INTERNATIONAL STANDARD

ISO/IEC 15938-3

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AMENDMENT 4
2010-10-15

Information technology — Multimedia content description interface —

Part 3: **Visual**

AMENDMENT 4: Video signature tools

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

Partie 3: Visuel

AMENDEMENT 4: Outils de vidéosignature

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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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Amendment 4 to ISO/IEC 15938-3:2002 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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Information technology — Multimedia content description interface —

Part 3:
Visual

AMENDMENT 4: Video signature tools

Replace 1.2 with:

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, motion, localization of the described objects in the image or video sequence and also unique and robust identification of visual material. An overview of the visual description tools is shown in Figure 1.

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, GofGopFeature describes representative descriptions over video segment, 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 and ImageSignature descriptors, are associated with visual features and are grouped into five feature categories: Color, Texture, Shape, Motion and Localization.

The color description tools include five color descriptors to represent different aspects of color features: representative colors (DominantColor), color distribution (ScalableColor), spatial distribution of colors (ColorLayout and ColorStructure) and perceptual feeling of illumination color (ColorTemperature). It also contains three supporting tools, ColorSpace and ColorQuantization used in DominantColor and IlluminationInvariantColor to extend four color descriptors, DominantColor, ScalableColor, ColorLayout and ColorStructure, to support illumination invariant similarity matching. An extension of ScalableColor to a group of frames or pictures (GoFGoPColor) is also included in this group. 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 extension of RegionShape is also defined as ShapeVariation to describe temporal variation of shape over video segment. The Shape3D and Perceptual 3D Shape descriptors provide 3-dimensional shape information; the former

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represents an intrinsic shape characterization of 3D mesh models, and the latter represents part-based representation of a 3D object.

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.

The FaceRecognition descriptor and the Advanced Face Recognition descriptor are 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.

The signature descriptors provide a "fingerprint" that uniquely identifies image and video content. The signatures are robust (unchanging) across a wide range of common editing operations, but are sufficiently different for every item of "original" content to allow unique and reliable identification – just like human fingerprints. There are two visual signatures; the ImageSignature and VideoSignature are descriptors for images and videos respectively. The signatures have no direct association with specific visual features such as colour, shape or texture.

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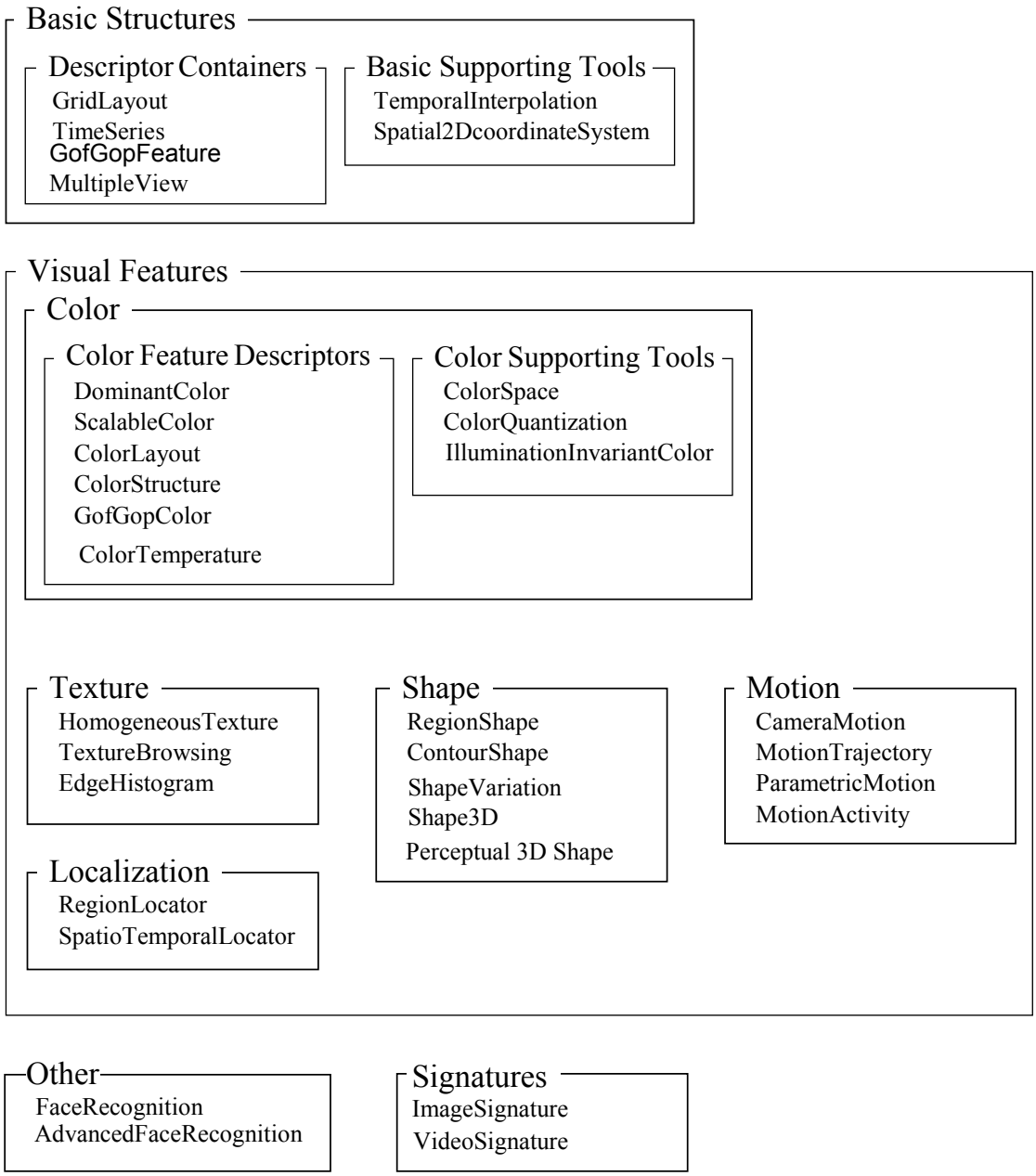

Figure 1 — Overview of Visual Description Tools

In 3.3, extend the definitions:

floor Maximum integer number less than or equal to the given floating point number

Replace 4.2.2 with:

4.2.2 Generic binary representation

The use of the video-specific syntax is signalled using the codec configuration mechanism defined in ISO/IEC 15938-1. 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">
      <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>
```


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```
    </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>
        <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>
```

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```
    </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>
    <Term termID="27">
       <Name xml:lang="en">MPEG7GofGopFeature</Name>
       <Definition   xml:lang="en">ISO/IEC   15938-3   Binary   Gof   Gop   Feature
Codec</Definition>
    </Term>
    <Term termID="28">
       <Name xml:lang="en">MPEG7ColorTemperature</Name>
       <Definition   xml:lang="en">ISO/IEC   15938-3   Binary   Color   Temperature
Codec</Definition>
    </Term>
    <Term termID="29">
       <Name xml:lang="en">MPEG7ShapeVariation</Name>
       <Definition   xml:lang="en">ISO/IEC   15938-3   Binary   Shape   Variation
Codec</Definition>
    </Term>
    <Term termID="30">
       <Name xml:lang="en">MPEG7IlluminationInvariantColor</Name>
       <Definition  xml:lang="en">ISO/IEC  15938-3  Binary  Illumination  Invariant
Color Codec</Definition>
    </Term>
    <Term termID="31">
       <Name xml:lang="en">MPEG7AdvancedFaceRecognition</Name>
       <Definition xml:lang="en">ISO/IEC 15938-3 Binary Advanced Face Recognition
Codec</Definition>
    </Term>
    <Term termID="32">
       <Name xml:lang="en">MPEG7Perceptual3DShape</Name>
       <Definition  xml:lang="en">ISO/IEC  15938-3  Binary  Perceptual  3D  Shape
Codec</Definition>
    </Term>
    <Term termID="33">
       <Name xml:lang="en">MPEG7ImageSignature</Name>
       <Definition   xml:lang="en">ISO/IEC   15938-3   Binary   Image   Signature
Codec</Definition>
    </Term>
    <Term termID="34">
       <Name xml:lang="en">MPEG7VideoSignature</Name>
       <Definition   xml:lang="en">ISO/IEC   15938-3   Binary   Video   Signature
Codec</Definition>
    </Term>
</ClassificationScheme>
```


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In 5.2.4, replace Table 1 with:

Table 1 — Assignment of IDs to descriptors

ID	Descriptor
0	Forbidden
1	CameraMotion
2	ColorLayout
3	ColorSpace
4	ColorStructure
5	ColorQuantization
6	ContourShape
7	DominantColor
8	EdgeHistogram
9	FaceRecognition
10	GoFGoPColor
11	GridLayout
12	HomogeneousTexture
13	IrregularVisualTimeSeries
14	MotionActivity
15	MotionTrajectory
16	MultipleView
17	ParametricMotion
18	RegionLocator
19	RegionShape
20	RegularVisualTimeSeries
21	ScalableColor
22	Shape3D
23	Spatial2DCoordinateSystem
24	SpatioTemporalLocator
25	TemporalInterpolation
26	TextureBrowsing
27	GofGopFeature
28	ColorTemperature
29	ShapeVariation
30	IlluminationInvariantColor
31	AdvancedFaceRecognition
32	Perceptual3DShape
33	ImageSignature
34	VideoSignature
35-255	Reserved

After 11.3, add the following:

11.4 Video Signature

11.4.1 Introduction

The visual content descriptors in Sections 6-9 are very useful when trying to find videos with similar content. These descriptors are intended to be general and were found to be unsuitable for the task of finding duplicate content. The video signature descriptor is designed to identify duplicate video content. This descriptor is robust (unchanging) to a wide range of common video editing operations, but is sufficiently different for every "original" content to identify it uniquely and reliably – just like human fingerprints.

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The video signature is composed of three main elements,

- a frame signature,
- a set of compact summary frame signatures - referred to as words
- and a group-of-frames representation for a temporal segment -referred to as a bag-of-words.

A video is assumed to be made up of a set of frames (or pictures) each representing a single temporal sample. A frame is made of a set of pixels each representing a single spatial sample. The frame signature is extracted from each frame of a video. It is a 380 dimensional vector of base-3 ternary values that describe the intensities and the intensity inter-relations between pixel regions in the frames. Each dimension can be characterized as a mean, first or second order operator.

Words are compact, 1 byte, representations of the frame signature. All possible combinations of values for a word are referred to as the vocabulary. The words provide a summary representation of the frame.

A bag-of-words representation is often used in text searching to compare the similarity between two documents. It ignores the ordering of the text and therefore provides some robustness to editing. For the video signature a bag-of-words records the occurrence of *words* within a temporal segment of frames. The bag-of-words therefore provides a coarse descriptor for the temporal segment.

The video signature descriptor syntax provides support for description of single or multiple static spatial regions within the frame. Each spatial region is a rectangular region having arbitrary position and size, with edges parallel to the edges of the frame. Each spatial region may have its own start and end media times. This feature is useful when describing content such as videos with picture-in-picture, where the entire frame region can be described as the first spatial region and the picture-in-picture region can be described as the second spatial region.

The extraction procedure shall be applied to each spatial region independently. Specifically, only pixels within the spatial region are processed to extract the video signature.

11.4.2 DDL representation syntax

```
<complexType name="VideoSignatureType" final="#all">
  <complexContent>
    <extension base="mpeg7:VisualDType">
      <sequence>
        <element name="VideoSignatureRegion" maxOccurs="4294967295">
          <complexType>
            <sequence>
              <element name="VideoSignatureSpatialRegion" minOccurs="0">
                <complexType>
                  <sequence>
                    <element name="Pixel" minOccurs="2" maxOccurs="2">
                      <simpleType>
                        <restriction base="mpeg7:integerVector">
                          <length value="2" />
                        </restriction>
                      </simpleType>
                    </element>
                  </sequence>
                </complexType>
              </element>
              <element name="StartFrameOfSpatialRegion" type="mpeg7:unsigned32"/>
              <element name="MediaTimeUnit" type="mpeg7:unsigned16"/>
              <element name="MediaTimeOfSpatialRegion" minOccurs="0">
                <complexType>
                  <sequence>
```


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```
            <element name="StartMediaTimeOfSpatialRegion" type="mpeg7:unsigned32"/>
            <element name="EndMediaTimeOfSpatialRegion" type="mpeg7:unsigned32"/>
          </sequence>
        </complexType>
      </element>
      <element name="VSVideoSegment" maxOccurs="4294967295">
        <complexType>
          <sequence>
            <element name="StartFrameOfSegment" type="mpeg7:unsigned32"/>
            <element name="EndFrameOfSegment" type="mpeg7:unsigned32"/>
            <element name="MediaTimeOfSegment" minOccurs="0">
              <complexType>
                <sequence>
                  <element name="StartMediaTimeOfSegment" type="mpeg7:unsigned32"/>
                  <element name="EndMediaTimeOfSegment" type="mpeg7:unsigned32"/>
                </sequence>
              </complexType>
            </element>
            <element name="BagOfWords" minOccurs="5" maxOccurs="5">
              <simpleType>
                <restriction>
                  <simpleType>
                    <list itemType="mpeg7:unsigned1"/>
                  </simpleType>
                  <length value="243"/>
                </restriction>
              </simpleType>
            </element>
          </sequence>
        </complexType>
      </element>
      <element name="VideoFrame" maxOccurs="4294967295">
        <complexType>
          <sequence>
            <element name="MediaTimeOfFrame" type="mpeg7:unsigned32" minOccurs="0"/>
            <element name="FrameConfidence" type="mpeg7:unsigned8"/>
            <element name="Word">
              <simpleType>
                <restriction>
                  <simpleType>
                    <list itemType="mpeg7:unsigned8"/>
                  </simpleType>
                  <length value="5"/>
                </restriction>
              </simpleType>
            </element>
            <element name="FrameSignature">
              <simpleType>
                <restriction>
                  <simpleType>
                    <list itemType="mpeg7:unsigned2"/>
                  </simpleType>
                  <length value="380"/>
                </restriction>
              </simpleType>
            </element>
          </sequence>
        </complexType>
      </element>
    </sequence>
```

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```
          </complexType>
        </element>
      </sequence>
    </extension>
  </complexContent>
</complexType>
```

Descriptor example:

```
<VideoSignature>
  <VideoSignatureRegion>
    <VideoSignatureSpatialRegion>
      <Pixel>0 0</Pixel>
      <Pixel>719 479</Pixel>
    </VideoSignatureSpatialRegion>
    <StartFrameOfSpatialRegion>0</StartFrameOfSpatialRegion>
    <MediaTimeUnit>1000</MediaTimeUnit>
    <MediaTimeOfSpatialRegion>
      <StartMediaTimeOfSpatialRegion>0</StartMediaTimeOfSpatialRegion>
      <EndMediaTimeOfSpatialRegion>5038</EndMediaTimeOfSpatialRegion>
    </MediaTimeOfSpatialRegion>
    <VSVideoSegment>
      <StartFrameOfSegment>0</StartFrameOfSegment>
      <EndFrameOfSegment>89</EndFrameOfSegment>
      <MediaTimeOfSegment>
        <StartMediaTimeOfSegment>0</StartMediaTimeOfSegment>
        <EndMediaTimeOfSegment>2969</EndMediaTimeOfSegment>
      </MediaTimeOfSegment>
      <BagOfWords>1 1 1 1 0 1 0 0 .....
        .............
      </BagOfWords>
        .............
    </VSVideoSegment>
<!-- 2 more VSVideoSegments -->
    <VideoFrame>
      <MediaTimeOfFrame>0</MediaTimeOfFrame>
      <FrameConfidence>100</FrameConfidence>
      <Word>1 2 3 4 5</Word>
      <FrameSignature>1 2 1 0 1 0 2 1 0 2 .....
        .............
      </FrameSignature>
    </VideoFrame>
<!-- 150 more VideoFrames -->
  </VideoSignatureRegion>
</VideoSignature>
```


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11.4.3 Binary Representation Syntax

VideoSignature {	Number of bits	Mnemonics
NumOfSpatialRegions	32	uimsbf
for(r=0; r< NumOfSpatialRegions; r++) {		
SpatialLocationFlag	1	bslbf
if(SpatialLocationFlag == 1) {		
for(i=0;i<2;i++){		
PixelX	16	uimsbf
PixelY	16	uimsbf
}		
}		
StartFrameOfSpatialRegion	32	uimsbf
NumOfFrames	32	uimsbf
MediaTimeUnit	16	uimsbf
MediaTimeFlagOfSpatialRegion	1	bslbf
if(MediaTimeFlagOfSpatialRegion == 1) {		
StartMediaTimeOfSpatialRegion	32	uimsbf
EndMediaTimeOfSpatialRegion	32	uimsbf
}		
NumOfSegments	32	uimsbf
for(i=0; i< NumOfSegments; i++) {		
StartFrameOfSegment	32	uimsbf
EndFrameOfSegment	32	uimsbf
MediaTimeFlagOfSegment	1	bslbf
if(MediaTimeFlagOfSegment == 1) {		
StartMediaTimeOfSegment	32	uimsbf
EndMediaTimeOfSegment	32	uimsbf
}		
for(j=0; j< WordsPerFrame; j++) {		
BagOfWords[j]	243	bslbf
}		
}		
CompressionFlag	1	bslbf
if(CompressionFlag ==0) {		
for(i=0; i< NumOfFrames; i++) {		
MediaTimeFlagOfFrame	1	bslbf
if(MediaTimeFlagOfFrame == 1) {		
MediaTimeOfFrame	32	uimsbf
}		
FrameConfidence	8	uimsbf
for(j=0; j< WordsPerFrame; j++) {		
Word[j]	8	uimsbf
}		
FrameSignature	608	bslbf
}		
} else {		
for (i=0; i<NumOfFrames; i++) {		
MediaTimeFlagOfFrame	1	bslbf
if(MediaTimeFlagOfFrame == 1) {		
MediaTimeOfFrame	32	uimsbf
}		
FrameConfidence	8	uimsbf
for (j=0; j < WordsPerFrame; j++) {		
Word[j]	8	uimsbf
}		
}		

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