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Graphic technology — Image quality evaluation methods for printed matter —

Part 22: Evaluation of colour graininess

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Foreword

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This document was prepared by Technical Committee ISO/TC 130, *Graphic technology*.

A list of all parts in the ISO 18621 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The subject of image quality is broad and complex, due to its multidimensionality. A large number of measurement methods have been developed to describe attributes of printed image quality[1]. Many different methods may be available to provide a measure of a particular image quality attribute, usually on completely different numerical scales and, with few exceptions, providing no well-defined correlation with visual perception to establish the visual significance of a measured difference. A fraction of these methods has been developed in a manner that is independent of marking technology, permitting general, technology-independent measurement of an image quality attribute.

The evaluation of perceived image quality in prints is an active field of research. Definitions of measurements of print quality attributes that correlate with visual perception by technology-independent means, even across many printing technologies, is under current scrutiny. Nevertheless, these evaluations are complex due to subjectivity and dimensionality. It is influenced by a number of different quality attributes. It is often difficult and complicated to evaluate the influence of all attributes on overall image quality, and their influence on other attributes.

Graininess measurements provide an indication of the apparent high frequency image noise in a digital printing system and typically refers to aperiodic fluctuations of density at a spatial frequency greater than 0,4 cycles per millimetre in all directions for standard viewing distance of 400 mm. Many methods have been developed over the years, for instance, the method defined in ISO/IEC 24790[2], which is restricted to luminance based variations. In this document this approach has been extended for colour variations, while default viewing distance is 40 cm (reading distance).

Graphic technology — Image quality evaluation methods for printed matter —

Part 22: Evaluation of colour graininess

1 Scope

This document defines a process independent measurement method for the evaluation of graininess of printed products. It provides requirements for the test form and measurement devices to be used as well as the formulas to compute the colour graininess score (S_{CG}).

2 Normative references

There are no normative references in this document.

3 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
CIEDE2000 colour difference
method of/formula for calculating colour difference, ΔE_{00}/$CIEDE_{00}$

Note 1 to entry: See ISO/CIE 11664-6[3] for details.

Note 2 to entry: The default weights for lightness, chroma and hue are (1:1:1).

Note 3 to entry: The unit is 1.

3.2
CIELAB colour space
CIE 1976 *L* a* b colour space**
three-dimensional, approximately uniform colour space produced by plotting L*, a*, b* in Cartesian co-ordinates

[SOURCE: adapted from 17-23-077 of CIE S 012 [4]]

3.3
graininess
appearance of unintended microscopic but visible aperiodic fluctuations of colour (microscopic means variations with spatial frequencies greater than about 0,4 cy/mm)

4 Requirements

4.1 Principles

The graininess score is evaluated using a calibrated scanner. After a Gaussian filter that roughly simulates human visual transfer function is applied, the CIEDE2000 colour differences (ΔE_{00}) between each colour of a micro region within a region of interest (ROI) and their average value are analysed.

A root mean square (RMS) of ΔE_{00} values is calculated for each colour patch, and an average of the RMSs is calculated as the graininess score. In the case of the evaluation for the average graininess of printing systems, the evaluated colour patches should be selected evenly from whole colour gamut of the device, and the use of control strip that complies with 4.3.1 is recommended.

In the case of the evaluation for the average graininess of particular colours in printed matter, the evaluated colour patches should be selected from regions of interest in the printed matter. These regions should be uniformly tinted to allow a reliable measurement. The evaluation parameters can be determined according to the expected viewing distance. This document provides evaluation parameters for a viewing distance of 40 cm.

Based on practical experiences an exemplary description of the visual meaning of the perceived level of noisy variations within a patch are given in an informative Annex A.

This method is restricted to samples having a smooth surface which can be measured by an apparatus defined in 4.2.

4.2 Apparatus

The measurement device shall be in conformance with a colorimetrically characterised flatbed scanner with a spatial resolution of 600 pdi or higher. The colour accuracy of the scanner should be evaluated by a scanner target defined in ISO 12641-1[5] or ISO 12641-2[6] with an individually measured chart. The average colour difference shall be CIEDE2000 ≤ 3.

NOTE 1 More information on scanner qualification can be found ISO/TS 18621-31.

NOTE 2 Where scanners produce images with resolution higher than 600 ppi it is usual practice to resample these using bilinear interpolation.

4.3 Procedure

4.3.1 Testform

For printing system evaluation, the evaluated colour patches should be representative of all combinations of ink amounts typically used by the printing system. In the case of CMYK printing systems, a chart should include all combinations of 10 %, 20 %, 40 %, 70 % of Cyan, Magenta and Yellow (64 patches) combined with 0 %, 10 %, 20 %, 40 %, 70 % of Black to produce a total of 320 colours.

For evaluation of all or part of printed product, the colour patches of the main colours of importance should be placed in the test form. The number of colour patches shall be 9 or more to reduce evaluation variability. When the number of the important colours is less than 9, some patches of the same colour shall be added so that total number of colour patches is at least 9.

NOTE In some occurrence, it is reasonable to use control strip with approximately 70 patches as defined in ISO 12647-7. The minimum patch is typically 10 by 10 mm or more.

4.3.2 Printing and measuring

In case the samples to be evaluated are not present, they can be printed either in device mode or simulation mode[7]. Measure the values in CIELAB colour space by scanning all patches and storing the scan as a TIFF image using the CIELAB encoding.

NOTE ISO/TS 18621-31:2024, D.5.3 provides details on how to convert scanned RGB to CIELAB.

4.4 Evaluation

The graininess of colour prints shall be evaluated as follows.

a) Open the scanned CIELAB image data.

b) If image data is greater than 600 ppi, convert to 600 ppi using bilinear interpolation.

c) Apply Gaussian filter with a cut-off frequency of 30 cycle/degree to the L* component image and with a cut-off frequency of 7,5 cycle/degree to the a* and b* component images.

NOTE Detailed information about gaussian filter is provided in Annex B.

c) Set a region of interest (ROI) of 59 by 59 pixels around the central position of the 1st colour patch. Compute an average CIELAB value of the ROI.

d) Compute the CIEDE2000 colour difference between CIELAB value of each pixel in the ROI and the average CIELAB value.

e) Compute a root mean square of all CIEDE2000 colour differences (3 481 in total) in the ROI.

f) Repeat c) to e) for all colour patches.

g) The final graininess value S_{CG} is the arithmetical average value of these root mean squares.

The spatial transformation used and the intended viewing distance should be reported. The unit of the graininess score is in terms of CIEDE2000 units. The mathematical unit is 1.

The calculation process is also illustrated in Figure 1.

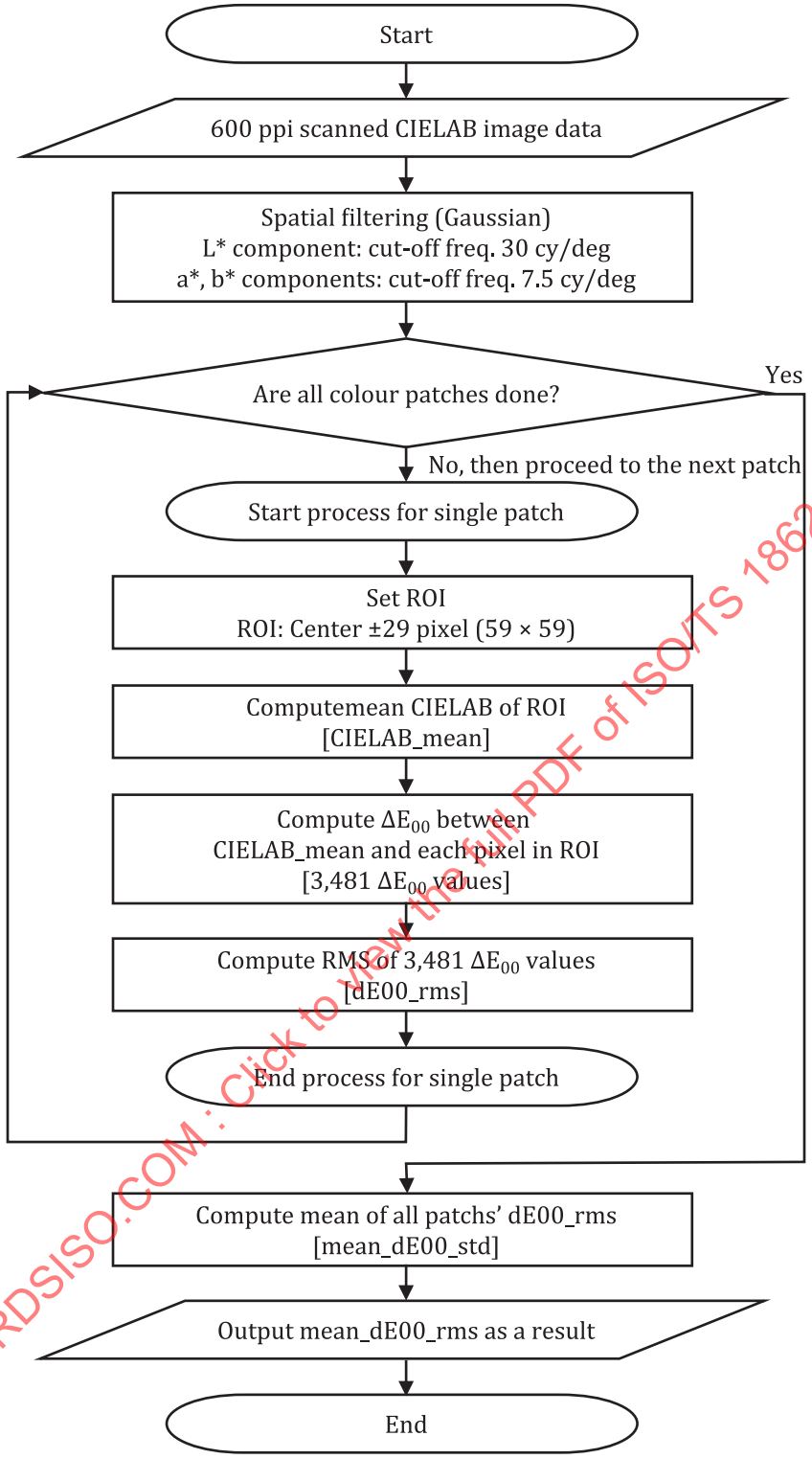

Figure 1 — Computation flowchart

4.5 Reporting

When reporting S_{CG}, the report shall indicate whether the assessment was performed for a printing system or for all or part of a printed product. For printing system evaluation, the printing conditions shall be reported and where specific colours are evaluated, their tone values and the mode of printing shall be reported.

EXAMPLE 1 S_{CG} = 0,3 (Gray area of printed product, CMYK=0,0,0,50)

EXAMPLE 2 S_{CG} = 0,52 (Printed product, Sample photobook)

EXAMPLE 3 S_{CG} = 0,64 (Printing system, 320-patch target, Simulate FOGRA39)

EXAMPLE 4 S_{CG} = 0,84 (Fogra MediaWedge CMYK V3, Simulation Mode)

Colour graininess scores evaluated from different sets of colour patches shall not be compared.

Annex A
(informative)

Interpreting graininess, S_{CG}

This annex provides the conclusion from experiments[8], [9] on how to link the resulting scores with practical descriptions of single patches. It is known that such descriptions are subjective and that they depend on many influencing factors such as the concrete use case, customer expectations and experiences as well as viewing conditions. It may also apply for images but a more elaborate statistical pooling and a patch selection method are required, testing for which have yet to be conducted by the date of publication.

This categorisation is based on experiments under ISO 3664 P1 compliant viewing. However, the Table A.1 allows a quick categorisation of a reasonable first approximation, here A, B, C, D, E and F.

Table A.1 — Proposed categories for the defined S_{CG} metric

S_{CG}	Category name	Categorical descriptions provided to the observers during the experiment
$0 \leq S_{CG} \leq 0{,}45$	A	Completely smooth to barely perceptible grain
$0{,}45 < S_{CG} \leq 0{,}9$	B	Barely perceptible to very slight grain
$0{,}9 < S_{CG} \leq 1{,}35$	C	Very slight grain to noticeable grain
$1{,}35 < S_{CG} \leq 1{,}8$	D	Noticeable grain to obvious grain
$1{,}8 < S_{CG} \leq 2{,}25$	E	Obvious grain to very grainy, rough appearance
$S_{CG} > 2{,}25$	F	Very grainy, rough appearance to grain dominates appearance