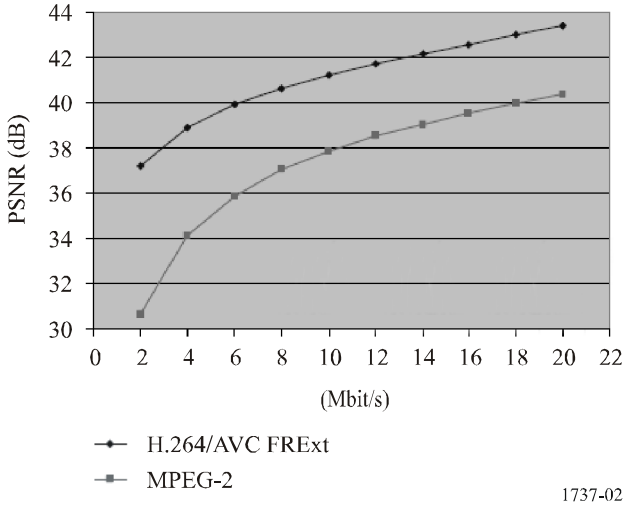


The result of an example objective (PSNR) comparison test performed by FastVDO[2] is shown in Fig. 2. These objective results confirm the strong performance of the high profile. (Again, sub-optimal uses of B frames make the plotted performance conservative for FREXt.)

[2] FastVDO is a company specializing in technology for media communications and infrastructure software. It is located in Columbia, MD, USA.

FIGURE 2

PSNR comparison



References

SULLIVAN, G.J., TOPIWALA, P. and LUTHRA, A. [August, 2004] The H.264/AVC Advanced Video Coding Standard: Overview and Introduction to the Fidelity Range Extensions. Presented at the SPIE Conference on Applications of Digital Image Processing XXVII, Special Session on Advances in the New Emerging Standard: H.264/AVC.

WEDI, T. and KASHIWAGI, Y. [July 2004] Subjective quality evaluation of H.264/AVC FRExt for HD movie content. Joint Video Team document JVT-L033.