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Information technology — Advanced image coding and evaluation —

Part 2: Evaluation procedure for nearly lossless coding

Technologies de l'information — Codage d'image avancé et évaluation —
Partie 2: Mode opératoire d'évaluation pour codage presque sans perte

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Foreword

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

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword – Supplementary information.

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

ISO/IEC 29170 consists of the following parts, under the general title *Information technology — Advanced image coding and evaluation*:

— *Part 1: Guidelines for coding system evaluation (forthcoming)*

— *Part 2: Evaluation procedure for visually lossless coding*

Introduction

This International Standard normalizes a procedure to evaluate coding systems by subjective methods. The procedure is particularly useful for evaluating lightly compressed coding systems used, for instance, in display stream compression where a source compresses image data sent to a display. Examples of display streams include but are not limited to a wired link between a set-top box unit and a television or between a mobile host graphics processor and a display panel module in a mobile appliance. Viewers of these displays should be unaware that a coding system is employed in the device or system. A coding system will be considered visually lossless if the test results meet a pre-defined acceptable quality level demonstrated by the performance criteria described in this Specification under the viewing conditions specified and media sets provided.

Appliances that may require visually lossless performance for compressed display streams include: computer monitor displays, televisions, mobile phone and tablet displays. Data compression for these systems allows existing display links to carry more display data than is possible with uncompressed image streams or to reduce system power consumption or both.

The types of coding systems tested by this procedure may have the following properties:

a) The presence of a coding system should be undetectable to a user who is viewing the display.

b) The coding system operates in real-time, with negligible latency, low complexity hardware and minimal memory in both the encoder and the decoder.

This procedure builds on prior standardization and best practices embodied in ISO 3664, ISO 20462-2 and ISO/IEC TR 29170-1.

Information technology — Advanced image coding and evaluation —

Part 2:
Evaluation procedure for nearly lossless coding

1 Scope

This Technical Specification normalizes evaluation and grading of a light coding system used for displays and display systems, but is independent of the display technology. This procedure measures whether an observer can distinguish between an uncompressed reference and the reconstructed image to a pre-determined, statistically meaningful level.

The procedure compares individual images with two possible forced choice comparison test methods. This procedure relies on subjective evaluation methods designed to discern image imperfections on electronic colour displays of any technology or size.

Image selections for testing a specific coding system has bearing on the results this procedure will yield, but specific images required for testing are not within scope, excluding an informative annex describing self-test certification. Image categories may vary between end-usage products. For example, content relevant to television manufacturers may or may not be relevant to computer display manufacturers. Due to the nature of this procedure as a visual psychophysical test, observer's age is considered a meaningful parameter of the results.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3664, *Graphic technology and photography — Viewing conditions*

3 Terms and definitions

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

3.1
advance time
time a reference image or test image is displayed during an interleaved pair comparison test

3.2
algorithm
unique combination of test conditions that contribute to a unique test image, for example, the combination of coding an image with one compression level and one coding method represents coding with one algorithm

Note 1 to entry: Coding an image with a different compression level and the same coding method represents a second unique algorithm.

3.3
blank time
time between trials when the display shows no stimulus

3.4
block of trials
long experiment is logically divided into a series of trials

Note 1 to entry: There is an expectation that the observer iteratively completes each trial presented during a short block of time without stopping for breaks beyond those allocated by the software presentation timing.

3.5
control image
cropped test image coded to ensure defects are easily detectable in a paired comparison test

3.6
evaluator
expert in the field of image or compression artefact analysis or vision science, who prepares images, categorizes images or instructs the observer

3.7
expert observer
observer skilled in vision science or coding technology and image artefacts

3.8
image
still representation of pixels rendered by the display

3.9
just noticeable difference
stimulus difference that would lead to a 0,75 probability of correct responses in a two-alternative forced-choice task

3.10
non-expert observer
observer with no special skills or training in vision science or coding technology

3.11
observer
individual performing the subjective evaluation procedure by evaluating stimulus to make paired comparison task choices

3.12
picture element
pixel
smallest element that is capable of generating the full intended functionality (e.g. colour and gray scale) of the display

Note 1 to entry: In a multicolour display, the smallest addressable element capable of producing the full colour range or the smallest element that is capable of generating the full functionality of the display.

3.13
reference image
cropped original image displayed during a trial

3.14
session
description of the full time interval in which an observer participates in the experiment on a given day

Note 1 to entry: It can encompass multiple blocks of trials. A full experiment can be divided into multiple sessions.

3.15
test image
cropped version of a reconstructed image after coding displayed during a trial

3.16
trial
single unit of the experiment

Note 1 to entry: A set of images will be presented on the screen for a defined viewing time. The trial is complete only when the observer has entered a response.

3.17
viewing time
number of seconds an observer views paired stimuli. The viewing time has a maximum value in all situations

3.18
visually lossless
fully decoded image or multimedia sample presenting a display that is visually indistinguishable from the original uncompressed data over the same spatial area and when viewed under the same conditions

4 Symbols and abbreviated terms

AQL acceptable quality level

PPD pixels per degree

RGB red-green-blue

5 Test methods

5.1 Protocol selection

The evaluator shall select the most suitable test protocol from those listed in Table 1 and contained in the listed annex. The protocol selection depends on the media under test, end display usage and the target AQL.

Table 1 — Visually lossless testing protocol

	Test Protocol	Comment
Annex A	forced choice paradigm with a non-flickering image	sensitive testing, suitable for testing images compressed and reconstructed by light coding systems, but not as sensitive as interleaved testing
Annex B	forced choice paradigm with interleaved images	most sensitive testing, suitable for testing images compressed and reconstructed by light coding systems

5.2 Media selection

Media selection takes images or other media for display rendering relevant to the display type and user applications.

Evaluators shall follow media selection procedures in Annex C after selecting a test protocol.

5.3 Observers

5.3.1 Observer selection

The observers shall be selected from a general population that may include both experts and non-experts. The observers for the experiment shall not include evaluators who participated in the media selection for the experiment being conducted.

The observer population should include variations in gender, ethnicity and age. The experiment is visual in nature and age can strongly correlate to visual acuity, therefore, participant age for this procedure favours the age range for the observer from 18 to 30 years old.

An observer's age shall not exceed 40 years.

This procedure recommends evaluators recruit a suitable number of observers sufficient to include no less than 10 observers who pass visual acuity (see 5.3.2) and test reporting (see D.1.2) requirements of this Technical Specification.

5.3.2 Observer visual screening

The following selection criteria shall apply:

a) Observers may wear corrective lens, either glasses or contacts that shall not have multiple focal lengths, e.g. progressive, bifocal or trifocal corrective lens.

b) Observers shall demonstrate normal visual acuity verified by using a Snellen reading test chart where the observer reads at 20/20 from 50 cm.

c) Participants shall demonstrate normal colour vision verified by testing with Ishihara plates or equivalent.

Evaluators can refer to Annex E for tools that help assess an observer's visual acuity.

5.3.3 Instructions to observers

Evaluators shall provide equivalent instructions to all observers with the criteria listed, here:

a) Explain the use of the software to record image assessments.

b) Explain the forced choice task. Every trial requires a response, even a guess.

c) Explain what to do if a conscious mistake is made, such as a finger slip, or the observer looked away and did not see the stimuli. If a retry is permitted (see 5.6), explain the method to retry that trial.

d) Explain where to sit and how to arrange the chair and use of the chin and headrest for the proper viewing position and comfort.

5.3.4 Training session

The evaluator should use a training session consisting of one block of trials for observers new to software used in subjective image testing. A training session will:

a) Use the control images from the experiment as test images.

b) Do not report data from the training session in the data results.

c) Use the same viewing time limit as the experiment.

d) Prompt the observer when a correct or incorrect response is entered. If incorrect, continue by repeating the test image until a correct response is entered.

Observers who have participated in the experiment usually do not need to repeat a training session.

5.4 Viewing conditions

5.4.1 Lighting and display calibration

Viewing conditions shall be consistent with ISO 3664 viewing condition for images displayed on colour monitors. Exceptions include:

a) The luminance of the white displayed on the monitor shall be between 100 cd/m^2 and 140 cd/m^2.

b) Displays that do not contain calibration tables should be avoided, but if used should have gamma setting verified close to 2,2 and deviations noted in the test report. Record maximum luminance of the display used in the procedure.

c) The colour of surrounding walls and ceilings do not require a specific colour but shall not cause distracting reflections that may affect the vision of the observer. An appropriate viewing booth is optionally desirable.

d) The display monitor shall render at least the number of bits per component present in the tested images.

5.4.2 Viewing distance

Viewing distance shall be controlled and ensured using a chin and forehead rest for observers. Figure 1 shows an example chin and forehead rest. The rest may be height adjustable to ensure small differences between observer's head size can be accommodated, the chair for the observer should have a large adjustment range to ensure the observer is as comfortable as possible during the procedure.

Figure 1 — Example chin and forehead rest

The viewing distance is a function of the pixels per degree (PPD) to be subtended at the set viewing distance.

The viewing distance shall be determined according to Table 2 based on horizontal pixels, the display pixel density and pixels subtended in one degree of arc.

Table 2 — Viewing distance versus display size and resolution

Condition	PPD[a]	D[b] cm
Viewing distance	30	D equals the larger of the value in the following equation or 12cm[c] $D = \frac{W}{H_{RES} \times \tan(\frac{1}{PPD})}$

[a] The experiment requires a consistent display orientation to be maintained and mobile display may have a different width and pixel resolution in landscape versus portrait orientation. PPD is calculated for each orientation. Detailed work on computer displays and mobile devices tends to be closer than for general entertainment, e.g., television, and requires evaluation with a more aggressive PPD than would be the case for Snellen acuity (30 cycles/degree or PPD = 60)

[b] W is the screen width (cm) and H_{RES} is the number of pixels across the display horizontally as viewed by the observer.

[c] The minimum focusing distance for normal vision is predetermined as 12 cm by this Technical Specification.

5.4.3 Viewing position

An observer shall be seated in a comfortable position oriented with respect to the display as shown in Figure 2 and Figure 3:

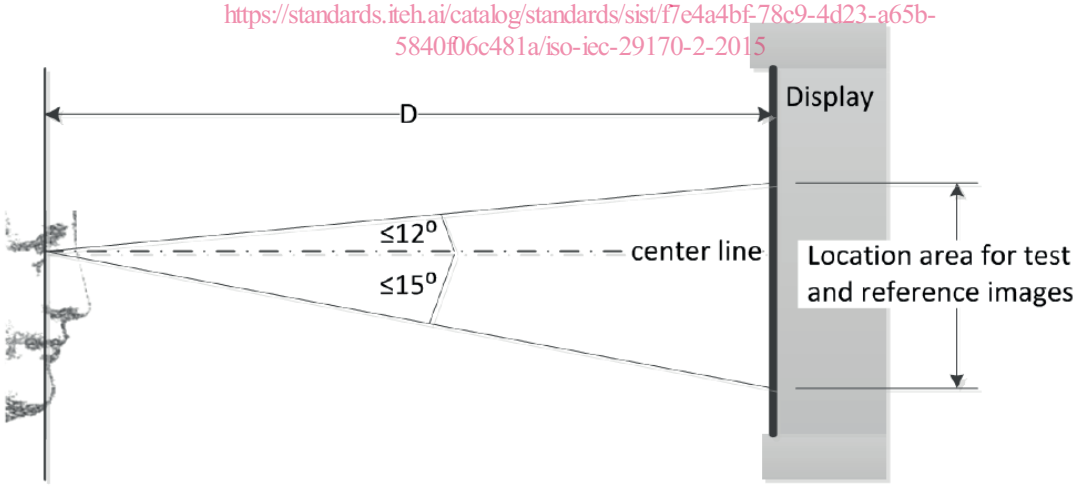

Figure 2 — Observer position with respect to the test display (side view)