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Part 3: Subjective quality assessment of high-fidelity images

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Contents

Page

Foreword ... **iv**

1 Scope ... **1**

2 Normative references ... **1**

3 Terms, definitions, symbols and abbreviated terms ... **1**

3.1 Terms and definitions ... 1

3.2 Symbols ... 3

3.3 Abbreviated terms ... 4

4 Methodological overview ... **4**

Annex A (normative) **Generation of stimuli** ... **7**

Annex B (normative) **Triplet selection and batch generation** ... **9**

Annex C (normative) **Observers and viewing conditions** ... **11**

Annex D (normative) **Boosted and plain triplet comparison (BTC / PTC)** ... **13**

Annex E (normative) **Data cleansing procedures** ... **15**

Annex F (normative) **JND scale reconstruction** ... **17**

Annex G (informative) **Interchange format** ... **21**

Annex H (informative) **Application range and design rationale** ... **24**

Bibliography ... **29**

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Foreword

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

A list of all parts in the ISO/IEC 29170 series can be found on the ISO and IEC websites.

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Information technology — JPEG AIC Assessment of image coding —

Part 3:
Subjective quality assessment of high-fidelity images

1 Scope

This document specifies a subjective image quality assessment methodology that covers a range from good quality up to mathematically lossless.

This document is applicable to the assessment of distortions due to image coding (i.e. lossy compression) and not necessarily other kinds of distortions (e.g. capture, sensor or rendering artefacts).

2 Normative references

There are no normative references in this document.

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

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

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

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

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

3.1.1
image quality
degree to which an image is free of undesirable aesthetic flaws or noticeable artefacts, as judged by observers

Note 1 to entry: This is an umbrella term that can refer to fidelity, appeal, or a combination of both.

3.1.2
appeal
aesthetic pleasingness of a stimulus under consideration, regardless of its difference with the source image

Note 1 to entry: It is possible to obtain distorted images with a better appeal than the source image (e.g. by applying denoising, sharpening, contrast or saturation stretching, or other image enhancement methods). Appeal of a stimulus can be assessed without reference to the source image.

3.1.3
fidelity
truthfulness to the source image, i.e. the degree to which there is no noticeable difference between the source image and the stimulus under consideration

Note 1 to entry: By definition, the source image itself has the highest possible fidelity; no distorted image can have a higher fidelity. Fidelity of a stimulus can only be assessed in relation to the source image. In this document, image quality refers specifically to fidelity.

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3.1.4
just noticeable difference
unit of difference between stimuli (distortion magnitude) corresponding to a 50 % detection rate, as estimated with Thurstone's Case V model

Note 1 to entry: The source image, by definition, is at the zero point of the JND scale.

3.1.5
observer
human with normal visual acuity and colour vision, who is a participant in a crowd-sourced or controlled-environment subjective experiment

3.1.6
stimulus
image to be judged by an observer, either a source image or a distorted image

3.1.7
distorted image
image that is an imperfect reproduction of a source image, i.e. it is based on a source image but to some extent differs from it

Note 1 to entry: The imperfections primarily considered in this document are those due to lossy compression artefacts originating, but can also include other types of information loss, sensor noise, capture artefacts, transmission errors or display issues.

3.1.8
source image
pristine image, which is the original from which distorted images are derived, for example by a lossy encoding/decoding process

3.1.9
assessment methodology
experimental methodology aimed at accurately estimating image quality

3.1.10
triplet comparison
psychophysical method that involves three stimuli derived from the same source, where the pivot stimulus is the reference image (source image) and the question asked is which of the other two stimuli (the test images) shows the stronger differences to the pivot

3.1.11
batch
series of study questions presented to observers to respond to

3.1.12
assignment
instance of a batch for an observer that is performing the test

3.1.13
session
one-time participation of an observer performing a set of assignments

3.1.14
study question
specific instance of a triplet comparison question

3.1.15
trap question
triplet comparison designed to help filter out unreliable observers, such as random clickers, where the maximum distortion level is compared to the undistorted source image, making the distortions relative to the corresponding source image readily discernible

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3.1.16
plain comparison
triplet questions in which the test images are not subjected to any boosting technique

3.1.17
boosted comparison
triplet questions in which the distortion of the test images is made more pronounced using techniques such as zooming, amplification, and flickering

3.1.18
distortion type
method with a parameter that corresponds to an expected distortion magnitude (e.g. a specific encoder/ decoder implementation, with a quality setting, quantization parameter or bitrate target), which can be used to produce a sequence of distorted images from a given source image

3.1.19
codec
image encoder and decoder process that yields a distortion type

3.1.20
data analysis
statistical procedures to process raw observer responses, filtering out unreliable assignments and combining results from boosted and plain comparisons in order to obtain a unified reconstructed JND scale

3.1.21
raw experiment data
unprocessed observer responses including all recorded information relevant for data analysis

3.1.22
data cleansing
pre-processing steps to filter the raw experiment data of unreliable assignments and outliers, which is the initial stage of data analysis

3.1.23
JND scale reconstruction
statistical procedures to derive quality scale values from the cleansed data

3.2 Symbols

$C(S,q)$	a distorted image derived from source image S by applying distortion type C with distortion magnitude parameter q
D	distortion magnitude in JND units
R	bit rate in bits per pixel
S	a source image
Φ	the cumulative normal distribution

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3.3 Abbreviated terms

ACR	absolute category rating
ACR-HR	absolute category rating with hidden reference
bpp	bits per pixel
BTC	boosted triplet comparison
CCR	comparison category rating
DCR	degradation category rating
DSCQS	double stimulus continuous quality scale
DSCS	double stimulus comparison scale, alternative name for CCR
DSIS	double stimulus impairment scale, alternative name for DCR
IQA	image quality assessment
JND	just noticeable difference
MLE	maximum likelihood estimation
MOS	mean opinion score
PC	pairwise comparison
PTC	plain triplet comparison
VAS	visual analog scale

4 Methodological overview

Image compression generally causes undesirable artefacts that reduce the perceived visual quality. The most commonly used subjective image quality assessment methodologies apply 5-level absolute category rating (ACR) which was designed to evaluate primarily heavily or medium compressed images. These methods therefore are not accurate when evaluating images in the range from high to visually lossless quality. Visually lossless quality is the quality range from 0 to 1 just noticeable difference (JND) units as measured by the flicker test methodology defined in ISO/IEC 29170-2.

The subjective image quality assessment methodologies defined in this document cover a range from good quality up to mathematically lossless. Good quality, here, is defined as the visual quality level corresponding to a mean opinion score of 4 on a 5-point scale in a side-by-side comparison as in ITU-R BT.500. The threshold of visually lossless quality, as determined by an AIC-2 flicker test (ISO/IEC 29170-2), is included in the range covered by this document. For mathematically lossless compression, image quality assessment does not apply, but the methods described in this document can provide meaningful differentiation (in fractional JND units) between images that are visually lossless.

This document introduces several methodologies for reliable fine-grained and precise subjective quality assessment in this high-quality range. The target is visual quality in the sense of fidelity, i.e., perceptual closeness to the corresponding source image, which is the primary traditional concern in image codec development.

For this purpose, this document specifies a methodology for subjective image quality assessment using an approach in which the fidelity of two distorted images, derived from the same source, are compared with each other. The human visual system is able to more sensitively detect minute differences in fidelity in such comparisons than by direct rating of each test image independently. Observers should focus on fidelity without being influenced by image aesthetics and occasional side effects of image compression

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