

Audiovisual Defect & Quality Description Schemes and Descriptors

PrestoSpace / Workpackage 08 / Task 3

RST3 - Restoration Metadata (Defect Description Scheme) - Report

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ABSTRACT This document contains a proposal for description of the condition of audiovisual essence, i.e. its technical quality and the defects it may have. Proposed descriptors are conformant to the MPEG-7 standard.

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1 Summary

The scope of this work is to define means for the description of the condition of audiovisual essence, i.e. its technical quality and the defects it may have. The defect and quality description shall allow getting an overview of the condition of the audiovisual material, navigating directly to defective video or audio sections and quickly estimating restoration efforts.

Standardised defects and quality description of audiovisual media is a pre-requisite for system interoperability inside the PrestoSpace restoration systems as well as for interoperability towards PrestoSpace digitisation and documentation systems. MPEG-7 has been selected as the bases for defects and quality description by the PrestoSpace restoration systems area because of its unique detailed spatiotemporally structured description capabilities. MPEG-7 shall be extended in a standard conformant way.

In MPEG-7 (version 1 and 2) already some quality and defect descriptors and description schemes has been standardised. The MediaQuality description scheme allows simple qualitative defect and quality description for different kind of media. The AudioSignalQuality description scheme allows relatively detailed error and quality measure descriptions, but only for audio materials.

This work defines to extend MPEG-7 by the following description capabilities:

- A general description scheme for visual defects and quality measures, complementary to the existing AudioSignalQuality description scheme. A defect is identified by a reference to a controlled vocabulary, a classification scheme for defects and quality measures.
- A extendable set of specific descriptors for visual quality measure and defect description, e.g. Dropout/Partial Frame Damage, Line Scratches, Full Frame/Channel Damage, Dust/Dirt Level, Noise Grain Level, Flicker Level, Image Instability, Blur, Blocking Level, Channel Misalignment, Color Range Defect.
For each quality measure or defect different information is given: a defect description, the temporal scope, the detailed properties to be described, the extraction/detection method and hints for visualisation of the defect or quality measure.
- Extension of the AudioSignalQuality description scheme by specific audio quality and defects descriptors, e.g. Pitch Shift or Wow&Flutter.

The defect and quality classification schemes which are currently defined in MPEG-7 only specify a few visual and audio defects. It is crucial to define comprehensive defect classification schemes, as they will serve as the basis for future defect & quality measure description in MPEG-7.

In this work the existing MPEG-7 classification schemes are massively extended resulting in the PrestoSpace impairments classification scheme. Based on information available in the BRAVA broadcast archive programme impairments dictionary the PrestoSpace impairments classification scheme contains the following information:

- A classification of the defects
- A hierarchical structure of the defects, e.g. a dropout defect and several specialized kinds of dropouts.
- Multilingual defect names and textual descriptions

The main organization criteria of the classification scheme are the visible and audible effects of defects. If the cause or origin of the defect is known (e.g. a certain device), it may be annotated using a classification scheme for systems and devices being the origin of a defect, as described in this document.

The structuring capabilities of MPEG-7 and the extensibility of the standard, which allows to add new description tools, makes it suitable for both the detailed description of defects and the statistical description of quality properties. Classification schemes can be used for describing a hierarchy of impairments, that either be used alone or in connection with the defect and quality description tools.

The proposed quality measure and defect description schemes, descriptors and classification schemes are implemented by JRS in an MPEG-7 defect and quality description API.

2 Initial MPEG-7 Situation

In MPEG-7 version 1 and 2 already some quality and defect descriptors and description schemes has been standardised. The following section provides an overview on available tools.

2.1 Descriptors and Description Schemes

2.1.1 MediaQualityD

The MediaQuality D (since version 1) [MPEG7-5] is an element in the MediaProfileDS and thus applicable to all media types. It contains the following elements:

- A quality rating, expressed as a floating point value (plus attribute expressing if this is a subjective or objective rating).
- A rating source (an agent) and a reference to the rating information.
- A list of perceptible defects, discriminated into visual and audio defects. Each defect is a reference to a term in a classification scheme. It is not possible to describe the defect further.

2.1.2 AudioSignalQualityDS

This is a description scheme defined in AMD1 to part 4 (MPEG-7 version 2) [MPEG7-4A1]. It can be added to each audio segment. The DS contains the following elements:

- balance
- noise level
- DC offset
- cross channel correlation
- delay
- a list of error events: each error event is described by
 - error class: a reference to a term in a classification scheme
 - time stamp and channel number
 - detection method (manual, automatic)
 - relevance (as a number)
 - status (checked, needs restoration, etc.)
 - text annotation

2.2 Classification Schemes

Classification schemes are MPEG-7 description schemes for defining hierarchies of controlled vocabulary. The following classification schemes exist for the description of defect and quality information (see Part 5 of the standard):

- AudioDefectsCS
- VisualDefectsCS

The classification scheme ErrorClassCS for audio defects is defined in Part 4 AMD 1.

2.2.1 VisualDefectsCS

```
<ClassificationScheme uri="urn:mpeg:mpeg7:cs:VisualDefectsCS:2001"
  domain="//MediaInformation/MediaProfile/MediaQuality/VisualDefects">
  <Term termID="1">
    <Name xml:lang="en">Block distortion</Name>
    <Name xml:lang="en">Blockiness</Name>
  </Term>
  <Term termID="2">
    <Name xml:lang="en">Blurring</Name>
    <Name xml:lang="en">Smearing</Name>
  </Term>
```

```

<Term termID="3">
  <Name xml:lang="en">Edge noise</Name>
  <Name xml:lang="en">Ring</Name>
  <Name xml:lang="en">Edge Busyness</Name>
</Term>
<Term termID="4">
  <Name xml:lang="en">Error blocks</Name>
  <Name xml:lang="en">Missing blocks</Name>
  <Definition xml:lang="en">Missing blocks due to packet loss</Definition>
</Term>
<Term termID="5">
  <Name xml:lang="en">Motion Jerkiness</Name>
  <Definition xml:lang="en">Jumpy movement of visual objects</Definition>
</Term>
<Term termID="6">
  <Name xml:lang="en">Motion Jitters</Name>
</Term>
<Term termID="7">
  <Name xml:lang="en">Scratches</Name>
</Term>
<Term termID="8">
  <Name xml:lang="en">Speckles</Name>
</Term>
<Term termID="9">
  <Name xml:lang="en">Noise</Name>
  <Name xml:lang="en">Random noise</Name>
</Term>
<Term termID="10">
  <Name xml:lang="en">Ghosting</Name>
</Term>
<Term termID="11">
  <Name xml:lang="en">Contouring</Name>
  <Definition xml:lang="en">Image contouring effects</Definition>
</Term>
<Term termID="12">
  <Name xml:lang="en">Color saturation error</Name>
</Term>
<Term termID="13">
  <Name xml:lang="en">Color distortions</Name>
</Term>
<Term termID="14">
  <Name xml:lang="en">Dithering</Name>
</Term>
</ClassificationScheme>

```

2.2.2 AudioDefectsCS

```

<ClassificationScheme uri="urn:mpeg:mpeg7:cs:AudioDefectsCS:2001"
  domain="//MediaInformation/MediaProfile/MediaQuality/AudioDefects">
  <Term termID="1">
    <Name xml:lang="en">Noise</Name>
  </Term>
  <Term termID="2">
    <Name xml:lang="en">Pops</Name>
  </Term>
  <Term termID="3">
    <Name xml:lang="en">Hisses</Name>
  </Term>
  <Term termID="4">
    <Name xml:lang="en">Clicks</Name>
  </Term>
  <Term termID="5">
    <Name xml:lang="en">Others</Name>
  </Term>
</ClassificationScheme>

```

2.2.3 ErrorClassCS

```

<ClassificationScheme uri="urn:mpeg:mpeg7:cs:ErrorClassCS" domain="//AudioSignalQuality/ErrorClass">
  <Term termID="click">
    <Name xml:lang="en">Click</Name>
    <Definition xml:lang="en">A high frequency burst of short duration
  </Definition>
  </Term>
  <Term termID="clicksegment">
    <Name xml:lang="en">ClickSegment</Name>
    <Definition xml:lang="en">A segment containing many Clicks
  </Definition>
  </Term>
  <Term termID="dropout">
    <Name xml:lang="en">DropOut</Name>
    <Definition xml:lang="en">An absence of high frequencies for a short period
  </Definition>
  </Term>
  <Term termID="pop">
    <Name xml:lang="en">Pop</Name>
    <Definition xml:lang="en">A low frequency burst
  </Definition>
  </Term>
  <Term termID="digitalclip">
    <Name xml:lang="en">DigitalClip</Name>
    <Definition xml:lang="en">Distortion occurred when a digital signal is clipped
  </Definition>
  </Term>
  <Term termID="analogclip">
    <Name xml:lang="en">AnalogClip</Name>
    <Definition xml:lang="en">Distortion occurred when an analog signal is clipped
  </Definition>
  </Term>
  <Term termID="samplehold">
    <Name xml:lang="en">SampleHold</Name>
    <Definition xml:lang="en">Click at start and end, short muting of signal
  </Definition>
  </Term>
</ClassificationScheme>

```

```
</Definition>
</Term>
<Term termID="blockrepeating">
<Name xml:lang="en">BlockRepeating</Name>
<Definition xml:lang="en">Repetition of a short block
</Definition>
</Term>
<Term termID="jitter">
<Name xml:lang="en">Jitter</Name>
<Definition xml:lang="en">A single sample click
</Definition>
</Term>
<Term termID="missingblock">
<Name xml:lang="en">MissingBlock</Name>
<Definition xml:lang="en">Click at the transition caused by missing blocks
</Definition>
</Term>
<Term termID="digitalzero">
<Name xml:lang="en">DigitalZero</Name>
<Definition xml:lang="en">Click at the transition caused by zero valued samples
</Definition>
</Term>
<Term termID="other">
<Name xml:lang="en">Other</Name>
<Definition xml:lang="en">Any other error
</Definition>
</Term>
</ClassificationScheme>
```

3 Scope, Requirements, Objective

3.1 Scope

The scope of this work is to define MPEG-7 description tools for the condition of audiovisual essence, i.e. its technical quality and the defects it may have. The defect and quality description shall allow getting an overview of the condition of the audiovisual material. They shall thus be compact descriptions and contain details, only if absolutely necessary.

The description will not include intermediate results of specific restoration algorithms, configurations of analysis or restoration and a history of applied restoration steps.

3.2 Requirements

The description will be mainly produced by automatic tools, and it shall also be automatically processable. Therefore,

- the time point or range for which a description is valid must be specified,
- quality has to be quantified numerically or by sets of defined terms,
- defects need to be at least unambiguously identifiable, and
- properties of defects may be further described numerically or by sets of defined terms.

Additionally, the descriptions need to be annotated and extended manually. Preferable, the descriptions are stored in a human readable format.

As the descriptions shall support a user in getting a quick overview of the condition of the material, they shall be defined in a way that they are easy to visualize. Especially quality measures and defect descriptors that represent a larger time range, should allow condensed visualization over time.

Quantitative descriptions of defects or properties should correspond to the perceived severity of the defect.

Defect and quality descriptions should be efficiently searchable. Whenever possible, the descriptors shall be defined in a way that they are easy to index.

3.3 Objective

The objective of this work is to define:

- Define a description scheme for visual quality and defects, similar to that for audio quality and defects defined in [MPEG7-4A1].
- In addition to the description scheme for audio defects, to allow the extension by detailed descriptors for specific quality measures and defect descriptors.
- Define these specific descriptors for some common quality measures and defects, further ones may be proposed later.
- If necessary, add a similar extension mechanism for specific descriptors to the audio quality and defect description scheme.
- Extend the existing MPEG-7 controlled vocabularies (classification schemes) for video and audio defects and quality measures.
- Recommend extraction methods for the descriptors specified in detail.

4 Description Proposal

4.1 Concept

The general concept for the proposed description scheme is the following:

- Define a **general description scheme** (DS) for visual defects and quality measures. The DS follows the MPEG-7 audio quality DS approach. An instance of the description scheme describes a temporal segment of visual material and contains following
 - A list of defects
 - A defect must be at least identified by a reference to a controlled defect vocabulary.
 - Optionally, a defect may be described by a specific defect descriptor.
 - A list of quality measures
 - A quality measure must be described by a specific descriptor.
- Define **specific descriptors** for some quality measures and defects. There will be two types of these specific descriptors
 - **Quality measure**: Describes defects statistics of a temporal segment of the audiovisual material. Examples are the noise level, the amount of blocking, the graininess, the amount of dust, the amount and average frequency of flicker etc.
 - **Defect**: Describes the occurrence of a defect in more detail. Usually a defect occurs at a time point or in a small time range (e.g. damaged frames). Depending on the defect, the spatial location may be given. Examples: a dropout (+ the region of the image affected), a line scratch (+ its vertical position over time), etc.
- If necessary, define a similar mechanism for attaching specific audio quality and defect descriptors to the existing audio quality and defect description scheme.

It will be possible to define quality measures for all material properties and defects by describing statistics of their occurrence in the material. Defect descriptors will not apply to those properties, which can only be expressed with a measure (e.g. noise).

The following sections define the general and specific defect and quality description tools. The definition of the MPEG-7 description schemes and descriptors can be found in Sections 9.1 through 9.3.

4.2 General Description Scheme for Visual Impairments

Similar to AudioSignalQualityDS, which has been proposed in AMD-1 to part 4 of the MPEG-7 standard, we propose to define a description scheme for visual quality and defects.

The DS is derived from VisualDSType and can thus be attached to any video segment. It contains:

- A list of impairments (quality measures and defects) for the segment.
 - for each impairment, there will be specified
 - class of impairment (reference to term in classification scheme)
 - 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: Text Annotation (optional)
- Origin: a devices or system from which the impairments originates (the term is reference to a classification scheme, optional)
- Optionally, a detailed specific descriptor for the defect or quality measure may be used
- Tool used for generating description (optional)
- Operator (optional)
- Comments: text annotation (optional)

4.3 General Description Scheme for Audio Impairments

4.3.1 Defects

In Section 4.6.3 the need for a detailed description of audio defects, which is currently not possible in AudioSignalQualityDS, has been identified.

A straight forward way would be to extend the ErrorEvent DS and defined specialised error events for specific defects. This could only be done by standardizing this extension, as there are no conformance rules for extensions of part 4 tools [MPEG7-7] like those for MDS tools.

4.3.2 Quality Measures

There is already a set of measures defined in AudioQuality DS. To add additional defect descriptions, it would be necessary to extend AudioQuality DS so that there is an unlimited set of generic quality measure elements. The specific quality measures are defined as extension of this generic quality measure type. The same considerations stated above for defects apply.

4.4 Specification of Quality and Defect Descriptors

For some common quality measures and defects detailed descriptors have been defined (cf. Section 4.6). The specification of a detailed quality defect descriptor contains the following points:

The type of descriptor for an impairment: quality measure, defect, or both (used depending on the application).

For each of the proposed quality measure descriptors the following information is described:

- The measures used to describe the material property or defect
- The temporal scope of the descriptor (program, shot, part of a shot, ...)
- The temporal density of the measure (each frame, every nth frame, once per shot, ...)
- Proposed method for extracting this information (optional)
- Proposed method for visualising this information (optional)

For each of the proposed defect descriptors the following information is described:

- The properties of the defect to be described

- The temporal scope of the descriptor (single frame/field, n frames/fields)
- If applicable, the spatial location of the defect. If so, and the temporal scope is larger than 1 frame, whether the location changes over time.
- How Proposed method for extracting this information (optional)
- Proposed method for visualising this information (optional)

4.5 Defect Classification Scheme

The existing defect classification schemes described in Section 2.2 will be extended, a proposal can be found in Section 6.

4.6 Detailed Defect Descriptions

4.6.1 Introduction

4.6.1.1 General thoughts on visualisation

Without going into specifics about a certain defect description, defects occurrences can be visualized using bars that appear in the temporal range where the defect is present. The colour of the bar can be used to identify the type of defect, or, if each defect is visualized on an own line, to represent some property of the defect.

A general visualisation for a quality measure, that varies throughout the sequence is a line graph or a bar graph using height to represent the impairment strength for a segment.

4.6.2 Visual Impairments

4.6.2.1 Dropout/Partial Frame Damage

Defects described: dropout or other damage affecting a part of a frame

Temporal scope: single frame or a few frames

Properties:

- Optionally
 - range of lines/pixels affected (line/pixel numbers, upper/lower/both fields)
 - area of the frame affected
- channel(s) affected
- replaced with line n-1 or n-2 by drop-out compensation

Extraction:

- imported from playback device
- detected as spatiotemporal discontinuities in the image sequence

Visualization:

The frame could be marked in a temporal overview (e.g. with a block or arrow), using the height of a block to indicate the size of the dropout area.

4.6.2.2 Line Scratches

Defects described: vertical scratches on film material

Temporal scope: arbitrary segments, a few to hundreds of frames

Properties:

- horizontal position
- width
- negative or positive

Extraction: specific line scratch detector

Visualization:

Bar graph for scratch appearance.

4.6.2.3 Full Frame/Channel Damage

Defects described: full frame or channel area distorted

Temporal scope: one to a few frames

Properties:

- Channel(s) affected

Extraction: temporal discontinuity in image sequence

Visualization:

4.6.2.4 Dust/Dirt Level

Quality described: dust or dirt spots level

Temporal density:

- typically per segment shot or part of a shot
- in some cases it may be useful to describe average size, intensity, etc. per frame

Measures:

- average number of dust spots
- average fraction of dust spot area of the image area
- average size of dust spots
- temporal average of minimal/maximal size dust spots per frame
- average intensity of bright and dark dust spots

Extraction:

For segment based description, perform dust detection on a number of regularly or randomly sampled frames of the segment (the number of samples could be a parameter that weights precision against runtime), calculate segment average from the results of the single frames.

For frame based description, dust detection (motion compensated difference to neighbours) for each frame, and measure of the properties of the result dust mask.

Visualization:

The results can be visualized as line graphs, different dust measures could be represented by

4.6.2.5 Noise/Grain Level

Quality property described: level of noise/grain

Temporal density: noise/grain level of the shot

Measures:

- Mean of the local luminance dispersion

- Spatial noise/grain size (as fraction of image size)
- Signal dependency of grain

Extraction

1. choose randomly an image in the current shot
2. choose areas with no image content structure, calculate local luminance dispersion for each
3. sort the dispersion values
4. with the N smallest dispersion values, compute the mean of the dispersion

Visualization: Bar height indicates amount of noise/grain, shading indicates signal dependency

4.6.2.6 Flicker Level

Quality property described: level of flicker

Temporal density: shot

Measures

- Average flicker intensity (expressed relative to the luminance range)
- Distribution of frequency of flicker
- Local variation of flicker (y/n)

Extraction: detect high frequent brightness fluctuations over time

Visualization: Bar height indicates amount of flicker

4.6.2.7 Line Scratches

Quality property described: number of line scratches

Temporal density: shot

Measures

- Number of scratches

Extraction:

Visualization:

4.6.2.8 Image Instability

Defects described: geometric position instability of the image

Temporal scope: shot

Properties:

- Average/maximum horizontal/vertical displacement (fraction of image area)

Extraction: motion detection of background object

Visualization: Bar height indicates amount of image instability

4.6.2.9 Blur

Quality property described: spatial resolution of image

Temporal density: shot

Measures

- characteristic scale of the edges (Scale Space – Lindeberg T.)

Extraction

Extract measure form one image per shot. The characteristic scales of the edges [ElderZucker98] are high when the image is blurred.

Visualization: Bar height indicates blur level

4.6.2.10 Blocking Level

Quality property described: blocking artefacts level from lossy DCT based encoding

Temporal density: per shot or part of a shot

Measures:

- average amount of blocking (normalized)

Extraction:

The feature will typically be extracted by choosing a number of regularly or randomly sampled frames from the segment to be described. The number of frames weights precision against runtime; in some cases, every frame of the image sequence may be chosen to achieve a precise result.

Extraction of the feature for one frame: amount of horizontal/vertical edge energy in relation to total edge energy, amplitude of the frequency components corresponding to blocking

Visualization:

Using a line graph to display the amount of blocking over time.

4.6.2.11 Channel Misalignment

Quality property described: colour channels are asynchronous

Temporal density: sequence of shots or whole material

Measures:

- Average misalignment in x/y (fraction of image size)

Extraction:

Visualization:

4.6.2.12 Color Range Defect

Quality property described: high-/low contrast in one or more channels, saturation/clipping

Temporal density: sequence of shots or whole material

Measures:

- Fraction of the intensity range used
- Area affected by saturation

Extraction:

Visualization:

4.6.3 Audio Defects

AMD1 of MPEG-7 Part 4 [MPEG7-4A1] defines AudioSignalQuality DS that provides standardized tools for describing audio signal defects and quality measures. Unfortunately, it has some severe drawback with regard to our field of applications, as it does not allow any precise quantitative description of defects. Although it is possible to define a sequence of ErrorEvent structures with precise time signatures, these structures currently do not have any parameter that would carry information about defect intensity. Therefore it is not possible to

use this descriptor for the purpose of wow defect description without introducing changes to the existing schema.

Thus an extension is for the high-level description of defects and quality measures proposed in the following is required.

4.6.3.1 Pitch Shift

Defects described: shift of the signal spectrum resulting from wow & flutter disturbance

Temporal scope: segment of audio signal defined by starting and ending timestamps.

Properties:

- relative detune
- confidence measure (optional)

Extraction:

- evaluated by an adequate software designed for this purpose
- each audio segment is assigned a discrete value as a result of splitting pitch variation curve

Visualization:

For a detailed visualization of a defect event, the relative detune values may be placed on the signal spectrogram and connected with splines to depict the pitch variation curve. This would enable to visualize the correlation between this curve and the harmonic components of the spectrum.

4.6.4 Audio Quality Measures

4.6.4.1 Wow & flutter

Defects described: statistical description of wow & flutter effects existing in audio signal

Temporal scope: entire audio signal

Properties:

- mean relative detune
- maximum relative detune
- variation of relative detune

Extraction:

- obtained through a statistical analysis of Pitch Shifter defect descriptors

Visualization:

5 General Considerations on Defect & Quality Description in MPEG-7

5.1 Content vs. Media

5.1.1 MediaInformation in MPEG-7

MPEG-7 is formally named multimedia content description interface, i.e. the scope of the standard is the description of multimedia content. The MediaInformationDS [MPEG7-5] models the relation between the content and the media representations (files, tapes, wax cylinders, etc.) of the content.

The standard uses two concepts to model the fact that the same content may be stored on different media:

- MediaProfiles: different encodings of the same content entity (e.g. film master, 2K scan, MP@ML MPEG-2 file)
- MediaInstances: physical instances holding the same content, maybe even encoded with the same profile (e.g. IMX MPEG-2 instance on Tape and IMX MPEG-2 instance on file)

5.1.2 The Problem for Defect and Quality Description

While much of the description usually stored in MPEG-7 is in fact a description of the content (e.g. shot information, speech-to-text transcription), defect and quality descriptions are related to a single media profile, maybe even to a single media instance. It should thus not be mixed with the content description, as the entity being described is different.

This is partly reflected in the standard by the fact that the MediaQualityDS is an element of the MediaProfileDS. As the scope of quality description in MPEG-7 v1 is definitely on encoding artefacts, it makes sense to attach the description to the profile and not a single instance. This is however different for the description of defects and the condition of archive material.

It is desirable, to use the powerful structuring tools defined in Part 5 for defect and quality description, which is a strong argument to use the same structure as used for content description and not put defect and quality description into the media profile part. This approach is used in the AudioSignalQualityDS defined in Part 4 AMD 1, which is modelled as a descriptor of an audio segment. As this proposal has been approved by the standards committee, it is standard conformant to model defect and quality descriptions in this way. However, the description is ambiguous, if the corresponding media information contains references to more than one media instance.

5.1.3 Possible Solutions

- Separate descriptions: keep the content and the D&Q description as separate MPEG-7 descriptions, either in the same file or completely separated.
- Use a MediaSourceDecomposition (with an appropriate criteria attribute) on the top most segment of the content and add a new root element for the content, which only refers to the instance, of which defects and quality are described. The description of this root segment may only contain defect and quality descriptions.
- Extend the MediaInstance element, so that it contains a root segment, to which structuring tools and video/audio descriptors may be attached. The description of this segment and the sub-segments may only contain defect and quality descriptions.

6 Classification Scheme Proposals

The classification schemes which are currently defined in MPEG-7 only specify a few defects and should be therefore extended to cover all the defects and quality measures that need to be described in WA RES. Note that classification schemes are not a normative part of the standard, so that they can be easily extended without the need to adapt or extend the XML schema defining the standard.

It is crucial to define comprehensive defect classification schemes, as they will serve as the basis for defect & quality measure description in MPEG-7. They can be used right away, without any extension of the standard by using them in the description tools described in Section .

Also the newly defined description schemes proposed in Section 4.6 will rely on classification schemes as basic information. Only for some common defects, more detailed descriptors, adding detailed description about the defect occurrence will be added. Applications that are not capable of understanding these specialized descriptors will still be able to get a rough description of the defect just from the temporal segment and the reference to a defect in the classification scheme.

A more detailed definition of the classification schemes can be found in Section 10.

6.1 PrestoSpace Impairments Classification Scheme

The public BRAVA broadcast archive programme impairments dictionary [BravaDict] is very much oriented towards completeness and can thus serve as a good starting point for extending the audio and visual defect classification schemes of the MPEG-7 standard. The BRAVA dictionary will thus be used as the basis of the PrestoSpace impairments classification scheme. The definition of a classification scheme from the impairments dictionary could include the following information:

- A classification of the defects
- A hierarchical structure of the defects, e.g. a dropout defect and several specialized kinds of dropouts. Although the structure of the classification scheme is basically hierarchical, other relations between terms may be specified (e.g. synonyms or preferred terms).
- Multilingual defect names and textual descriptions

The main organization criteria of the classification scheme are the visible and audible effects of defects. If the cause or origin of the defect is known, it may be annotated using the origin classification scheme (see below) or by selecting a narrower sub-term that specifies the defect in relation to a certain cause.

6.2 Devices and Systems Related to Impairments

Many defects originate from the use of certain devices or systems. The knowledge about the devices and systems used throughout the chain may help to better understand the annotated defect. Thus each defect and quality measure descriptor references to a classification scheme that contains the devices and systems that are related to the annotated impairments.

7 Glossary

Term	Description
Classification scheme	In MPEG-7, a classification scheme is a controlled vocabulary, including a hierarchical and multilingual definition of terms.
D	Descriptor: describes a single property.
DS	Description Scheme: a set of related descriptors.
Description tool	In MPEG-7, description schemes and descriptors are called description tools.
JRS	JOANNEUM RESEARCH
INA	Institut National de l'Audiovisuel
GUT	Gdansk University of Technology

8 References

- [BravaDict] The Brava broadcast archive programme impairments dictionary. http://brava.ina.fr/brava_public_impairments_list.en.html
- [ElderZucker98] James H. Elder and Steven W. Zucker, "Local Scale Control for Edge Detection and Blur Estimation", *IEEE Trans. Pattern Recognition and Machine Intelligence*, vol. 20, no. 7, Jul. 1998.
- [MPEG7-4A1] ISO/IEC, Multimedia Content Description Interface, Part 4: Audio, ISO/IEC 15938-4:2002/Amd 1:2004.
- [MPEG7-5] ISO/IEC, Multimedia Content Description Interface, Part 5: Multimedia Description Schemes, ISO/IEC 15938-5:2001.
- [MPEG7-7] ISO/IEC, Multimedia Content Description Interface, Part 7: Conformance, ISO/IEC 15938-7:2001.

9 Appendix A: Description Tools

9.1 Generic Visual Defect and Quality Measure Description Tools

9.1.1 VisualSignalQuality DS

9.1.1.1 Introduction

The visual signal quality DS is the container for a list of defect and quality measure descriptors. It extends VisualDS and can thus be attached to any visual segment.

9.1.1.2 VisualSignalQuality datatype syntax

```
<!-- ##### -->
<!-- Definition of VisualSignalQuality DS -->
<!-- ##### -->
<!-- Definition of VisualSignalQuality DS -->
<complexType name="VisualSignalQualityType">
  <complexContent>
    <extension base="mpeg7:VisualDSType">
      <sequence>
        <choice maxOccurs="unbounded">
          <element name="Impairment" type="psdq:VisualImpairmentType"/>
        </choice>
        <element name="Operator" type="mpeg7:PersonType" minOccurs="0"/>
        <element name="UsedTool" type="mpeg7:CreationToolType" minOccurs="0"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>
```

9.1.1.3 VisualSignalQuality datatype semantics

Semantics of the VisualSignalQualityType:

<i>Name</i>	<i>Definition</i>
VisualSignalQualityType	Describes defects and quality measures of a visual segment.
Impairment	Description of a defect that is present on the visual segment or a visual quality measure of the segment.
Operator	Identifies the operator who created the defect/quality description (optional).
UsedTool	Describes the tool that has been used for creating the defect/quality description.

9.1.2 Visual Impairment Description Tools

9.1.2.1 Introduction

The visual impairment type is the base type of specific defect and quality measure descriptors. It may also be used for annotation of defects and quality measures without further specific description.

9.1.2.2 Visual Impairment tools syntax

```

<!-- ##### -->
<!-- Definition of VisualImpairment DS -->
<!-- ##### -->
<!-- Definition of VisualImpairment DS -->
<complexType name="VisualImpairmentType">
  <complexContent>
    <extension base="mpeg7:VisualDType">
      <sequence>
        <element name="Class" type="mpeg7:ControlledTermUseType"/>
        <element name="Strength" minOccurs="0">
          <simpleType>
            <restriction base="mpeg7:unsigned8">
              <minInclusive value="0"/>
              <maxInclusive value="100"/>
            </restriction>
          </simpleType>
        </element>
        <element name="Relevance" type="mpeg7:unsigned4" minOccurs="0"/>
        <element name="Origin" type="mpeg7:ControlledTermUseType" minOccurs="0"
          maxOccurs="unbounded"/>
        <element name="DetectionProcess" type="psdq:DetectionProcessType"
          minOccurs="0"/>
        <element name="Comment" type="mpeg7:TextAnnotationType" minOccurs="0"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>

<!-- Definition of DetectionProcess -->
<simpleType name="DetectionProcessType">
  <restriction base="string">
    <enumeration value="manual"/>
    <enumeration value="automatic"/>
  </restriction>
</simpleType>

```

9.1.2.3 Visual Defect and Quality description base tools semantics

Semantics of the VisualImpairmentType:

<i>Name</i>	<i>Definition</i>
VisualImpairmentType	Describes the common properties of defects and quality measures.
Class	Identifies the impairment being described. Reference to a term, e.g. from ImpairmentCS.
Strength	Perceived strength of the impairment (optional, except when VisualImpairmentType

<i>Name</i>	<i>Definition</i>
	is used as a quality measure without using a specialisation of it).
Relevance	A value expressing the relevance of the defect/impairment (optional).
Origin	References to devices and/or systems that have influence on the defect (optional). Reference to a term, e.g. from ImpairmentOriginCS.
Detection Process	The process used for the detection of the defect or the measurement of the quality (optional).
Comment	Textual annotation of the defect/quality measure (optional).

9.2 Specific Visual Defect and Quality Measure Description Tools

9.2.1 Introduction

The specific visual impairment tools extend the generic visual impairment description scheme by specific properties of the defects and quality measures described.

9.2.2 Dropout Defect Description Tool

9.2.2.1 Dropout Defect description tool syntax

```

<!-- ##### -->
<!-- Definition of DropoutDefect -->
<!-- ##### -->
<!-- Definition of DropoutDefect -->
<complexType name="DropoutDefectType">
  <complexContent>
    <extension base="psdq:VisualImpairmentType">
      <sequence>
        <element name="AffectedArea" minOccurs="0">
          <complexType>
            <sequence>
              <choice maxOccurs="unbounded">
                <element name="Lines">
                  <complexType>
                    <attribute name="from" type="mpeg7:unsigned16"/>
                    <attribute name="to" type="mpeg7:unsigned16"/>
                  </complexType>
                </element>
                <element name="Region" type="mpeg7:RegionLocatorType"/>
              </choice>
              <element name="Field" type="psdq:FieldType"/>
            </sequence>
          </complexType>
        </element>
        <element name="AffectedChannels" type="psdq:ChannelListType"
minOccurs="0"/>
        <element name="ReplacedByDropoutCompensation" minOccurs="0">

```

```

        <complexType>
          <attribute name="replacedWithLine" type="integer"/>
        </complexType>
      </element>
    </sequence>
  </extension>
</complexContent>
</complexType>

<!-- Definition of ChannelList -->
<complexType name="ChannelListType">
  <sequence>
    <element name="Channel" maxOccurs="unbounded">
      <complexType>
        <simpleContent>
          <extension base="string">
            <attribute name="number" type="mpeg7:unsigned8" use="optional"/>
          </extension>
        </simpleContent>
      </complexType>
    </element>
  </sequence>
</complexType>

<!-- Definition of Field-->
<simpleType name="FieldType">
  <restriction base="string">
    <enumeration value="upper"/>
    <enumeration value="lower"/>
    <enumeration value="both"/>
  </restriction>
</simpleType>

```

9.2.2.2 Dropout Defect description tool semantics

Semantics of the DropoutDefectType:

<i>Name</i>	<i>Definition</i>
DropoutDefectType	Describes the occurrence of a dropout or partial frame damage defect event.
AffectedArea	The image area affected by the dropout/damage, specified by the range of line numbers or by a region (optional).
Lines	The range of line numbers affected by the dropout.
Region	The region in the image affected by the dropout/damage, described by a RegionLocatorType (defined in ISO/IEC 15938-3)
Field	The field(s) affected by the dropout/damage (upper, lower, both).
AffectedChannels	The channels affected by the dropout/damage (a list of channel names and optional channel numbers) (optional).
ReplacedByDropoutCompensation	If the dropout has been compensated in hardware by repeating another line, specify the offset of this line (e.g. -1, if the previous

<i>Name</i>	<i>Definition</i>
	line has been repeated) (optional).

9.2.3 Line Scratch Defect Description Tool

9.2.3.1 Line scratch defect description tool syntax

```

<!-- ##### -->
<!-- Definition of LineScratchDefect -->
<!-- ##### -->
<!-- Definition of LineScratchDefect -->
<complexType name="LineScratchDefectType">
  <complexContent>
    <extension base="psdq:VisualImpairmentType">
      <sequence>
        <element name="ScratchProperties">
          <complexType>

```



```

<extension base="psdq:VisualImpairmentType">
  <sequence>
    <element name="AffectedChannels" type="psdq:ChannelListType"/>
  </sequence>
</extension>
</complexContent>
</complexType>

```

9.2.4.2 Full frame damage description tool semantics

Semantics of the FullFrameDamageType:

Name	Definition
FullFrameDamageType	Describes the occurrence of a full frame damage of one or more channels.
AffectedChannels	The channels affected by the damage (a list of channel names and optional channel numbers).

9.2.5 Dust/Dirt Level Description Tool

9.2.5.1 Dust/dirt level description tool syntax

```

<!-- ##### -->
<!-- Definition of DustLevel -->
<!-- ##### -->
<!-- Definition of DustLevel -->
<complexType name="DustLevelType">
  <complexContent>
    <extension base="psdq:VisualImpairmentType">
      <sequence>
        <element name="NumberOfSpots" minOccurs="0">
          <complexType>
            <attribute name="average" type="mpeg7:unsigned32"/>
          </complexType>
        </element>
        <element name="Area" minOccurs="0">
          <complexType>
            <attribute name="average" type="mpeg7:zeroToOneType"/>
          </complexType>
        </element>
        <element name="Size" minOccurs="0">
          <complexType>
            <attribute name="average" type="mpeg7:zeroToOneType"
              use="optional"/>
            <attribute name="minimum" type="mpeg7:zeroToOneType"
              use="optional"/>
            <attribute name="maximum" type="mpeg7:zeroToOneType"
              use="optional"/>
          </complexType>
        </element>
        <element name="AverageIntensity" minOccurs="0">
          <complexType>
            <attribute name="brightSpots" type="mpeg7:zeroToOneType"
              use="optional"/>
            <attribute name="darkSpots" type="mpeg7: zeroToOneType "
              use="optional"/>
          </complexType>

```

```

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

```

9.2.5.2 Dust/dirt level description tool semantics

Semantics of the DustLevelType:

Name	Definition
DustLevelType	Describes the level of dust/dirt of the segment.
NumberOfSpots	Average number of dust/dirt spots per frame (optional).
Area	Average dust/dirt area per frame (as fraction of the image area) (optional).
Size	Temporal average of the minimum/average/maximum size of the dust/dirt spots per frame (as fraction of the image area) (optional).
AverageIntensity	Average intensity (brightness) of bright and dark dust spots (as fraction of the image intensity range) (optional).

9.2.6 Noise/Grain Level Description Tool

9.2.6.1 Noise/grain level description tool syntax

```

<!-- ##### -->
<!-- Definition of Noise/GrainLevel -->
<!-- ##### -->
<!-- Definition of NoiseGrainLevel -->
<complexType name="NoiseGrainLevelType">
  <complexContent>
    <extension base="psdq:VisualImpairmentType">
      <sequence>
        <element name="MeanLuminanceDispersion" type="float" minOccurs="0"/>
        <element name="Size" minOccurs="0">
          <complexType>
            <attribute name="average" type="mpeg7:zeroToOneType"/>
          </complexType>
        </element>
        <element name="BrightnessDependency" minOccurs="0">
          <complexType>
            <sequence maxOccurs="unbounded">
              <element name="GrainIntensity">
                <complexType>
                  <simpleContent>
                    <extension base="mpeg7:zeroToOneType">
                      <attribute name="brightness" type="mpeg7:zeroToOneType" use="required"/>
                    </extension>
                  </simpleContent>
                </complexType>
              </element>
            </sequence>
          </complexType>
        </element>
      </sequence>
    </extension>
  </complexContent>
</complexType>
</element>

```

```

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

```

9.2.6.2 Noise/grain level description tool semantics

Semantics of the NoiseLevelType:

<i>Name</i>	<i>Definition</i>
NoiseLevelType	Describes the level of noise/grain and its properties.
MeanLuminanceDispersion	Mean of the luminance dispersion caused by noise/grain (optional).
Size	Average size (diameter) of noise/grain (as fraction of the image width).
BrightnessDependency	Describes the dependency of noise/grain intensity on the image intensity by defining a list of mappings from image intensity values to noise/grain intensity values (optional).

9.2.7 Flicker Level Description Tool

9.2.7.1 Flicker level description tool syntax

```

<!-- ##### -->
<!-- Definition of FlickerLevel -->
<!-- ##### -->
<!-- Definition of FlickerLevel -->
<complexType name="FlickerLevelType">
  <complexContent>
    <extension base="psdq:VisualImpairmentType">
      <sequence>
        <element name="AverageIntensity" type="mpeg7:zeroToOneType"
          minOccurs="0"/>
        <element name="FrequencyDistribution" minOccurs="0">
          <complexType>
            <sequence maxOccurs="unbounded">
              <element name="FlickerIntensity">
                <complexType>
                  <simpleContent>
                    <extension base="mpeg7:zeroToOneType">
                      <attribute name="frequency" type="float"
                        use="required"/>
                    </extension>
                  </simpleContent>
                </complexType>
              </element>
            </sequence>
          </complexType>
        </element>
      </sequence>
    </complexType>
  </element>
  <element name="Local" type="boolean"/>
</sequence>
</extension>

```

```
</complexContent>
</complexType>
```

9.2.7.2 Flicker level description tool semantics

Semantics of the `FlickerLevelType`:

<i>Name</i>	<i>Definition</i>
<code>FlickerLevelType</code>	Describes the level of flicker of a segment.
<code>AverageIntensity</code>	Average intensity of flicker (fraction of the image intensity range) (optional).
<code>FrequencyDistribution</code>	Describes the frequency dependency of the flicker intensity. For a list of temporal frequencies (in Hz) the intensity of flicker is given as a fraction of the image intensity (optional).

9.2.8 Line Scratch Level Description Tool

9.2.8.1 Line scratch level description tool syntax

```
<!-- ##### -->
<!-- Definition of LineScratchLevel -->
<!-- ##### -->
<!-- Definition of LineScratchLevel -->
<complexType name="LineScratchLevelType">
  <complexContent>
    <extension base="psdq:VisualImpairmentType">
      <sequence>
        <element name="NumberOfScratches" type="mpeg7:unsigned16"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>
```

9.2.8.2 Line scratch level description tool semantics

Semantics of the `LineScratchLevelType`:

<i>Name</i>	<i>Definition</i>
<code>LineScratchLevelType</code>	Describes the amount of line scratches of a segment.
<code>NumberOfScratches</code>	The number of line scratches in the segment.

9.2.9 Image Instability Description Tool

9.2.9.1 Image instability description tool syntax

```
<!-- ##### -->
<!-- Definition of ImageInstability -->
<!-- ##### -->
<!-- Definition of ImageInstability -->
<complexType name="ImageInstabilityType">
  <complexContent>
    <extension base="psdq:VisualImpairmentType">
```

```

<sequence>
  <element name="HorizontalDisplacement" minOccurs="0">
    <complexType>
      <attribute name="average" type="mpeg7:zeroToOneType" use="optional"/>
      <attribute name="maximum" type="mpeg7:zeroToOneType" use="optional"/>
    </complexType>
  </element>
  <element name="VerticalDisplacement" minOccurs="0">
    <complexType>
      <attribute name="average" type="mpeg7:zeroToOneType" use="optional"/>
      <attribute name="maximum" type="mpeg7:zeroToOneType" use="optional"/>
    </complexType>
  </element>
</sequence>
</extension>
</complexContent>
</complexType>

```

9.2.9.2 Image instability description tool semantics

Semantics of the ImageInstabilityType:

<i>Name</i>	<i>Definition</i>
ImageInstabilityType	Describes the properties of image instability of a segment.
HorizontalDisplacement	The average and maximum displacement in horizontal direction as fraction of the image height (optional).
VerticalDisplacement	The average and maximum displacement in vertical direction as fraction of the image height (optional).

9.2.10 Blur Level Description Tool

9.2.10.1 Blur level description tool syntax

```

<!-- ##### -->
<!-- Definition of BlurLevel -->
<!-- ##### -->
<!-- Definition of BlurLevel -->
<complexType name="BlurLevelType">
  <complexContent>
    <extension base="psdq:VisualImpairmentType">
      <sequence>
        <element name="EdgeLoss">
          <complexType>
            <attribute name="average" type="mpeg7:zeroToOneType"
              use="optional"/>
            <attribute name="maximum" type="mpeg7:zeroToOneType"
              use="optional"/>
          </complexType>
        </element>
      </sequence>
    </extension>
  </complexContent>
</complexType>

```

9.2.10.2 Blur level description tool semantics

Semantics of the BlurLevelType:

9.2.11 Blocking Level Description Tool

9.2.11.1 Blocking level description tool syntax

```

<!-- ##### -->
<!-- Definition of BlockingLevel -->
<!-- ##### -->
<!-- Definition of BlockingLevel -->
<complexType name="BlockingLevelType">
  <complexContent>
    <extension base="psdq:VisualImpairmentType">
      <sequence>
        <element name="BlockEdgeIntensity">
          <complexType>
            <attribute name="average" type="mpeg7:zeroToOneType"
              use="optional"/>
            <attribute name="maximum" type="mpeg7:zeroToOneType"
              use="optional"/>
          </complexType>
        </element>
      </sequence>
    </extension>
  </complexContent>
</complexType>

```

9.2.11.2 Blocking level description tool semantics

Semantics of the BlockingLevelType:

<i>Name</i>	<i>Definition</i>
BlockingLevelType	Describes the level of blocking compression artefacts.
BlockEdgeIntensity	Average and maximum intensity of the edges introduced at block boundaries (optional).

9.2.12 Channel Misalignment Description Tool

9.2.12.1 Channel misalignment description tool syntax

```

<!-- ##### -->
<!-- Definition of ChannelMisalignment -->
<!-- ##### -->
<!-- Definition of ChannelMisalignment -->
<complexType name="ChannelMisalignmentType">
  <complexContent>
    <extension base="psdq:VisualImpairmentType">
      <sequence>
        <element name="HorizontalDisplacement" minOccurs="0">
          <complexType>
            <attribute name="average" type="mpeg7:zeroToOneType"
              use="optional"/>
            <attribute name="maximum" type="mpeg7:zeroToOneType"

```

```

        use="optional"/>
    </complexType>
</element>
<element name="VerticalDisplacement" minOccurs="0">
    <complexType>
        <attribute name="average" type="mpeg7:zeroToOneType"
            use="optional"/>
        <attribute name="maximum" type="mpeg7:zeroToOneType"
            use="optional"/>
    </complexType>
</element>
</sequence>
</extension>
</complexContent>
</complexType>

```

9.2.12.2 Channel misalignment description tool semantics

Semantics of the ChannelMisalignmentType:

<i>Name</i>	<i>Definition</i>
ChannelMisalignmentType	Describes the spatial misalignment of channels.
HorizontalDisplacement	The average and maximum displacement in horizontal direction as fraction of the image height (optional).
VerticalDisplacement	The average and maximum displacement in vertical direction as fraction of the image height (optional).

9.2.13 Color Range Description Tool

9.2.13.1 Color range description tool syntax

```

<!-- ##### -->
<!-- Definition of ColorRangeDefect -->
<!-- ##### -->
<!-- Definition of ColorRangeDefect -->
<complexType name="ColorRangeDefectType">
    <complexContent>
        <extension base="psdq:VisualImpairmentType">
            <sequence>
                <element name="Channel" maxOccurs="unbounded">
                    <complexType>
                        <sequence>
                            <element name="UsedRange" type="mpeg7:zeroToOneType"
                                minOccurs="0"/>
                            <element name="SaturatedArea">
                                <complexType>
                                    <attribute name="high" type="mpeg7:zeroToOneType"
                                        use="optional" />
                                    <attribute name="low" type="mpeg7:zeroToOneType"
                                        use="optional" />
                                </complexType>
                            </element>
                        </sequence>
                    </complexType>
                </element>
            </sequence>
            <attribute name="component" type="string"/>
        </extension>
    </complexContent>
</complexType>

```

```

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

```

9.2.13.2 Color range description tool semantics

Semantics of the ColorRangeDefectType:

Name	Definition
ColorRangeDefectType	Describes a defect related to the lumincance/color range.
Channel	The defect description for one channel.
component	The component name of the color channel (such as R, Y, Cb, etc.).
UsedRange	The fraction of the possible intensity range that is used (for a sequence, the average value is given) (optional).
SaturatedArea	The image are that is affected by saturation or clipping on the low or high end of the intensity range (optional).

9.3 Audio Defect and Quality Measure Description Tools

For audio defect and quality description, AudioSignalQuality DS [MPEG7-4A1] is used. For specific defect and quality descriptors, ErrorEventType is extended to model the properties of these defects.

9.3.1 Pitch Shift Defect Description Tool

9.3.1.1 Pitch shift defect description tool syntax

```

<!-- ##### -->
<!-- Definition of PitchShift -->
<!-- ##### -->
<!-- Definition of PitchShift -->
<complexType name="PitchShiftDefectType">
  <complexContent>
    <extension base="mpeg7v2:ErrorEventType">
      <sequence>
        <element name="RelativeDetune" type="float"/>
        <element name="Confidence" type="mpeg7:zeroToOneType"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>

```


<i>Name</i>	<i>Definition</i>
PitchShiftDefectType	Describes a pitch shift defect of an audio segment.
RelativeDetune	The relative detune of the pitch shift impairment.
Confidence	A confidence measure for the detection.

9.3.2 Wow/Flutter Defect Description Tool

9.3.2.1 Wow/flutter defect description tool syntax

```

<!-- ##### -->
<!-- Definition of Wow/Flutter -->
<!-- ##### -->
<!-- Definition of Wow/Flutter -->
<complexType name="WowFlutterDefectType">
  <complexContent>

```

10 Appendix B: Classification Schemes

10.1.1 Impairment Classification Scheme

The ImpairmentCS represents a hierarchical classification of audio and visual defects, organized by their perceptible effects.

The classification scheme will use some terms from AudioDefectCS, VisualDefectCS and ErrorClassCS. It will however not import these classification schemes, as it uses a deeper hierarchical structure, while these CSs are flat.

Figure 1 shows the top-level classes of ImpairmentCS.

10.1.2 Impairment Origin Classification Scheme

The ImpairmentOriginCS represents a hierarchical classification of devices and systems, that are (maybe causally) related to the impairment being described. This information can either be used to put the description into a better context (e.g. to describe dropout defects and the tape format being used) or to describe a causal relation (e.g. blocking caused by using a certain compression algorithm).

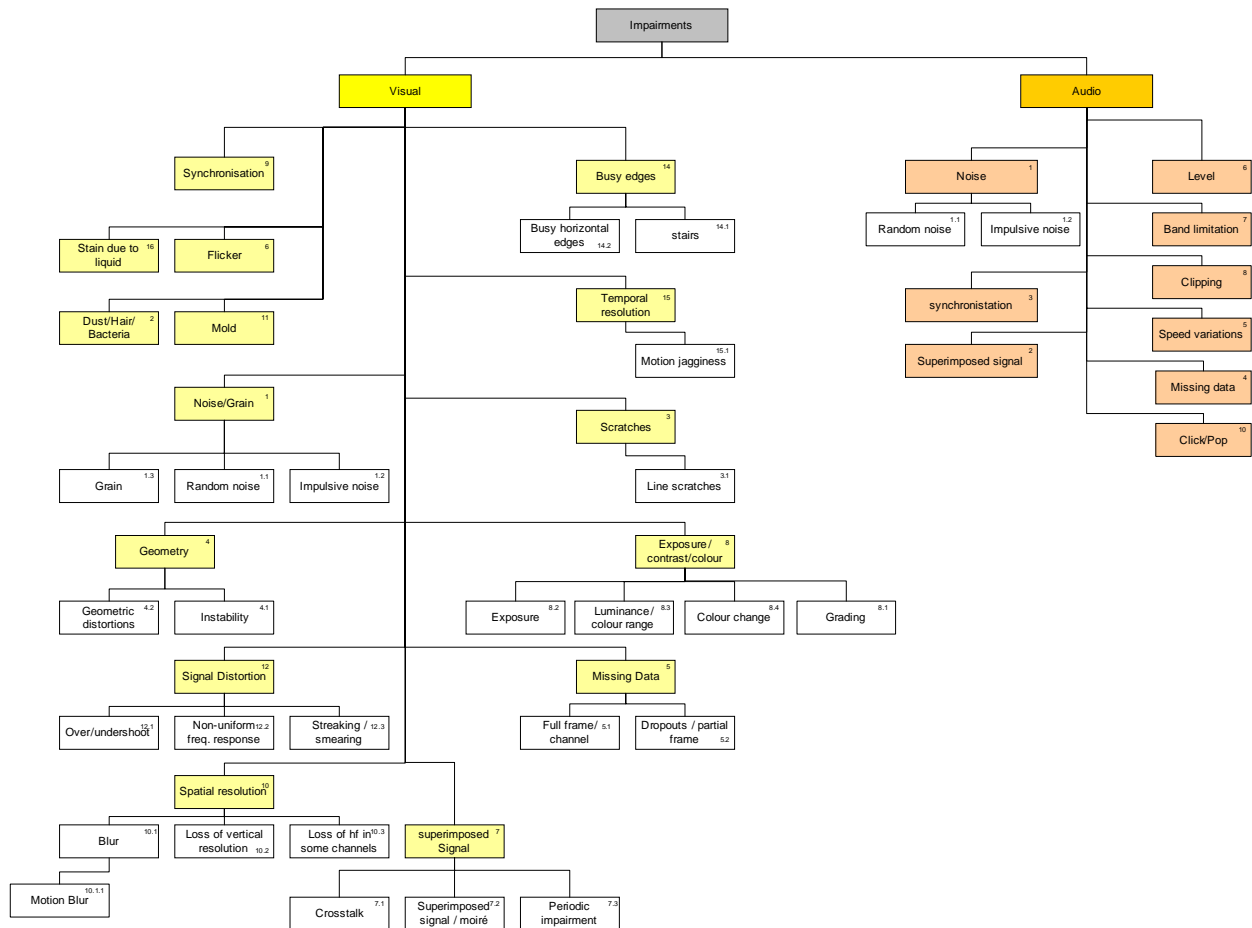


Figure 1: Top-level classes of ImpairmentCS.