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An MPEG-7 Extension for Describing Visual Impairments

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- Motivation
- Impairment description in existing multimedia metadata standards
- Proposed MPEG-7 extension
 - Description Scheme for visual impairments
 - specific descriptors for common impairments
 - Impairment Classification Scheme
- Application

Motivation (1)

- Quality analysis of audiovisual material
 - check for conformance with standards
 - detect defects (e.g. dust spots on film)
 - measure material properties (e.g. noise level)
- Applications
 - Broadcasting
 - ingest of material
 - after editing
 - before playout
 - Archiving
 - ingest
 - delivery
 - Content providers
 - before delivery

Motivation (2)

- Results of quality analysis usually handled within a system
 - immediate reaction, e.g. re-encode
 - not always possible, e.g. restoration needs to be performed
- Exchange of quality analysis results between systems is necessary
 - rich digitisation -> archive documentation
 - content owner <-> restoration service provider
 - archive -> broadcaster

Impairment Description in Existing MM Metadata Standards

- SMPTE Metadata Dictionary
 - overall assessment, test parameters, PSNR
 - audio quality parameters and events as defined by Broadcast Wave Format (BWF)
- MPEG-7
 - MediaQuality (MediaProfile DS): quality rating, rating source, list of perceptible defects (reference to CS)
 - AudioDefectsCS, VisualDefectsCS
- MPEG-7 part 4 AMD 1
 - AudioSignalQualityDS
 - a number of quality parameters for audio channels
 - defect events (reference to CS, time stamp, detection method, relevance, status, text annotation)
 - ErrorClassCS

Shortcomings

- Description of visual impairments
 - nothing comparable to AudioSignalQualityDS
- Detailed description of a defect events
 - spatial/temporal/spatiotemporal location
 - quantive description of defects
 - specific properties of defects
- Description of statistical quality measures
 - frequency, severity, etc. of defects in a segment of the material
 - allows automatic quality analysis without detecting every single defect (throughput!)
 - necessary for efficient reviewing by operator

Impairment Description Approach

- Impairment Description using MPEG-7
 - existing already impairment description capabilities, esp. for audio
 - structuring tools enable description on arbitrary granularity
- Extension for visual modality following the concept of AudioSignalQualityCS
 - generic impairment description scheme
 - list of events with specific description
 - impairment type identified by CS
- Specific impairment descriptors
 - specific properties and quantification
 - optional, impairment type and basic properties can be retrieved without understanding the specific descriptor
- Impairment Classification Scheme
 - Brava broadcast archive programme impairments dictionary

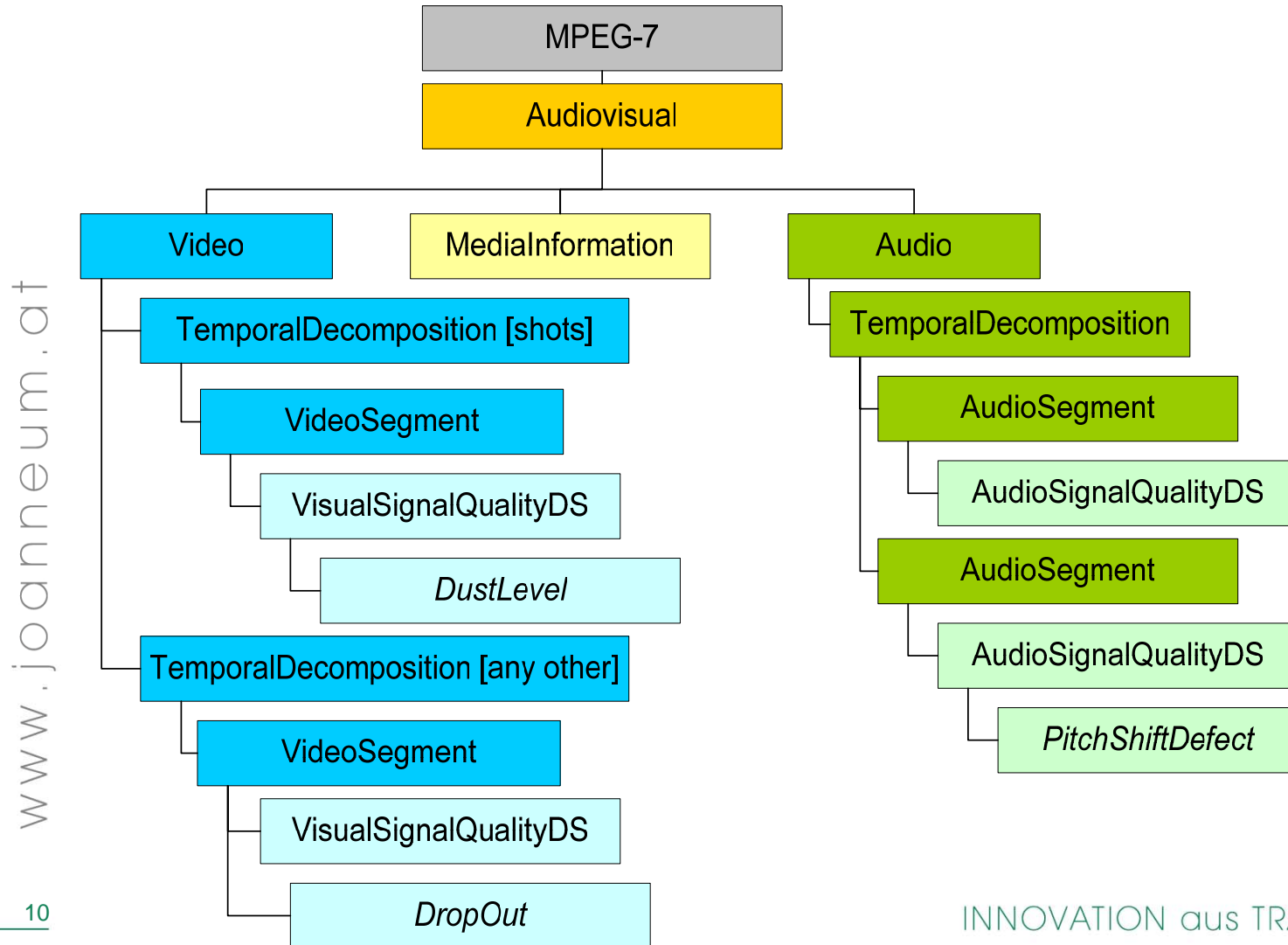
Visual Impairment Description Scheme

- List of impairments (quality measures and defects) for the segment.
 - for each impairment
 - type (reference to CS)
 - strength (normalized numerical value or one of a set of terms for severity levels) (optional)
 - relevance (numeric value, optional)
 - detection process (manual, automatic, optional)
 - comment (optional)
 - origin: a device or system from which the impairments originates (reference to CS, optional)
 - specific impairment descriptor (optional)
- Tool used for generating description (optional)
- Operator (optional)
- Comments (optional)

Specific Impairment Descriptors

- **Visual**
 - Dropout Defect
 - Line Scratch Defect
 - Full Frame Damage
 - Dust/Dirt Level
 - Noise/Grain Level
 - Flicker Level
 - Line Scratch Level
 - Image Instability
 - Blur Level
 - Blocking Level
 - Channel Misalignment
 - Color Range
 - Temporal Sampling
- **Audio**
 - Pitch Shift Defect
 - Wow/Flutter Defect

Integration in MPEG-7 Document



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MPEG-7 XML Example: Specific Grain/Noise Descriptor

...

<VideoSegment>

```

<VisualDescriptor xsi:type="psdq:VisualSignalQualityType">
  <Impairment xsi:type="psdq:NoiseGrainLevelType">
    <Class href="http://www.prestospace.org/mpeg-7/ImpairmentCS/visual1.3"/>
    <Strength>10</Strength>
    <DetectionProcess>automatic</DetectionProcess>
    <Size average="0.001"/>
    <BrightnessDependency>
      <GrainIntensity brightness="0.0">0.02</GrainIntensity>
      <GrainIntensity brightness="0.5">0.01</GrainIntensity>
      <GrainIntensity brightness="1.0">0.02</GrainIntensity>
    </BrightnessDependency>
  </Impairment>
</VisualDescriptor>

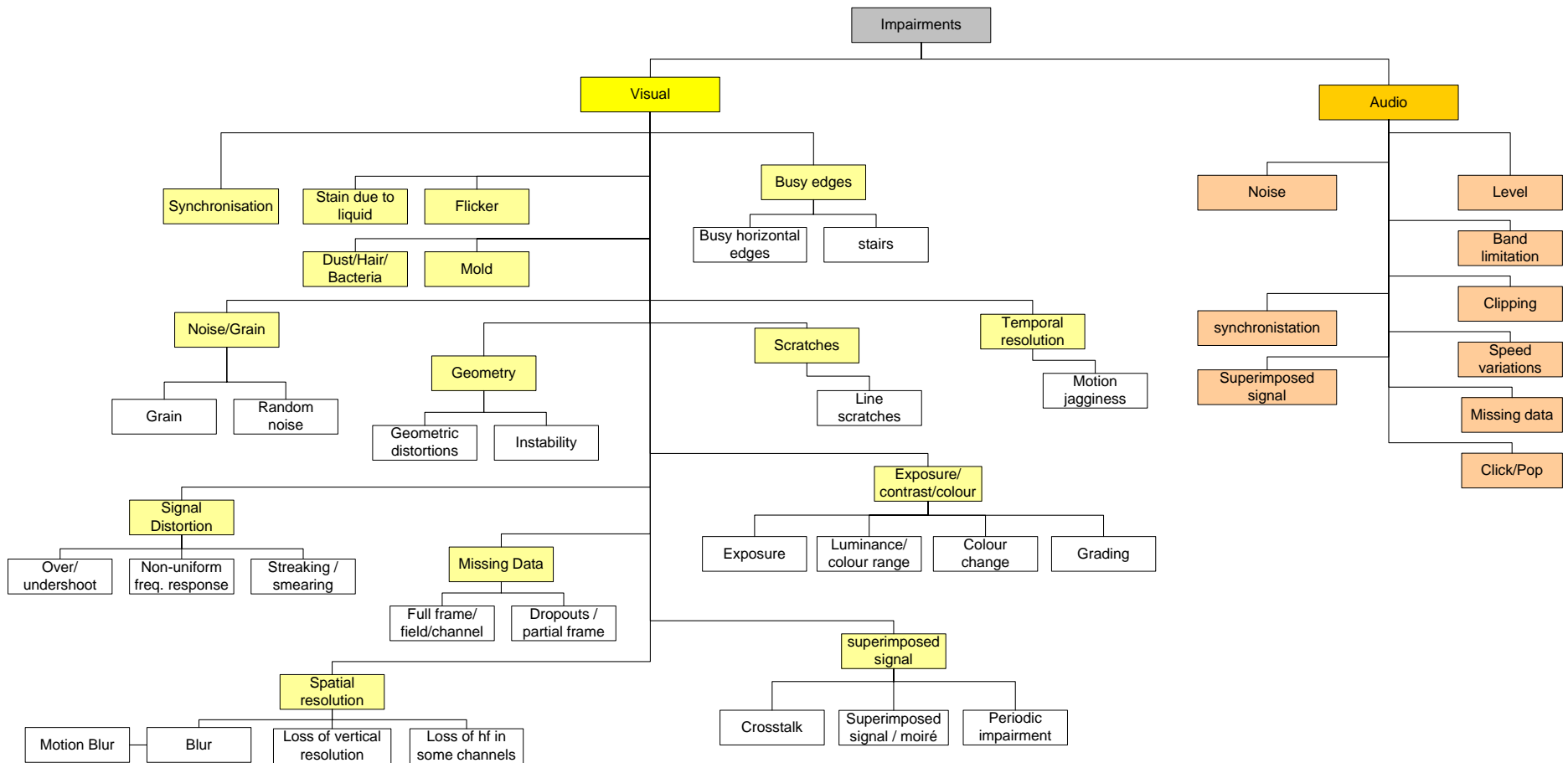
```

</VideoSegment>

...



Impairments Classification Scheme (top levels)



Impairments Classification Scheme (MPEG-7 XML)

```

<ClassificationScheme uri="http://www.prestospace.org/mpeg-7/ImpairmentCS"
  domain="//VisualSignalQualityType/Impairment
  //AudioSignalQualityType/ErrorEventList/ErrorEvent">
  <Term termID="visual">
    <Name xml:lang="en" >Visual defect</Name>
    <Term termID="visual1">
      <Name xml:lang="en" >Noise/Grain</Name>
      <Term termID="visual1.1">
        <Name xml:lang="en">Random Noise</Name>
        <Term termID="T20">
          <Name xml:lang="en" >Inverter Noise</Name>
          <Name xml:lang="fr" >Bruit d'inverseur</Name>
          <Definition><Description xml:lang="en">Cited By L.E.
            Weaver, Breakthrough of inverter switching pulses, narrow
            bandwidth random noise.</Description></Definition>
        </Term>
        <Term termID="T22">
          <Name xml:lang="en" >Quantification Noise</Name>
          <Name xml:lang="fr" >Bruit de Quantification</Name>
  
```

coarse classification

specific class

multilingual

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Impairment Description API

- Impairment Description API
 - based on existing JRS MPEG-7 Library
 - C++ on Win32, Linux, Mac OS X
 - extension covering the new types
- Resources
 - MPEG-7 Library
 - XML Schema for proposed extension
 - Impairment CS
 - available at <http://mpeg-7.joanneum.at>

Application Demo

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Conclusion

- Analysis of audiovisual content is a common task
- Description format for exchange is necessary
- MPEG-7 is a suitable metadata format for impairment information
- Extensions
 - concept of part 4 AMD 1 transferred to visual signals
 - more detailed description for both specific video and audio defects
 - MPEG-7 classification schemes are necessary for a unified and structured description of defect types

Questions?

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www.prestospace.org

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