RP 202-2008
Revision of RP 202-2000

SMPTE RECOMMENDED PRACTICE

Video Alignment for Compression Coding

Table of Contents

Page

Approved April 18, 2008
Correction to Section 3 Normative References made on July 10, 2009

Foreword

SMPTE (the Society of Motion Picture and Television Engineers) is an internationally-recognized standards developing organization. Headquartered and incorporated in the United States of America, SMPTE has members in over 80 countries on six continents. SMPTE's Engineering Documents, including Standards, Recommended Practices and Engineering Guidelines, are prepared by SMPTE's Technology Committees. Participation in these Committees is open to all with a bona fide interest in their work. SMPTE cooperates closely with other standards-developing organizations, including ISO, IEC and ITU.

SMPTE Engineering Documents are drafted in accordance with the rules given in Part XIII of its Administrative Practices.

SMPTE Recommended Practice RP 202 was prepared by Technology Committee C24.

Introduction

As bit-rate reduction has become pervasive in emission, contribution, and distribution of video content, multiple compression and decompression (codec) cycles are required. Concatenation of codecs may be needed for production, post-production, transcoding, or format conversion. Any time video transformations to or from the coefficient domain of macroblock-based algorithms are performed, care must be exercised in alignment of the video both horizontally and vertically as it is coded from the raster format or decoded and placed in the raster format.

Over multiple compression and decompression cycles, it is highly desirable to maintain the original positioning of the video signal within the raster. Less obvious, but just as important, is the need for macroblock alignment to reduce artifacts among encoders and decoders from various equipment vendors. If concatenated encoders do not share common macroblock boundaries, then additional quantization noise, motion-estimation errors, and poor mode decisions may result. Likewise, encoding decisions that may be carried through the production and post-production process with recoding data present will rely upon macroblock alignment. Conforming to this practice will minimize artifacts in multiple generations of compression (bit-rate reduction) encoding and decoding by optimizing macroblock alignment.

1 Scope

This practice specifies the spatial alignment for video compression (bit-rate reduction) encoders and decoders, including but not limited to MPEG-2, MPEG-4 Part 10 (AVC) and SMPTE VC-1. Both standard-definition and high-definition video formats for production, distribution, and emission systems are addressed.

2 Conformance Notation

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword “reserved” indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword “forbidden” indicates “reserved” and in addition indicates that the provision will never be defined in the future.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

Unless otherwise specified the order of precedence of the types of normative information in this document shall be as follows. Normative prose shall be the authoritative definition. Tables shall be next, followed by formal languages, then figures, and then any other language forms.

3 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

SMPTE 274M-2008, Television — 1920 x 1080 Image Sample Structure, Digital Representation and Digital Timing Reference Sequences for Multiple Picture Rates

SMPTE 293M-2003, Television — 720 x 483 Active Line at 59.94-Hz Progressive Scan Production — Digital Representation

SMPTE 296M-2001, Television — 1280 x 720 Progressive Image Sample Structure — Analog and Digital Representation and Analog Interface (R2006)

ITU-R BT.656-5 (12/07), Interface for Digital Component Video Signals in 525-Line and 625-Line Television Systems Operating at the 4:2:2 Level of Recommendation ITU-R BT.601

ITU-R BT.1358-1 (09/07) Studio Parameters of 625 and 525 Line Progressive Scan Television Systems

4 Nomenclature

4.1 Coding range: The range of coded lines and coded pels is referred to as the coding range. This practice does not differentiate between encoders and decoders. For any format in Table 1, encoders should compress the specified range. Likewise, decoders should decompress the stream and place the video in the specified range. Therefore, regardless of encoding or decoding, the ranges for lines and pels are referred to as the coding range.

4.2 Coded lines: The specific vertical lines to be encoded, or where decoded video should be placed vertically.

4.3 Coded pels: The specific horizontal pels to be encoded, or where decoded video should be placed horizontally.

4.4 Format: The scanning format referenced by number of active lines.

4.5 Resolution: Two-dimensional definition of image space. Horizontal units of pels and vertical units of lines.

5 Recommended Coding Ranges

Table 1 contains the recommended coding ranges for bit-rate reduction encoders and decoders. Line and pel numbering for the various video formats shall be as defined in the normative references listed in Section 3.

Table 1 – Recommended Coding Ranges for Various Video Formats

Format	Resolution	Coded pels	Coded lines		
	Pels × lines		Field 1	Field 2	Frame
480I	720 × 480	0-719	23-262	286-525	---------
480P	720 × 480	0-719	---------	---------	45-524
512I	720 × 512	0-719	7-262	270-525	---------
512P	720 × 512	0-719	---------	---------	13-524
576I	720 × 576	0-719	23-310	336-623	---------
576P	720 × 576	0-719	---------	---------	45-620
608I	720 × 608	0-719	7-310	320-623	---------
608P	720 × 608	0-719	---------	---------	13-620
720P	1280 × 720	0-1279	---------	---------	26-745
1080I	1920 × 1080 (See Note 4)	0-1919	21-560	584-1123	---------
1080P	1920 × 1080 (See Note 4)	0-1919	---------	---------	42-1121

NOTES

1 Interchange between 480I and 480P, 512I and 512P, 576I and 576P or 608I and 608P video that has been encoded according to this practice will require a format conversion including vertical filter that provides appropriate transformation of the information to avoid improper alias, vertical location, and/or unnecessary loss of picture content.

2 Interchange of 480I video that has been encoded according to this practice with 480I video that has been encoded using field-2 lines 285-524 will require a format conversion that provides appropriate transformation of the picture information to avoid improper vertical location and/or unnecessary loss of picture content.

3 Interchange of 576I video that has been encoded according to this practice with 576I video that has been encoded using field-2 lines 335-622 will require a format conversion that provides appropriate transformation of the picture information to avoid improper vertical location and/or unnecessary loss of picture content.

4 In macroblock-based compression systems that code in multiples of 16 lines, 1088 lines are actually coded. The additional eight lines are added at the bottom of the picture prior to encoding and are discarded after decoding.

Table 2 – Normative Reference Documents for the Formats of Table 1

Format	Reference
480I, 512I, 576I, 608I	ITU-R BT.656
480P, 512P	SMPTE 293M
576P, 608P	ITU-R BT.1358
720P	SMPTE 296M
1080I, 1080P	SMPTE 274M

6 Backward Compatibility

6.1 Vertical Alignment

A large installed base of 480I and 576I equipment exists. Backward compatibility issues exist primarily for 480I relative to coded ranges. Thus, in choosing the correct 480 lines to encode for 480I, generic legacy data on line 21 was accounted for, but not other vertical interval data on line 22, so the range coded was lines 22-261 and 285-524. Also, in some cases, a consumer product MPEG-2 decoder may expect that the encoded video it receives is shifted up a line from this recommendation. However, even on display devices that do not overscan, this will likely not be noticeable to the viewer.

6.2 Horizontal resolution modifications

Some MPEG-2 encoders reduce the horizontal resolution of the video. Horizontal resolution reductions should occur only at the emission stage to ensure macroblock alignment during the production process. For applications where resolution reductions at the emission stage require significant changes in the number of pixels, the reduction will normally be performed with filtering and subsampling; hence, no horizontal macroblock alignment is expected. Examples would be resolution reductions from 720 pixels to 544 pixels or down-converting from HDTV to SDTV.

For small resolution reductions in SDTV applications, cropping is often used in order to remove any blanking edge distortions that may be difficult for the emission encoder. An example would be a resolution reduction from 720 pixels to 704 pixels. Filtering and subsampling may also be used; however, neither method provides the desired horizontal macroblock alignment. Therefore, it is important that no resolution changes are made prior to that required for the final emission encoding.

Annex A (Informative)
Bibliography

ISO/IEC 13818-2:2000, Information Technology — Generic Coding of Moving Pictures and Associated Audio Information: Video

ISO/IEC 14496-10:2005, Information Technology — Coding of Audio-Visual Objects — Part 10: Advanced Video Coding

SMPTE 421M-2006, Television — VC-1 Compressed Video Bitstream Format and Decoding Process