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Graphic technology — Prepress digital data exchange —

Part 2: XYZ/sRGB encoded standard colour image data (XYZ/SCID)

Technologie graphique — Échange de données numériques de préimpression —

Partie 2: Données d'images en couleur normalisées codées XYZ/sRGB (XYZ/SCID)

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 12640-2 was prepared by Technical Committee ISO/TC 130, *Graphic technology*.

ISO 12640 consists of the following parts, under the general title *Graphic technology — Prepress digital data exchange*:

— *Part 1: CMYK standard colour image data (CMYK/SCID)*

— *Part 2: XYZ/sRGB encoded standard colour image data (XYZ/SCID)*

Part 1 was published in 1997 with the number ISO 12640 and is in the process of being renumbered.

A Part 3, under the title of *CIELAB standard colour image data (CIELAB/SCID)*, is in preparation.

Introduction

The technical content of this International Standard was initiated by the Image Processing Technology Standard Committee in Japan as input to, and in coordination with, ISO/TC 130, WG 2.

0.1 The need for standard XYZ/sRGB digital test images

The existing Standard Colour Image Data (CMYK/SCID, ISO 12640) is defined in terms of CMYK dot percentages and as such is mainly applicable to printing applications. If attempts are made to apply it to other systems such as monitors, CMY printers, etc., the following problems arise.

- The image data, being expressed in terms of CMYK dot percentages, have no simple relationship to colorimetric values.
- The image data have a bit depth of only 8-bits, often causing inaccurate colour conversions.
- The image data are output-referred to a CMYK printing device; additional colour rendering may be required to create image data suitable for other devices.

In order to solve these problems a set of image data has been prepared that

- is expressed as sRGB encoded ITU-R BT.709-3 RGB primary based tristimulus values, and
- is output-referred to the standard sRGB display and viewing conditions defined in IEC 61966-2-1.

Furthermore, this part of ISO 12640 also provides 16-bit CIE XYZ image data that correspond to the display produced CIE XYZ tristimulus values for the sRGB image data, with a display white point chromaticity equivalent to that of CIE Illuminant D_{65}.

Because they exist as consistent and high quality image data sets, images of this part of ISO 12640 are expected to be widely used for the following:

- evaluating the colour reproduction capability of imaging systems and output devices;
- evaluating the coding technologies necessary for the storage and transmission of high-definition image data, etc.

0.2 Characteristics of test images

The performance of any colour reproduction system will normally be evaluated both subjectively (by viewing the final output image) and objectively (by measurement of control elements). This requirement dictates that the test images include both natural scenes (pictures) and synthetic images (computer graphics, a business graph, a colour chart and a colour vignette).

Because the results of subjective image evaluation are strongly affected by the image content, it was important to ensure that the natural images were of high quality and contained diverse subject matter.

0.3 Development of digital test images

A survey was conducted of all TC130 member countries to identify desirable image content and to solicit submission of suitable images for consideration. The image set that resulted consists of eight natural and seven synthetic images. The natural images include flesh tones, images with detail in the extreme highlights or shadows, neutral colours, brown and wood tone colours which are often difficult to reproduce, memory colours, complicated geometric shapes, fine detail, and highlight and shadow vignettes. The synthetic images selected were generated electronically and include computer graphics, a business graph, a colour chart and a series of colour vignettes.

All of the images consist of pixel interleaved data with the data origin at the upper left of the image, as viewed normally, and organized by rows. The file formats of the RGB images are compliant with TIFF 6.0 format. TIFF 6.0 does not define a method for storing XYZ colourspace. The XYZ images set the TIFF Photometric tag to 2 (RGB), which allows TIFF readers to open the TIFF file; however, the image will not be displayed correctly. The images can be imported and manipulated as necessary by a wide variety of commonly used imaging software packages, on platforms in general use in the industry. See Annex C for details of the TIFF header.

Graphic technology — Prepress digital data exchange —

Part 2:
XYZ/sRGB encoded standard colour image data (XYZ/SCID)

1 Scope

This part of ISO 12640 specifies a set of 15 standard colour images (encoded as both 16-bit XYZ and 8-bit RGB digital data provided in electronic data files) that can be used for the evaluation of changes in image quality during coding, image processing (including transformation compression and decompression), displaying on a colour monitor or printing. They can be used for many graphic technology applications such as research, development, product evaluation, and process control.

2 Normative references

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

IEC 61966-2-1:1999, *Multimedia systems and equipment — Colour measurement and management — Part 2-1: Default RGB colour space - sRGB*

ITU-R BT.709-3:1998, *Parameter values for the HDTV standards for production and international programme exchange*

TIFF, Revision 6.0 Final, Aldus Corporation (now Adobe Systems Incorporated), June 3, 1992

3 Terms and definitions

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

3.1
check sum
sum of the digits in a file that can be used to check if a file has been transferred properly

NOTE Often, only the least significant bits are summed.

3.2
colour sequence
order in which the colours are stored in a data file

3.3
colour space
geometric representation of colours in space, usually of three dimensions

[CIE Publication 17.4, definition 845-03-25]

NOTE This part of ISO 12640 is based on two colour spaces, XYZ and sRGB. The relationship between XYZ and sRGB is given in 5.2.

3.4
global colour change
change to the colours in an image applied consistently to all parts of the image

NOTE This is in contrast to a local colour change where selected spatial areas of an image are changed separately from the rest of the image area.

3.5
orientation
origin and direction of the first line of data, with respect to the image content, as viewed by the end user

NOTE The codes used to specify orientation are contained in ISO 12639.

3.6
pixel
smallest element of an image that can be uniquely processed, and is defined by its spatial coordinates and encoded with colour values

NOTE If a pixel is the result of interpolation, then it shall be noted as such.

3.7
pixel colour value
numeric values associated with each of the pixels

3.8
pixel interleaving
colour data organized such that the XYZ or RGB colour values for one pixel of each colour space are followed by the same sequence of colour values for the next pixel

NOTE 1 The specific order of colours is determined by the **ColorSequence** (3.2) tag as defined in ISO 12639.

NOTE 2 Other forms of data interleaving are line and plane.

3.9
tristimulus values
amounts of the three reference colour stimuli, in a given trichromatic system, required to match the colour of the stimulus considered

[CIE Publication 17.4, definition 845-03-22]

4 Image data

This part of ISO 12640 consists of colour image data, encoded as 16-bit XYZ data and 8-bit sRGB data, for 8 natural images and 7 synthetic images. The image characteristics of these data are described in Clause 5 and the data structure in Clause 6. The image data itself is contained in thirty data files that are included in this part of ISO 12640. File names correspond to the image names as described in 5.3 and 5.4.

5 Data description and definition

5.1 Data set definition

Each set of standard colour image data consists of eight natural (photographed) images and seven synthetic images created digitally on a computer. The natural images are identified as N1 to N8, and each of them also has a descriptive name derived from the picture content (e.g. woman with glass). The synthetic images,

identified as S1 to S7, consist of computer graphics images, a business graph, a colour chart and a series of colour vignettes.

The sRGB images are identified by ISO-sRGB in small type in order to distinguish them from the XYZ images which have the designation ISO-XYZ. The co-ordinates of the text insertion are provided in Annex D.

5.2 Relationship between CIE XYZ and sRGB colour data

5.2.1 Characteristics of standard output-referred sRGB image data

In order to assure maximum interoperability among a large number of imaging devices, sRGB image data are output-referred to the hypothetical sRGB display and viewing conditions specified in IEC 61966-2-1. Whatever colour processing is required to produce the desired image appearance on the sRGB display in the sRGB viewing conditions shall be performed prior to encoding sRGB image data. The sRGB image data should be considered to convey the desired sRGB appearance. Subsequent colour rendering may be performed to produce a somewhat different appearance as necessitated by different media capabilities and viewing conditions, but in general such colour rendering should not automatically alter the appearance in a substantial way, or consider that the sRGB image data is “unfinished”. Exceptions to this rule include editing and manipulation of image data by a user, and the processing of arbitrary RGB image data which may not be sRGB.

5.2.2 Relationship between XYZ data and sRGB data

The encoding transformations between CIE 1931 XYZ tristimulus values and sRGB digital values are specified in IEC 61966-2-1, and are provided below. These transformations define how XYZ tristimulus values shall be calculated from 8-bit sRGB values. The colorimetric values so determined shall be those of the intended image colorimetry when viewed on the reference display, in the reference viewing conditions, by the standard observer.

The relationships are defined as follows:

$$R'_{sRGB} = R_{8bit} / 255 \quad (1)$$

$$G'_{sRGB} = G_{8bit} / 255 \quad (2)$$

$$B'_{sRGB} = B_{8bit} / 255 \quad (3)$$

where

R_{8bit} is the code value for sRGB R in 8-bit encoding;

G_{8bit} is the code value for sRGB G in 8-bit encoding;

B_{8bit} is the code value for sRGB B in 8-bit encoding;

R'_{sRGB} is the sRGB R image value;

G'_{sRGB} is the sRGB G image value;

B'_{sRGB} is the sRGB B image value.

If $R'_{sRGB} \leqslant 0{,}040\,45$, then $R_{sRGB} = R'_{sRGB} / 12{,}92$; else $R_{sRGB} = \left(R'_{sRGB} + 0{,}055/1{,}055\right)^{2{,}4}$.

If $G'_{sRGB} \leqslant 0{,}040\,45$, then $G_{sRGB} = G'_{sRGB} / 12{,}92$; else $G_{sRGB} = \left(G'_{sRGB} + 0{,}055/1{,}055\right)^{2{,}4}$.

If $B'_{sRGB} \leqslant 0{,}040\,45$, then $B_{sRGB} = B'_{sRGB} / 12{,}92$; else $B_{sRGB} = \left(B'_{sRGB} + 0{,}055/1{,}055\right)^{2{,}4}$.

and

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = \begin{pmatrix} 0{,}412\,4 & 0{,}357\,6 & 0{,}180\,5 \\ 0{,}212\,6 & 0{,}715\,2 & 0{,}072\,2 \\ 0{,}019\,3 & 0{,}119\,2 & 0{,}950\,5 \end{pmatrix} \begin{pmatrix} R_{\text{sRGB}} \\ G_{\text{sRGB}} \\ B_{\text{sRGB}} \end{pmatrix} \tag{4}$$

where R_{sRGB}, G_{sRGB} and B_{sRGB} represent linear sRGB values, and the X, Y and Z values represent those that would be measured if the sRGB images were displayed on a hypothetical sRGB display, and the measurements are conducted in a fashion that eliminates veiling glare and viewing flare.

The CIE Publication 131 XYZ tristimulus values resulting from Equation (4) are relative values scaled from 0,0 to 1,0 (not 0,0 to 100,0 as is sometimes done). Absolute tristimulus values are calculated from the 0,0-to-1,0 scaled relative values by multiplying by 80 (the sRGB display white point luminance).

5.2.3 XYZ image data

The XYZ image data computed in 5.2.2 are converted to 16-bits-per-channel code values (which are contained in the XYZ image data files) by normalizing them with the corresponding value for the display white point and multiplying by the data range represented by 16 bits. Thus:

$$X_{16\text{bit}} = 65\,535 \times (X / X_{65}) \tag{5}$$

$$Y_{16\text{bit}} = 65\,535 \times (Y / Y_{65}) \tag{6}$$

$$Z_{16\text{bit}} = 65\,535 \times (Z / Z_{65}) \tag{7}$$

where

$X_{16\text{bit}}$ is the code value for X in 16-bit encoding;

$Y_{16\text{bit}}$ is the code value for Y in 16-bit encoding;

$Z_{16\text{bit}}$ is the code value for Z in 16-bit encoding;

X, Y and Z are any set of tristimulus values computed in 5.2.2, which are the tristimulus values of a pixel on the display, excluding internal flare, veiling glare, and viewing flare;

X_{65}, Y_{65} and Z_{65} are the tristimulus values of the display white point.

5.2.4 Image data arrangement

The image data are pixel-interleaved in the order of R then G then B (8-bit), or X then Y then Z (16-bit). The arrangement of data follows the scanning of each image from the upper left corner to the right, then moving to the next lower horizontal line.

5.3 Natural images

The characteristics and typical usage for the natural images are provided in Table 1. The descriptive names of these images are given following the identification code. Figure 1 shows reduced-size reproductions of the natural images. The natural images have the following characteristics:

— Picture size 4 096 × 3 072 pixels;

NOTE 1 The natural images (4 096 × 3 072 pixels) produce a physical image size of 256 mm by 192 mm when rendered at 16 pixels/mm.

— Interleaving — pixel interleaving;

— Colour sequence — RGB or XYZ;

— Colour values — RGB data consisting of three 8-bit values;
XYZ data consisting of three 16-bit values;

— Image data orientation — horizontal scanning starting from top left and ending at bottom right.

NOTE 2 Although the original of the image “Field fire” is a painting, it is classified as a natural image.

NOTE 3 The encoding of the data in the headers of the individual files is provided in Annex C, and is in accordance with the formats specified in ISO 12639.

NOTE 4 The unused light end code values for N1 and N5 limit the tonal range present in these images.

NOTE 5 Clipping at light or dark end of N2, N4 and N8 may impact perceived quality for highly critical observers. However, such clipping is present in many typical images.

Table 1 — Natural images

ID	Image name	Aspect	Characteristics
N1	Woman with glass	Portrait	Close-up image of a woman with a glass; suitable for evaluating the reproduction of human skin tones
N2	Flowers	Landscape	Useful for assessing tonal reproduction of highlight tones and contouring in dark tones
N3	Fishing goods	Portrait	Low-key image of fishing goods; suitable for evaluating image sharpness
N4	Japanese goods	Landscape	Image obtained by photographing a collection of Japanese traditional handicrafts, including many highly saturated colours; suitable for evaluating colour reproduction capabilities
N5	Field fire	Landscape	Useful for evaluating the accuracy of colour reproduction for delicate colours
N6	Pier	Landscape	Image with complicated geometric shapes; suitable for evaluating the results of image processing
N7	Threads	Landscape	Image of woollen yarn, colour pencils and ribbons; suitable for evaluating the colour gamut of devices
N8	Silver	Portrait	Image of silverware; suitable for evaluating the tone reproduction of greys, as well as the reproduction of the lustrous appearance of metallic objects

N1 — Woman with glass

N2 — Flowers

N3 — Fishing goods

N4 — Japanese goods

N5 — Field fire

N6 — Pier

N7 — Threads

N8 — Silver

Figure 1 — Reduced-size reproductions of the natural images