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ISO/IEC 15938-3

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Information technology — Multimedia content description interface —

Part 3: Visual

Technologies de l'information — Interface de description du contenu multimédia —

Partie 3: Visuel

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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ISO/IEC 15938-3 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

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ISO/IEC 15938 consists of the following parts, under the general title *Information technology — Multimedia content description interface*:

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— *Part 1: Systems*

— *Part 2: Description definition language*

— *Part 3: Visual*

— *Part 4: Audio*

— *Part 5: Multimedia description schemes*

— *Part 6: Reference software*

— *Part 7: Conformance testing*

— *Part 8: Extraction and use of MPEG-7 descriptions*

Annexes A and B form a normative part of this part of ISO/IEC 15938. Annex C is for information only.

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Introduction

This standard, also known as "Multimedia Content Description Interface," provides a standardized set of technologies for describing multimedia content. The standard addresses a broad spectrum of multimedia applications and requirements by providing a metadata system for describing the features of multimedia content.

The following are specified in this standard:

- **Description Schemes (DS)** describe entities or relationships pertaining to multimedia content. Description Schemes specify the structure and semantics of their components, which may be Description Schemes, Descriptors, or datatypes.
- **Descriptors (D)** describe features, attributes, or groups of attributes of multimedia content.
- **Datatypes** are the basic reusable datatypes employed by Description Schemes and Descriptors
- **Description Definition Language (DDL)** defines Description Schemes, Descriptors, and Datatypes by specifying their syntax, and allows their extension.
- **Systems tools** support delivery of descriptions, multiplexing of descriptions with multimedia content, synchronization, file format, and so forth.

This standard is subdivided into eight parts:

Part 1 – Systems: specifies the tools for preparing descriptions for efficient transport and storage, compressing descriptions, and allowing synchronization between content and descriptions.

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Part 2 – Description definition language: specifies the language for defining the standard set of description tools (DSs, Ds, and datatypes) and for defining new description tools.

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Part 3 – Visual: specifies the description tools pertaining to visual content.

Part 4 – Audio: specifies the description tools pertaining to audio content.

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Part 5 – Multimedia description schemes: specifies the generic description tools pertaining to multimedia including audio and visual content.

Part 6 – Reference software: provides a software implementation of the standard.

Part 7 – Conformance testing: specifies the guidelines and procedures for testing conformance of implementations of the standard.

Part 8 – Extraction and use of MPEG-7 descriptions: provides guidelines and examples of the extraction and use of descriptions.

This document contains the visual elements (Descriptors and Description Schemes) that are considered for being part of the standard. All these Descriptive Structures are classified according to the types of visual features they describe. For each Descriptive Structure, there is one corresponding section in this document. The section specifies textual and binary syntax and semantics of the structures.

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Information technology — Multimedia content description interface —

Part 3: Visual

1 Scope

1.1 Organization of the document

The structure of this document is as follows. Clauses **2**-**4** specify the terms, abbreviations, symbols and conventions used throughout the document. Clauses **5**-**11** contain definitions of the description tools standardized by 15938-3 grouped by the visual features they are associated with, starting with basic structures and containers in Clause **5**, through color, texture, shape, motion, localization in Clause **10**. Clause **11** contains the remaining, unclassified items.

Each description tool is described by the following subclauses:

- Syntax: Normative DDL specification of the Ds or DSs.
- Binary Syntax: Normative binary representation of the Ds or DSs.
- Semantic: Normative definition of the semantics of all the components of the corresponding D or DS.

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1.2 Overview of Visual Description Tools

This part of ISO/IEC 15938 specifies tools for description of visual content, including still images, video and 3D models. These tools are defined by their syntax in DDL and binary representations and semantics associated with the syntactic elements. They enable description of the visual features of the visual material, such as color, texture, shape and motion, as well as localization of the described objects in the image or video sequence. An overview of the visual description tools is shown in Figure 1.

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The basic structure description tools include five supporting tools of visual descriptions defined in clauses **6**–**11**. They are categorized into two groups, descriptor containers and basic supporting tools. The former consists of three datatypes, GridLayout providing efficient representations of visual features on grids, TimeSeries representing temporal arrays of several descriptions, and MultipleView describing a 3D object using several pictures captured from different view angles. The latter contains two tools, Spatial2DCoordinateSystem used to specify the 2D coordinate system and TemporalInterpolation indicating the interpolation method between two samples on a time axis.

The remaining description tools, except for the FaceRecognition descriptor, are associated with visual features and are grouped into five feature categories: Color, Texture, Shape, Motion and Localization.

The color description tools include four color descriptors to represent different aspects of color features: representative colors (DominantColor), color distribution (ScalableColor), spatial distribution of colors (ColorLayout and ColorStructure). It also contains two supporting tools, ColorSpace and ColorQuantization used in DominantColor and an extension of ScalableColor to a group of frames or pictures (GoFGoPColor). All the color descriptors can be extracted from arbitrarily shaped regions.

The texture description tools facilitate browsing (TextureBrowsing) and similarity retrieval (HomogeneousTexture and EdgeHistogram) using the texture of a still or moving image region. All the texture descriptors can be extracted from arbitrarily shaped regions.

The shape description tools include two descriptors that characterize different shape features of a 2D object or region. The RegionShape descriptor captures the distribution of all pixels within a region and the Contour Shape descriptor characterizes the shape properties of the contour of an object. The Shape3D descriptor provides an intrinsic shape characterization of 3D mesh models.

The motion description tools include four descriptors that characterize various aspects of motion. The CameraMotion descriptor specifies a set of basic camera operations such as, for example, panning and tilting. The motion of a key point (pixel) from a moving object or region can be characterized by the MotionTrajectory descriptor. The ParametricMotion descriptor characterizes an evolution of an arbitrarily shaped region over time in terms of a 2D geometric transformation. Finally, the MotionActivity descriptor captures the pace of the motion in the sequence, as perceived by the viewer. All motion descriptors except for CameraMotion can be extracted from arbitrarily shaped regions.

The localization description tools can be used to indicate regions of interest in the spatial (RegionLocator) and spatio-temporal (SpatioTemporalLocator) domains.

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The FaceRecognition descriptor is not associated with any particular visual feature and can be used to describe a human face for applications requiring the matching and retrieval of face images.

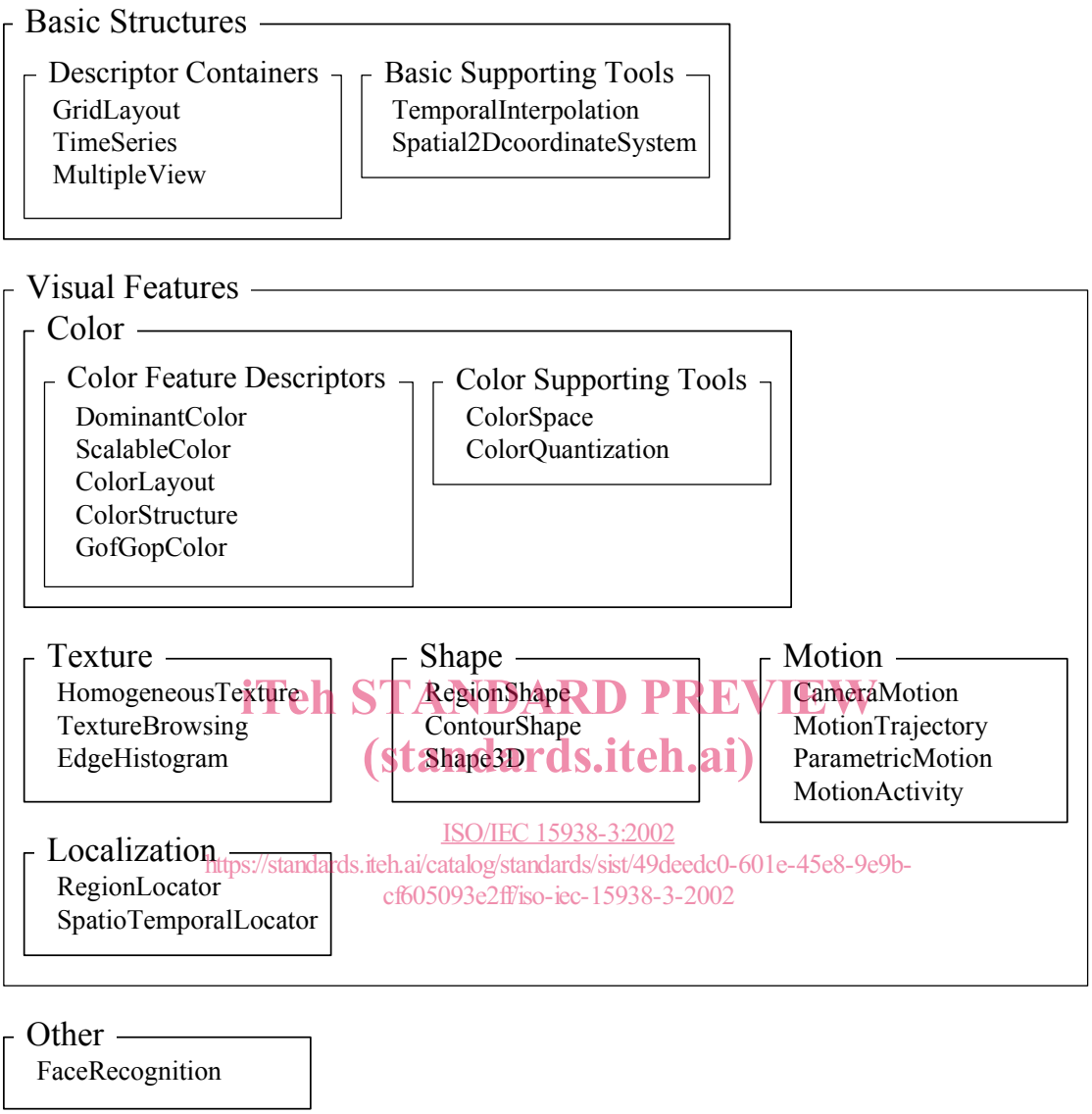

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Figure 1 — Overview of Visual Description Tools

2 Terms and Definitions

2.1 Default reference axis

The default reference axis for angle calculation is the positive *x* (horizontal) axis. Positive angle is calculated anti-clockwise.

2.2 DCT coefficients

DCT coefficient

The signed amplitude of a specific cosine basis function.

AC coefficient

Any DCT coefficient for which the frequency in one or both dimensions is non-zero.

DC coefficient

The DCT coefficient for which the frequency in both dimensions is zero.

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2.3 Data element

An item of data as represented before encoding and after decoding.

3 Abbreviations and Symbols

3.1 General

The mathematical symbols used to describe ISO/IEC 15938-3 are similar to those used in the C programming language. However, integer divisions with truncation and rounding are specifically defined. Numbering and counting loops generally begin with zero.

3.2 Abbreviations

ART	Angular-Radial Transform
CSS	Curvature Scale Space
DDL	Description Definition Language
DS	Description Scheme
D	Descriptor
DCT	Discrete Cosine Transform
FOC	Focus of Contraction
FOE	Focus of Expansion
GoF	Group of Frames
GoP	Group of Pictures
HMMD	Hue-Min-Max-Difference
HSV	Hue-Saturation-Value
RGB	Red-Green-Blue

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3.3 Arithmetic operators

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+ Addition
- Subtraction (as a binary operator) or negation (as a unary operator)
++ Increment, i.e. x++ is equivalent to x=x+1
-- Decrement, i.e. x-- is equivalent to x=x-1

* Multiplication
x Multiplication
^ Power
/ Integer division with truncation of the result towards zero. For example, 7/4 and -7/-4 are truncated to 1 -7/4 and 7/-4 are truncated to -1
// Integer division with rounding to the nearest integer. Half-integer values are rounded away from zero unless otherwise specified. For example, 3//2 is rounded to 2, and -3//2 is rounded to -2.
÷ Used to indicate division in mathematical equations where no rounding is intended
% Modulus operator, defined only for positive numbers
ld Logarithm base 2
ceil Minimum integer number greater or equal than the given floating point number

3.4 Logical operators

|| Logical OR
&& Logical AND
! Logical NOT

3.5 Relational operators

> Greater than
>= Greater than or equal to
≥ Greater than or equal to
< Less than
<= Less than or equal to
≤ Less than or equal to

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== Equal to
!= Not equal to

3.6 Bitwise operators

| OR
& AND
>> Shift right with sign extension
<< Shift left with zero fill

3.7 Conditional operator

?: $condition\,?\,a:b = \begin{cases} a & if\,(condition) \\ b & otherwise \end{cases}$

3.8 Assignment

= Assignment operator

3.9 Mnemonics

The following mnemonics are defined to describe the different data types used in the coded bitstream.

bslbf Bit string, left bit first, where "left" is the order in which bits are written in ISO/IEC 15938-3. Bit strings are generally written as a string of 1s and 0s within single quote marks, e.g. '1000 0001'. Blanks within a bit string are for ease of reading and have no significance. For convenience, large strings are occasionally written in hexadecimal, in which case conversion to a binary in the conventional manner will yield the value of the bit string. Thus, the left-most hexadecimal digit is first and in each hexadecimal digit the most significant of the four digits is first.

vluimsbf5 Variable length unsigned integer most significant bit first representation consisting of two parts. The first part defines the number *n* of 4-bit bit fields used for the value representation, encoded by a sequence of *n-1* "1" bits, followed by a "0" bit signaling its end. The second part contains the value of the integer encoded using the number of bit fields specified in the first part.

uimsbf Unsigned integer, most significant bit first.

simsbf Signed integer, in two's complement format, most significant bit (sign) first.

vlclbf Variable length code, left bit first, where "left" refers to the order in which the VLC codes are written in ISO/IEC 15938-3. The byte order of multibyte words is most significant byte first.

fsbf Float (32 bit), sign bit first. The semantics of the bits within a float are specified in the IEEE Standard for Binary Floating Point Arithmetic (ANSI/IEEE Std 754-1985).

UTF-8 Binary string encoding defined in ISO 10646/IETF RFC 2279.

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3.10 Constants

π 3.141 592 653 58…
e 2.718 281 828 45…

3.11 Functions

max() Maximum value in argument list
min() Minimum value in argument list

Sign() $Sign(x) = \begin{cases} 1 & x \geq 0 \\ -1 & x < 0 \end{cases}$

Abs() $Abs(x) = \begin{cases} x & x \geq 0 \\ -x & x < 0 \end{cases}$

$\sum_{i=a}^{i<b} f(i)$ Summation of $f(i)$ with *i* taking integer values from *a* up to, but not including b.

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L1 norm $$L1(\mathbf{x},\mathbf{y}) = \sum_i |x_i - y_i|$$

L2 norm $$L2(\mathbf{x},\mathbf{y}) = \sum_i (x_i - y_i)^2$$

Euclidean distance $$D(\mathbf{x},\mathbf{y}) = sqrt\left(\sum_i (x_i - y_i)^2\right)$$

4 Conventions

4.1 Method of describing the DDL representation syntax

The method of describing the DDL representation syntax is defined in ISO/IEC 15938-2 (MPEG-7 Description Definition Language).

4.2 Method of describing the binary representation syntax

4.2.1 Introduction

The video description elements can be encoded using the generic encoding mechanism defined in ISO/IEC 15938-1 or the video-specific binary representation syntax defined in the “Binary representation syntax” subclauses below.

4.2.2 Generic binary representation

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The use of the video-specific syntax is signaled using the codec configuration mechanism defined in ISO/IEC 15938-1 and the following classification scheme is defined for this purpose:

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```
<ClassificationScheme uri="urn:mpeg:mpeg7:cs:VisualDescriptorCodecCS:2001">
   <Term termID="1">
      <Name xml:lang="en">MPEG7CameraMotion</Name>
      <Definition xml:lang="en">ISO/IEC 15938-3 Binary Camera Motion
            Codec</Definition>
   </Term>
   <Term termID="2">
      <Name xml:lang="en">MPEG7ColorLayout</Name>
      <Definition xml:lang="en">ISO/IEC 15938-3 Binary Color Layout
            Codec</Definition>
   </Term>
   <Term termID="3">
      <Name xml:lang="en">MPEG7ColorQuantization</Name>
      <Definition xml:lang="en">ISO/IEC 15938-3 Binary Color Quantization
            Codec</Definition>
   </Term>
   <Term termID="4">
      <Name xml:lang="en">MPEG7ColorSpace</Name>
      <Definition xml:lang="en">ISO/IEC 15938-3 Binary Color Space
            Codec</Definition>
   </Term>
   <Term termID="5">
      <Name xml:lang="en">MPEG7ColorStructure</Name>
      <Definition xml:lang="en">ISO/IEC 15938-3 Binary Color Structure
            Codec</Definition>
   </Term>
   <Term termID="6">
      <Name xml:lang="en">MPEG7ContourShape</Name>
      <Definition xml:lang="en">ISO/IEC 15938-3 Binary Contour Shape
            Codec</Definition>
   </Term>
   <Term termID="7">
```

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```
    <Name xml:lang="en">MPEG7DominantColor</Name>
    <Definition xml:lang="en">ISO/IEC 15938-3 Binary Dominant Color
          Codec</Definition>
</Term>
<Term termID="8">
    <Name xml:lang="en">MPEG7EdgeHistogram</Name>
    <Definition xml:lang="en">ISO/IEC 15938-3 Binary Edge Histogram
          Codec</Definition>
</Term>
<Term termID="9">
    <Name xml:lang="en">MPEG7FaceRecognition</Name>
    <Definition xml:lang="en">ISO/IEC 15938-3 Binary Face Recognition
          Codec</Definition>
</Term>
<Term termID="10">
    <Name xml:lang="en">MPEG7FoFGoPColor</Name>
    <Definition xml:lang="en">ISO/IEC 15938-3 Binary GoFGoP Color
          Codec</Definition>
</Term>
<Term termID="11">
    <Name xml:lang="en">MPEG7GridLayout</Name>
    <Definition xml:lang="en">ISO/IEC 15938-3 Binary Grid Layout
          Codec</Definition>
</Term>
<Term termID="12">
    <Name xml:lang="en">MPEG7HomogeneousTexture</Name>
    <Definition xml:lang="en">ISO/IEC 15938-3 Binary Homogeneous Texture
          Codec</Definition>
</Term>
<Term termID="13">
    <Name xml:lang="en">MPEG7IrregularVisualTimeSeries</Name>
    <Definition xml:lang="en">ISO/IEC 15938-3 Binary Irregular Time Series
          Codec</Definition>
</Term>
<Term termID="14">
    <Name xml:lang="en">MPEG7MotionActivity</Name>
    <Definition xml:lang="en">ISO/IEC 15938-3 Binary Motion Activity
          Codec</Definition>
</Term>
<Term termID="15">
    <Name xml:lang="en">MPEG7MotionTrajectory</Name>
    <Definition xml:lang="en">ISO/IEC 15938-3 Binary Motion Trajectory
          Codec</Definition>
</Term>
<Term termID="16">
    <Name xml:lang="en">MPEG7MultipleView</Name>
    <Definition xml:lang="en">ISO/IEC 15938-3 Binary Multiple View
          Codec</Definition>
</Term>
<Term termID="17">
    <Name xml:lang="en">MPEG7ParametricMotion</Name>
    <Definition xml:lang="en">ISO/IEC 15938-3 Binary Parametric Motion
          Codec</Definition>
</Term>
<Term termID="18">
    <Name xml:lang="en">MPEG7RegionLocator</Name>
    <Definition xml:lang="en">ISO/IEC 15938-3 Binary Region Locator
          Codec</Definition>
</Term>
<Term termID="19">
    <Name xml:lang="en">MPEG7RegionShape</Name>
```

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```
      <Definition xml:lang="en">ISO/IEC 15938-3 Binary Region Shape
            Codec</Definition>
   </Term>
   <Term termID="20">
      <Name xml:lang="en">MPEG7RegularVisualTimeSeries</Name>
      <Definition xml:lang="en">ISO/IEC 15938-3 Binary Regular Time Series
            Codec</Definition>
   </Term>
   <Term termID="21">
      <Name xml:lang="en">MPEG7ScalableColor</Name>
      <Definition xml:lang="en">ISO/IEC 15938-3 Binary Scalable Color
            Codec</Definition>
   </Term>
   <Term termID="22">
      <Name xml:lang="en">MPEG7Shape3D</Name>
      <Definition xml:lang="en">ISO/IEC 15938-3 Binary Shape 3D
            Codec</Definition>
   </Term>
   <Term termID="23">
      <Name xml:lang="en">MPEG7Spatial2DCoordinateSystem</Name>
      <Definition xml:lang="en">ISO/IEC 15938-3 Binary Spatial 2D Coordinate
            System Codec</Definition>
   </Term>
   <Term termID="24">
      <Name xml:lang="en">MPEG7SpatioTemporalLocator</Name>
      <Definition xml:lang="en">ISO/IEC 15938-3 Binary SpatioTemporal Locator
            Codec</Definition>
   </Term>
   <Term termID="25">
      <Name xml:lang="en">MPEG7TemporalInterpolation</Name>
      <Definition xml:lang="en">ISO/IEC 15938-3 Binary Temporal Interpolation
            Codec</Definition>
   </Term>
   <Term termID="26">
      <Name xml:lang="en">MPEG7TextureBrowsing</Name>
      <Definition xml:lang="en">ISO/IEC 15938-3 Binary Texture Browsing
            Codec</Definition>
   </Term>
</ClassificationScheme>
```

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4.2.3 Video binary representation

The video-specific bitstream retrieved is described in subclauses entitled “Binary syntax representation” in clauses 5—11. Each data item in the bitstream is in bold type. It is described with its name, its length in bits, and a mnemonic for its type and order of transmission.

The action caused by a decoded data element in a bitstream depends on the value of that data element and on data elements previously decoded. The following constructs are used to express the conditions when data elements are present and are in normal type.

while (condition) {
data_element
…
}
	If the condition is true, then the group of data elements occurs next in the data stream. This repeats until the condition is not true.

do { **data_element** … } while (condition)	The data element always occurs at least once. The data element is repeated until the condition is not true.

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if (condition) {
data_element
…
} else {
data_element
…
}
	If the condition is true, then the first group of data elements occurs next in the data stream.
	If the condition is not true, then the second group of data elements occurs next in the data stream.

for (i=m ; i<n ; i++) {
data_element
…
}
	The group of data elements occurs (n-m) times. Conditional construct within the group of data elements may depend on the value of the loop control variable i, which is set to m for the first occurrence, incremented by one for the second occurrence, and so forth.

/* comments */	Explanatory comments that may be deleted entirely without in any way altering the syntax.

The syntax uses a 'C-code' convention that a variable or expression evaluating to a non-zero value is equivalent to a condition that is true and a variable or expression evaluating to zero is equivalent to a condition that is false. In many cases a literal string is used in a condition. In such cases a literal string is used to describe the value of a bitstream element.

As noted, a group of data element may contain nested conditional constructs. For compactness, the brackets {} are omitted when only one data element follows. The elements of a multidimensional table are represented as follows.

data_element[n] data_element[n] is the n+1st element in an array of data

data_element[m][n] data_element[m][n] is the m+1st,n+1st element in a two-dimensional array of data

data_element[l][m][n] data_element[l][m][n] is the l+1st,m+1st,n+1st element in a three-dimensional array

The elements of a multidimensional array are transmitted in the bitstream starting with data_element[0][0] and with the outermost elements incremented first, i.e. data_element[0][1] is sent second, data_element[0][2] third, etc.

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4.3 Method of describing the descriptor semantics

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The general semantics of the descriptors are defined in the introductory sections of respective subclauses. The semantics of the syntax components is defined in sections "Descriptor components semantics". The ordering in the semantics sections normally follows the order in which the items appear in the binary representation syntax, which is typically equivalent to the order of items in the DDL instantiation (not schema specification).

5 Basic structures

5.1 Introduction

This clause introduces five supporting tools for the visual descriptions defined in clauses 6–11. They are categorized into two groups, descriptor containers and basic supporting tools. The former consists of three datatypes, GridLayout providing efficient representations of visual features on grids, VisualTimeSeries representing temporal arrays of several descriptions, and MultipleView describing a 3D object using several pictures captured from different view angles. The latter contains two tools, Spatial2DCoordinateSystem used to specify the 2D coordinate system and TemporalInterpolation indicating the interpolation method between two samples on a time axis.

5.2 Grid layout

5.2.1 Introduction

This datatype specifies a structure that allows an image to be split into a set of rectangular regions, so that each region can be described separately. Each region of the grid can be described in terms of other descriptors such as color or texture.

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5.2.2 DDL representation syntax

```
<complexType name="GridLayoutType" final="#all">
   <sequence>
      <element name="Descriptor" type="mpeg7:VisualDType"
         minOccurs="1" maxOccurs="65025"/>
   </sequence>
   <attribute name="numOfPartX" type="mpeg7:unsigned8" use="required"/>
   <attribute name="numOfPartY" type="mpeg7:unsigned8" use="required"/>
   <attribute name="descriptorMask" use="optional">
      <simpleType>
         <restriction base="string">
            <pattern value="(0|1)*"/>
         </restriction>
      </simpleType>
   </attribute>
</complexType>
```

5.2.3 Binary representation syntax

GridLayout {	**Number of bits**	**Mnemonic**
DescriptorID	8	uimsbf
numOfPartX	8	uimsbf
numOfPartY	8	uimsbf
DescriptorMaskPresent	1	bslbf
if(DescriptorMaskPresent) {		
descriptorMask	partNumX*partNumY	bslbf
}		
for(k=0;k<partNumX*partNumY; k++) {		
if(DescriptorMaskPresent) {		
if(descriptorMask[k]) {		
Descriptor[k]		Descriptor instance specified by descriptorID
}		
} else {		
Descriptor[k]		Descriptor instance specified by descriptorID
}		
}		
}		

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5.2.4 Descriptor components semantics

DescriptorID
This field, which is only present in the binary representation, specifies a descriptor identifier. The descriptor identifier indicates the descriptor type accommodated in the grid layout.

The assignment of IDs to the descriptors is specified in Table 1.

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