SMPTE ST 2073-1:2017
Revision of
SMPTE ST 2073-1:2014

SMPTE STANDARD

VC-5 Video Essence — Part 1: Elementary Bitstream

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Approved
April 5, 2017

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Foreword

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SMPTE Engineering Documents are drafted in accordance with the rules given in its Standards Operations Manual.

SMPTE ST 2073-1 was prepared by Technology Committee 10E.

Intellectual Property

At the time of publication no notice had been received by SMPTE claiming patent rights essential to the implementation of this Engineering Document. However, attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

Introduction

This section is entirely informative and does not form an integral part of this Engineering Document.

The VC-5 codec is a variable-bit-rate codec intended for high-quality video acquisition and post-production, capable of encoding diverse image and video formats.

(1) The key design goals of the VC-5 codec are:

(2) Very high visual quality (visually lossless in most applications);

(3) Efficient implementation of both decoders and encoders;

(4) Support for any color space or color difference component sampling;

(5) Direct encoding of camera sensor output without conversion to a different format;

(6) Adaptability and ease of use in video editing and post-production.

The VC-5 codec uses reversible integer wavelet transforms applied to the entire image to prevent blocking artifacts. Since the transforms are reversible, the only losses are due to quantization. Lowpass wavelet coefficients are encoded without quantization to preserve visual quality.

The wavelet transforms can be implemented efficiently using only integer shift and add operations. Highpass wavelet coefficient values equal to zero are run length coded. Runs of zeros and non-zero coefficients are represented using variable-length codes that are efficient for both decoding and encoding.

The VC-5 bitstream can represent any image that can be unpacked into component arrays by an image unpacking process prior to encoding (Figure 1). A component array is like an image plane and typically would contain a single type of color or data, although component arrays containing multiple types of image data are not precluded by this standard. Each of the component arrays represented in the bitstream can have different dimensions.

The image unpacking process is not specified by this standard and can implement image pre-processing algorithms, which also are not defined in this standard. The encoding process takes an ordered set of component arrays and represents the component arrays in the bitstream such that a decoding process can reconstruct the set of component arrays that were input to the encoding process in the same order as input to the encoding process. The reconstructed set of component arrays duplicates the component arrays input to the encoder except for losses due to compression.

The decoding process can be followed by an image repacking process that converts the ordered set of component arrays into a packed representation of the image. The image repacking process is not specified by this standard. The image repacking process can implement image post-processing algorithms as required by the application. An image display process that transforms the packed image into a displayable picture can follow the image repacking process. For example, the packed image can include data values that must be mapped to colors to create a displayable image.

The VC-5 codec is intended to accept common image formats, including images with RGB and YCbCr color components with an optional alpha channel. Image formats can use color difference component sampling, for example YCbCr with 4:2:2 or 4:2:0 sampling.

The VC-5 codec is not restricted to a particular set of image dimensions, pixel formats, or color standards. Color Filter Array (CFA) images, including Bayer pattern images, can be unpacked into component arrays that can be represented in a VC-5 bitstream without conversion to a different image format. Component arrays containing non-color data, such as disparity values, can be represented in a VC-5 bitstream. Component arrays can use up to 24 bits of precision to represent each value in the component array.

The syntax of a VC-5 bitstream is based on tag-value pairs that allow for future extensions. Each tag is a 16-bit number and only a small number of tags have been assigned. The value is a 16-bit number, but a tag-value pair can be used to represent the type and size of a large block of data, providing support for values larger than 16 bits.

The number of component arrays and the width and height of each component array is limited only by the scheme for representing information as tag-value pairs.

A VC-5 bitstream can include all of the information required by a decoding process to reconstruct the component arrays represented in the bitstream, but the bitstream does not have to include information that is provided by an external source. For example, a bitstream that is embedded in a media container can omit information that is provided by the container.

The VC-5 codec can adapt to specific applications by representing an image using minimal syntax or including extensive information required to describe the output of sophisticated image sensors or complex workflows.

Wavelet transforms are applied recursively to each component array with the lowpass band from each wavelet transform input to the next transform. Fewer inverse transforms can be applied during decoding to produce a lower resolution proxy image, allowing a decoder to balance decoding speed and image quality as required by specific applications.

1 Scope

This standard specifies the compressed representation and decoding process for the core VC-5 bitstream.

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 engineering document. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this engineering document are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

None.

4 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp