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Part 17: Extensions for coding of discontinuous media

*Technologies de l'information — Système de codage d'images JPEG
2000 —*

Partie 17: Extensions pour le codage des supports discontinus



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This document was prepared by ITU-T (as ITU-T - T.816) and drafted in accordance with its editorial rules, in collaboration with Joint Technical Committee ISO/IEC JTC 1, *Information technology, Subcommittee SC 29, Coding of audio, picture, multimedia and hypermedia information*.

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RECOMMENDATION ITU-T T.816 (V1)

Information technology – JPEG 2000 image coding system: Extensions for coding of discontinuous media

Summary

Rec. ITU-T T.816 | ISO/IEC 15444-17 provides extensions of the scalable image coding tools described in Rec. ITU-T T.800 | ISO/IEC 15444-1 and Rec. ITU-T T.801 | ISO/IEC 15444-2, of two types. First, new wavelet-like image transforms known as "breakpoint-dependent" transforms are defined, whose underlying basis functions can be discontinuous at defined locations within the image component to which they are applied. Second, new scalable coding tools are described for a new type of image component known as a "breakpoint component", which provides a successively refinable and hierarchical description of the breakpoint locations used by the breakpoint-dependent transforms. Any non-initial component or components within a codestream conforming to this Recommendation | International Standard can be breakpoint components and any of the components in the codestream other than breakpoint components can use a breakpoint-dependent transform that depends upon one of the breakpoint components in the same codestream. These new tools together allow for the scalable coding of imagery that naturally exhibits strong discontinuities in the spatial domain. An important example of such imagery is depth maps.

This Recommendation was developed jointly with ISO/IEC JTC 1/SC 29/WG 1 (JPEG) and is common text with ISO/IEC 15444-17.

History

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ITU-T T.801 | ISO/IEC 15444-2 provide a suite of scalable coding technologies that are particularly suitable for photographic media, but less effective at coding media with hard discontinuities. An important example of such media is depth imagery, where each image sample is related to the length of the 3D line segment between the corresponding scene point and the camera. Depth imagery includes stereo disparity maps, where sample values are reciprocally related to depth. Another example of media with strong discontinuities is optical flow data, where each sample location is a two-dimensional vector. In these examples, discontinuities arise naturally at the boundaries of scene objects. Moreover, where this happens, intermediate values that might be obtained by bandlimited image resampling or interpolation operations have no physical meaning – i.e., they do not correspond to the depth or flow vector of any object in the original scene. The discrete wavelet transform (DWT) employed in JPEG 2000 is not well suited to the coding of such media, both from the perspective of coding efficiency and considering the nature of distortions that result when the wavelet sub-band samples are quantized.

To address these challenges, this Recommendation | International Standard introduces alternate "breakpoint-dependent" spatial wavelet transforms that are dependent on an auxiliary image component, known as a "breakpoint component." This Recommendation | International Standard also introduces scalable coding technologies for breakpoint components. Any non-initial component or components within the codestream can be designated as breakpoint components, allowing them to be used as the source of breakpoints for other components, or tiles thereof, which specify the use of breakpoint-dependent wavelet transforms.

This Recommendation | International Standard specifies two different types of breakpoint components, designated as "QuadBPT" and "TriBPT" components, with associated decoding and synthesis tools. Associated with the type of breakpoint component is a corresponding breakpoint-dependent wavelet transform, with its synthesis tools. The reconstruction procedures described in this Recommendation | International Standard produce individual sample values. In the TriBPT case, it is possible instead to directly reconstruct a deformable triangular mesh, whose complexity is related to the number of non-zero wavelet coefficients and the number of decoded breaks, which are identified here as "vertices." In each case, breakpoints introduce tears in the mesh. This feature can be valuable in computer graphics applications, where the mesh elements provide a more convenient description of the data than individual samples.

The normative material of this Recommendation | International Standard is contained within the main body together with Annex A. Additionally, Annex B describes ways of encapsulating breakpoint data within a linear file structure, that can be used as a source for encoding and a target for decoding procedures.

Information technology – JPEG 2000 image coding system: Extensions for coding of discontinuous media

1 Scope

This Recommendation | International Standard defines QuadBPT and TriBPT image components, collectively known as "breakpoint components", and specifies decoding and reconstruction procedures for recovering breakpoint component sample values from the codestream. This Recommendation | International Standard also specifies "breakpoint-dependent" spatial wavelet transforms that can be used in place of the transforms specified in Recommendation ITU-T T.800 | ISO/IEC 15444-1 for selected image components or tile-components. Extensions to the codestream syntax of Rec. ITU-T T.800 | ISO/IEC 15444-1 are specified to enable the identification of breakpoint components, of components that can use a breakpoint-dependent spatial wavelet transform, and the association of breakpoint components with such breakpoint-dependent wavelet transforms.

2 Normative references

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to agreements based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent edition of the Recommendations and Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunication Standardization Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

2.1 Identical Recommendations | International Standards

- Recommendation ITU-T T.800 (2019) | ISO/IEC 15444-1:2019, *Information technology – JPEG 2000 image coding system: Core coding system*.
- Recommendation ITU-T T.801 (2021) | ISO/IEC 15444-2:2021, *Information technology – JPEG 2000 image coding system: Extensions*.

3 Definitions

3.1 Terms defined elsewhere

For the purposes of this Recommendation | International Standard, the terms and definitions given in Rec. ITU-T T.800 | ISO/IEC 15444-1 apply.

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

- ITU Terms and definitions database: available at <https://www.itu.int/go/terms>
- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.2 Terms defined in this Recommendation | International Standard

This Recommendation | International Standard defines the following terms:

3.2.1 2-span: Square configuration of width 2 and height 2, with 9 grid-points, such that the four corner grid-points all have coordinates that are divisible by 2.

3.2.2 4-span: 2×2 configuration of 2-spans (3.2.1), involving 25 grid-points, such that the four corner grid-points all have coordinates that are divisible by 4.

3.2.3 ambivalent break: Induced break (3.2.5) that has insufficient precision to determine whether the break occurs in the first or second half of the arc.

3.2.4 arc: Line segment connecting grid-points with even valued coordinates at any resolution of a breakpoint tile-component.