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Information technology — Coded representation of immersive media — Part 9: Geometry-based point cloud compression

FDIS stage

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Foreword

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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 23090 series can be found on the ISO website and IEC websites.

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Introduction

Advancements in 3D capturing and rendering technologies are enabling new applications and services in the fields of assisted and autonomous driving, cartography, cultural heritage, industrial processes, immersive real-time communication, and ~~Virtual/Augmented/Mixed~~virtual/augmented/mixed reality (VR/AR/MR) content creation, transmission and communication. Point clouds have arisen as one of the main representations for such applications. A point cloud frame consists of a set of 3D points. Every point, in addition to having a 3D position, may also be associated with numerous other attributes such as colour, transparency, reflectance, timestamp, surface normal and classification. Such representations require a large amount of data, which can be costly in terms of storage and transmission. This document provides the method for efficiently compressing point cloud representations.

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Information technology — Coded representation of immersive media — Part 9: Geometry-based point cloud compression

1 Scope

This document specifies geometry-based point cloud compression.

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.

Recommendation ITU-T T.35, Procedure for the allocation of ITU-T defined codes for non-standard facilities

~~*ISO/IEC 8825-1 (*~~Rec. ITU-T X.690~~*),* |~~ ISO/IEC 8825-1, *Information technology — ASN.1 encoding rules — Part 1: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*

~~*ISO/IEC 9834-1 (*~~Rec. ITU-T X.660~~*),* | ISO/IEC 9834-1, *Information technology — Procedures for the operation of object identifier registration authorities ~~— Part 1~~: General procedures and top arcs of the international object identifier tree — Part 1:*

~~*ISO/IEC 9834-8 (*~~Rec. ITU-T X.667~~*),* | ISO/IEC 9834-8, *Information technology — Procedures for the operation of object identifier registration authorities — Part 8: Generation of universally unique identifiers (UUIDs) and their use in object identifiers*

ISO/IEC 23091-2, *Information technology — Coding-independent code points — Part 2: Video*

3 Terms and definitions

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

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

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

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

3.1 General terms

3.1.1

point
fundamental element of a *point cloud* ~~()~~(3.1.2) comprising a position specified as *Cartesian coordinates* ~~()~~(3.1.8) and zero or more *attributes* ~~()~~(3.1.19)

3.1.2
point cloud
unordered list of *points* ~~()~~(3.1.1)

3.1.3
point cloud sequence
sequence of one or more *point clouds* ~~()~~(3.1.2)

3.1.4
point cloud frame
point cloud ~~()~~(3.1.2) in a *point cloud sequence* ~~()~~(3.1.3)

3.1.5
coded point cloud frame
coded representation of a *point cloud frame* ~~()~~(3.1.4)

3.1.6
canonical point order
~~**canonical decoding order**~~
order of *points* ~~()~~(3.1.1) decoded from a *slice* ~~()~~(3.1.21) according to the decoding ~~and parsing~~ processes

Note 1 to entry: The decoding processes are specified in ~~this document~~Clause 9.

3.1.7
bounding box
axis-aligned cuboid defining a spatial region that bounds a set of *points* ~~()~~(3.1.1)

3.1.8
Cartesian coordinates
~~<Cartesian>~~ three scalar multiples of respective orthogonal *XYZ* ~~()~~(3.1.11) unit vectors with finite precision and bounds that specify a position relative to a fixed reference

3.1.9
angular coordinates
~~<angular> a~~ position specified as the radial distance ~~ρ~~ from the V axis, an azimuth angle ~~φ~~ in the S-T plane and an indexed elevation

3.1.10
attribute coordinates
~~<attribute> either~~ *STV* ~~()~~(3.1.12) or scaled *RPI* ~~()~~(3.1.13) point coordinates used to code an *attribute* (3.1.19)

3.1.11
XYZ ~~(axes)~~
XYZ axes
X, Y and Z axes, in that order, used to represent *Cartesian coordinates* ~~()~~(3.1.8)

3.1.12

STV~~(~~
STV axes~~)~~
S, T and V axes, in that order, that are a sequence-dependent permutation of the *XYZ axes* ~~()~~(3.1.11); used to represent the coded *geometry* ~~()~~(3.1.18)

3.1.13
RPI~~(~~
RPI axes~~)~~
R, P and I axes, in that order, used to represent *angular coordinates* ~~()~~(3.1.9)

3.1.14
sequence coordinate system
scaled and translated application-specific coordinate system that applies to an entire coded *point cloud sequence* ~~()~~(3.1.3) and in which all *points* ~~()~~(3.1.1) have non-negative~~,~~ fixed-point coordinates

3.1.15
coding coordinate system
scaled *sequence coordinate system* ~~()~~(3.1.14) that applies ~~for~~to an entire coded *point cloud sequence* ~~()~~(3.1.3) and in which all *points* ~~()~~(3.1.1) have non-negative integer coordinates

3.1.16
slice coordinate system
translated *coding coordinate system* ~~()~~(3.1.15) that applies ~~for~~to a single *slice* ~~()~~(3.1.21) and in which all *points* ~~()~~(3.1.1) in the slice have non-negative integer coordinates

3.1.17
beam
sampler of point positions using *angular coordinates* (3.1.9) by rays cast with a fixed elevation and from a point on and rotating around the V axis at the angular origin

3.1.18
geometry
point positions ~~()~~(3.4.1) associated with a set of *points* ~~()~~(3.1.1)

3.1.19
attribute
scalar or vector property associated with each *point* ~~()~~(3.1.1) in a *point cloud* ~~()~~(3.1.2)

EXAMPLE Colour, reflectance, frame index~~, etc~~.

3.1.20
position
<bit> bit in a binary string or value, representing the factor 2^{position} ~~*2 position*~~

EXAMPLE The LSB has bit position 0.

3.1.21
slice
geometry (3.1.18) and *attributes* (3.1.19) for part of, or an entire, *coded point cloud frame* ~~()~~(3.1.5)

Note 1 to entry: the *bounding boxes* (3.1.7) of any two slices can intersect.

3.1.22
tile
set of *slices* {3.1.21} identified by a common slice_tag *syntax element* {3.2.16} value {} whose *geometry* {3.1.18} should be contained within a *bounding box* {3.1.7} specified in a tile inventory *data unit* {3.2.13}

3.1.23
Morton code
non-negative integer obtained by interleaving the bits of three integers

3.1.24
Morton order
order of elements ordered according to their *Morton code* {3.1.23}

3.1.25
sparse array
array with fewer set elements than total addressable elements; unset

Note 1 to entry: Unset elements can have an inferred value when accessed.

3.2 High Terms related to high-level syntax and entropy coding terms

3.2.1
ASN.1
abstract syntax notation one
notation specified by Rec. ITU-T X.660 | 680 | ISO/IEC 9834 8824-1 that is used for the definition of data types, values and constraints on data types

[SOURCE: Rec. ITU-T X.660 | ISO/IEC 9834-1]

3.2.2
bin
binary symbol (bit) of the *binarized* {3.2.3} representation of a *syntax element* element's {3.2.16} value {}

3.2.3
binarization
specification of a *syntax element*'s {3.2.16} value {} as a sequence of *bins* {3.2.2}

3.2.4
bypass
<symbol> a<contextual probability model> static, equiprobable probability model

3.2.5
bypass symbol
<*bypass*-contextualized {3.2.4} *bin* {3.2.2}

3.2.6
bypass stream>
sequence of *bypass symbols* {3.2.5} that are not encoded in an arithmetic-coded *bitstream* {3.2.7}

3.2.7
bitstream
<data> sequence of bits

3.2.8
bitstream
<coded sequence> sequence of bits, in the form of encapsulated *data units* ~~(}~~(3.2.13), that represents a coded *point cloud sequence* ~~(}~~(3.1.3)

3.2.9
set bit
bit with the value 1

3.2.10
unset bit
bit with the value 0

3.2.11
byte
sequence of 8 bits, typeset with the most significant bit on the left and the least significant bit on the right.

Note 1 to entry: When represented in a bitstream, the most significant bit of a byte is first.

3.2.12
byte aligned
bitstream ~~(}~~(3.2.7) position that is an integer multiple of eight bits from the position of the first bit in the bitstream

3.2.13
data unit
DU
sequence of *bytes* ~~(}~~(3.2.11) conveying a single *syntax structure* ~~(}~~(3.2.17) of known length

3.2.14
data unit header
parameters, located from the start of a *data unit* ~~(}~~(3.2.13)

3.2.15
data unit footer
parameters, located from the end of a *data unit* ~~(}~~(3.2.13)

3.2.16
syntax element
element of data represented in the *bitstream* ~~(}~~(3.2.7)

3.2.17
syntax structure
zero or more *syntax elements* ~~(}~~(3.2.16) present together in the *bitstream* ~~(}~~(3.2.7) in a specified order

3.2.18
parameter set