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Information technology — Plenoptic image coding system (JPEG Pleno) —

Part 1: **Framework**

Technologies de l'information — Système de codage d'images plénoptiques (JPEG Pleno) —
Partie 1: Cadre

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Contents

Page

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

A list of all parts in the ISO/IEC 21794 series can be found on the ISO website.

Introduction

This document is part of a series of standards for a system known as JPEG Pleno. This document defines the JPEG Pleno framework. It facilitates the capture, representation, exchange and visualization of plenoptic imaging modalities. A plenoptic image modality can be a light field, point cloud or hologram, which are sampled representations of the plenoptic function in the form of, respectively, a vector function that represents the radiance of a discretized set of light rays, a collection of points with position and attribute information, or a complex wavefront. The plenoptic function describes the radiance in time and in space obtained by positioning a pinhole camera at every viewpoint in 3D spatial coordinates, every viewing angle and every wavelength, resulting in a 7D function.

JPEG Pleno specifies tools for coding these modalities while providing advanced functionality at system level, such as support for data and metadata manipulation, editing, random access and interaction, protection of privacy and ownership rights.

Information technology — Plenoptic image coding system (JPEG Pleno) —

Part 1: Framework

1 Scope

This document specifies the plenoptic image coding system framework architecture and its instantiation via a generic file format for storage of plenoptic modalities as well as associated metadata descriptors.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 646, *Information technology — ISO 7-bit coded character set for information interchange*

ISO/IEC 15444-1:2019, *Information technology — JPEG 2000 image coding system — Part 1: Core coding system*

ISO/IEC 15444-2:2004, *Information technology — JPEG 2000 image coding system — Part 2: Extensions*

ISO/IEC 21794-2:—[1], *Information technology — Plenoptic image coding system (JPEG Pleno) — Part 2: Light field coding*

3 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:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
big-endian
byte ordering for which the most significant byte and least significant byte are sequentially ordered from lower memory address to higher memory address, respectively

3.2
box
structured collection of data describing the image or the image decoding process

3.3
box content
data wrapped within the box structure

1) Under preparation. Stage at time of publication: ISO/IEC DIS 21794-2:2019.

3.4
box type
kind of information stored within the box

3.5
coder
embodiment of a coding process

3.6
codestream
coded data representation that includes all necessary data to allow a (full or approximate) reconstruction of the sample values of a digital image

3.7
coding process
encoding process, decoding process, or both

3.8
complex wavefront
wavefront represented with a complex representation, which can be, for example, real-imaginary or amplitude-phase

3.9
component
two-dimensional array of samples having the same designation in the output or display device, e. g., red, green or blue

3.10
decoder
embodiment of a decoding process

3.11
decoding process
process that takes as its input a codestream and outputs a continuous-tone image

3.12
encoder
embodiment of an encoding process

3.13
encoding process
process that takes as its input a continuous-tone image and outputs a codestream

3.14
hologram
sampled representation of the plenoptic function in the form of a complex wavefront

3.15
holographic display
three-dimensional display that renders a complex optical wavefront

3.16
light field
sampled representation of the plenoptic function in the form of a vector function that represents the radiance of a discretized set of light rays

3.17
light field data
recorded light field

3.18
plenoptic function
radiance in time and in space obtained by positioning a pinhole camera at every viewpoint in 3D spatial coordinates, every viewing angle and every wavelength, resulting in a 7D function

3.19
plenoptic data
sampled representation of the plenoptic function

Note 1 to entry: Example plenoptic functions are light field, point cloud and holographic representation.

3.20
plenoptic object
plenoptic element
plenoptic data representing a part of the scene described by the plenoptic function

3.21
point cloud
sampled representation of the plenoptic function in the form of collection of points with position and attribute information

3.22
superbox
box that carries other boxes as payload data

3.23
wavefront
locus of spatial points that share the same phase of the light wave

4 Abbreviated terms

3D	three dimensional
CGH	computer-generated holography
IPR	intellectual property rights
JPEG	Joint Photographic Experts Group
JPL	Jpeg PLeno file format
UUID	Universally Unique IDentifier
XML	eXtensible Markup Language

5 Conventions

5.1 Conformance language

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

5.2 Naming conventions for numerical values

Integer numbers are expressed as bit patterns, hexadecimal values or decimal numbers. Bit patterns and hexadecimal values have both a numerical value and an associated particular length in bits.

Hexadecimal notation, indicated by prefixing the hexadecimal number by "0x", is used instead of binary notation to denote a bit pattern having a length that is an integer multiple of 4. For example, 0x41 represents an eight-bit pattern having only its second most significant bit and its least significant bit equal to 1. An octal notation is indicated by prefixing the octal value "\", this notation is used instead of binary notation to denote a bit pattern having a length that is an integer multiple of 3. Numerical values that are specified under a "**Code**" heading in tables that are referred to as "code tables" are bit pattern values (specified as a string of digits equal to 0 or 1 in which the left-most bit is considered the most-significant bit). Other numerical values not prefixed by "0x" are decimal values. When used in expressions, a hexadecimal value is interpreted as having a value equal to the value of the corresponding bit pattern evaluated as a binary representation of an unsigned integer (i.e., as the value of the number formed by prefixing the bit pattern with a sign bit equal to 0 and interpreting the result as a two's complement representation of an integer value). For example, the hexadecimal value 0xF is equivalent to the 4-bit pattern '1111' and is interpreted in expressions as being equal to the decimal number 15.

6 Framework definition

The plenoptic image coding system (JPEG Pleno) specifies a framework that facilitates the capture, representation and exchange of point cloud, light field and holographic imaging modalities. These imaging modalities are light representations of the plenoptic function[1], regardless of which modality was used to capture or create parts of the entire content:

— **Point clouds** are a set of data points representing the plenoptic function in a given, often 3D, coordinate system with associated attributes;

— **Light fields** are a sampled representation of the plenoptic function by capturing it by either an array of cameras (resulting in wide baseline light field data) or by a single light field camera that uses microlenses to sample individual rays of light that contribute to the final image (resulting in narrow baseline light field data);

— **Holograms** are a sampled interferometric representation of the plenoptic function that is based on a wave-based light propagation model.

This framework supports conversations between different modalities throughout an end-to-end processing chain. This document defines file format and codestream syntax for plenoptic modalities while providing advanced functionalities at system level. It also supports data and metadata manipulation, editing, random access and interaction, protection of privacy and ownership.

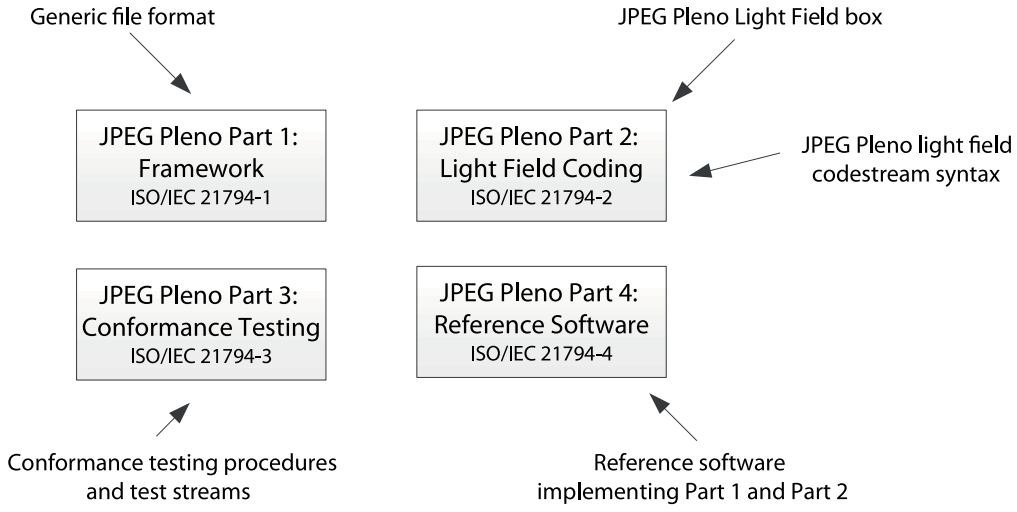

Figure 1 — JPEG Pleno framework

The ISO/IEC 21794 series consists of the following Parts (Figure 1).

— This document outlines the overall JPEG Pleno framework and specifies the generic JPEG Pleno file format.

— ISO/IEC 21794-2 specifies the file format and codestream syntax for coded light fields. Moreover, it specifies output of JPEG Pleno light field encoders and provides documentation on the encoding and decoding procedures.

— ISO/IEC 21794-3[2)] specifies conformance testing protocols.

— ISO/IEC 21794-4[2)] specifies reference software.

7 File format architecture

This document shares common definitions for the structure of files (a sequence of objects, called boxes here, and atoms in other similar file formats), and a common definition of the general structure of an object (the size and type).

The specification of the file format in Annex A is built upon the structure of ISO/IEC 15444-1 and ISO/IEC 15444-2 file formats.

All these specifications require that readers ignore objects that are unrecognizable to them.

This document shall take precedence over those on which it is based, in any case where there are differences or conflicts; however, no such conflicts are known to exist.

For better readability and understanding the syntax description for the different file formats is done in the same way as in the base formats.

8 Organization of the document

Annex A specifies the JPEG Pleno box-based file format, which includes definitions of boxes to carry light field, point cloud and holographic data. Every JPEG Pleno file shall conform to the specified file format syntax.

Annex B specifies the JPEG Pleno reference grid system, a coordinate system that allows for positioning plenoptic modalities in a global reference grid system, while using a local coordinate system per plenoptic element to facilitate efficient local addressing.

Annex C provides an example of how plenoptic objects can be signalled using the JPEG Pleno framework.

2) Under preparation.