Technical Report BAM(8640)E

Basic Principles of Colour Management using 16 equally spaced gray steps and 16 CIE-test colours in *olv** coordinates

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Data and URL addresses:

The Technical Report 8640 include *olv** data and the *PS*-function s*etrgbcolor* to produce a 16-step equally spaced colour series and the 16 CIE-test colours in *linear* arrangement.

Production and Intention of the Digital Image Files for Colour Management

The *olv**-data have been produced taking a photographic picture on a film material and using a scanning process (the photo-CD-process) for this picture. A slide film (sf, over exposure +0.5 stops) for taking the equally spaced gray scale and the CIE-test colours was used. The Photo-CD process gives a digital file on a Photo-CD which was transferred to an EPS-file by the *Kodak Access Software* using the option *transfer to EPS*. This resulting file is a file with hexadecimal image data one can read and edit by any editor on any computer operating system. The file comes in 5 resolutions between 192 pixels x 128 pixels, 384 x 256, .., 3072 pixels x 2048 pixels (It takes between 100 kByte and 48 Mbyte depending on resolution).

Only the 32 test colours and the corresponding digital data are in the digital image files of this report.

The *olv*_ad*‘* data (star-dash) in the file (192 pixels x 128 pixels, and very similar for all other resolutions from the analog-digital process) correspond to *olv** data of the original test colours in the scene (16 grays and the CIE-test colours). The *olv*_ad*‘* data can be read by an editor or by different software products *(e. g. Adobe Photoshop, Illustrator, ...)* using a *colour pipette* which shows *rgb, cmyk* or *lab* data. The *olv*_ad*‘* data are normally called *rgb* data within the software products.

Attention: The used software must be checked to decide if the hexadecimal data in the file are really shown and not in some way transferred. One may use the following picture to proof this property:

http://o2.ps.bam.de/INFVM03/8640/E4640-3N.PDF

http://o2.ps.bam.de/INFVM03/8640/E4640-3N.EPS

The 8 bit hexadecimal data 0, 11, 22, ... EE, FF or the corresponding equally spaced digital data 0, 17, 34, ..., 238, 255 must be shown with tolerances of one bit.

Series 8640

The colour series 8640 show different ways how to change the output by the standard *PS*-function *settransfer.* This *PS*-function exists in different standard *PS*-versions for achromatic and chromatic images which will not be discussed here.

***PS*-function** *settransfer* **and intention of user defined *PS*-functions**

A **square or a square root function** is used in the examples to transfer the image data which will change the viewed image in a controlled way. Instead of using a transfer function the hexadecimal image data can be manually changed by an editor or an additional computer program can make an intended transfer.

Most important for a colour management workflow

1. The user can define an own transformation for the **analog-digital process (ad)**, which transfers **the monotonic and not equally spaced *olv*_ad*‘* data to the equally spaced original *olv** input data**. So a user will get a digital

file with the original *olv** data of the taking scene. This function may use the 32 digital ***olv***_**ad**** data recommended to come with every image file.

2. The user can define an own transformation for the **digital–analog process (da)** which transfer **the monotonic and not equally spaced *olv**_ad*' data of output to the equally spaced original *olv** input data.**

3. The user can store **both transfer for the *ad* and *da* process** within a *PS*-printer and can let do the *PS*-Software within the printer the Colour Management between input and output.

4. There may be recommended *PS*-names and *PS*-transfer functions to be stored in the *PS*-devices. Then the workflow may need no additional software within the user computer environment.

5. Many software raster image processors (RIP) and e. g. the software *Adobe Acrobat Distiller* work with user defined *PS*-transfer functions. *Adobe Acrobat Distiller* offers an option to preserve or to calculate the two transformations **ad** and **da** if transfering an *EPS*-file into a *PDF*-file. If the two Colour Management Workflow transformations **ad** and **da** are calculated within the RIP-software, e. g. *Adobe Acrobat Distiller* then an output of the PDF file in possible on nearly every printer and computer platform.

The input image reference file with *olv data**

This resulting image file data are widely independent of:

1. Exposure (under and overexposure: -1 and +2 stops for slide film and -2 and +4 stops for negative film)

2. Film material (slide (sf) or negative film (nf) material)

3. Developing process of the film material

4. Parameters of the Photo-CD scanning process

5. Parameters of the software transferring the Photo-CD-file to an EPS-file

In conclusion: The intention to get the same digital file for the reference gray and CIE-test colours in a standard reference scene is reached with high precision. *(Remark: One must make the same transformation for all pixels)*

An extensive study which result in two very similar ISO/IEC-test pictures using slide and negative film material is in the paper:

Automatic colour management for variable processes between original scene reproduction using 16 colours of ISO/IEC-test

http://o2.ps.bam.de/CISV06.PDF

Two pictures are shown in this paper based on slide and negative film material. The **ad** transfer function is based on the 16 gray colours only.

More information is found in

http://o2.ps.bam.de/CISP06.PDF

and

http://o2.ps.bam.de/CGIP15.PDF

Input and output image reference files with *olv data**

One may call the produced file the **input image reference file**. One can construct also an **output image reference file** using the intended *olv** data for the gray colours equally spaced in digital units 0, 17, 34, ..., 238, 255 and for the CIE-test colours *(i*=0 to F) computed in the two figures

http://o2.ps.bam.de/INFVM03/8750/E8751-3N.PDF

and

http://o2.ps.bam.de/INFVM03/8750/E8751-7N.PDF

Remark: Input and output image reference files with *cmy** or *LAB** data offer equivalent possibilities.

Series 8640

The PostScript files of these reports include a 16-step gray scale with equidistant data and CIE-test colours in *olv** coordinates. The data are produced with a real scene and the 32 colours within the scene. We will differ between *settransfer* and *hexadecimal (hex)* transformations. The *settranfer* transformation uses a function and the *hex* transformation changes the *hex* data in the file manually using the same function here.

Square root and square *hex* and *settransfer* transformations

The three parts of Fig. 8640-3 use no transformation or a 2fold *settransfer* transformation of *olv** data:

1. { } *settransfer* = no *settransfer* transformation of image data; defines the original image

2. {0.5 exp 2.0 exp} *settransfer* = 2fold *settransfer* transformation of image data (square root and square function); the result is the original image

3. {2.0 exp 0.5 exp} *settransfer* = 2fold *settransfer* transformation of image data (square and square root function); the result is the original image

http://o2.ps.bam.de/INFVM03/8640/E4640-3N.PDF

http://o2.ps.bam.de/INFVM03/8640/E4640-3N.EPS

The three parts of Fig. 8640-7 use no transformation or one square root transformation of *olv** data:

1. { } *settransfer* = no *settransfer* transformation of image data; defines the original image

2. {0.5 exp} *settransfer* = square root *settransfer* transformation of image data; the image looks lighter

3. { } *settransfer* =no *settransfer* transformation; manual square root change of image hex data; the image looks lighter

http://o2.ps.bam.de/INFVM03/8640/E4640-7N.PDF

http://o2.ps.bam.de/INFVM03/8640/E4640-7N.EPS

The three parts of Fig. 8641-3 use no transformation or one square transformation of *olv** data:

1. { } *settransfer* = no *settransfer* transformation of image data; defines the original image

2. {0.5 exp} *settransfer* = square *settransfer* transformation of image data; the image looks darker

3. { } *settransfer* =no *settransfer* transformation; manual square change of image hex data; the image looks darker

http://o2.ps.bam.de/INFVM03/8640/E4641-3N.PDF

http://o2.ps.bam.de/INFVM03/8640/E4641-3N.EPS

The three parts of Fig. 8641-7 use no transformation or one *settransfer* and one *hex* transformation of *olv** data:

1. { } *settransfer* = no transformation of image data; defines the original image

2. {2.0 exp} *hex* + {0.5 exp} *settransfer* = square *hex* and square root *settransfer* transformation; same image

3. {2.0 exp} *settransfer* + {0.5 exp} *hex* = square root *hex* and square *settransfer* transformation; same image

http://o2.ps.bam.de/INFVM03/8640/E4641-7N.PDF

http://o2.ps.bam.de/INFVM03/8640/E4641-7N.EPS

The Technical Report 8640 includes one 16-step colour series between White *W* and Black *N* and the 16 CIE-test colours of ISO/IEC 15775. The coordinates *olv** are used. See the URL

http://o2.ps.bam.de/INFVM03/8640/A4Q8640E.PDF

http://o2.ps.bam.de/INFVM03/8640/A4Q8640E.PS

Remark 1: Settransfer functions to change the input data according to the decimal olv*_ad*‘ data in the file are under development.

Remark 2: Settransfer functions intended to consider an offset of the image data at Black *N* and White *W* are under development. Such offsets appear if a user works in the colorimetric PRint system (CPR) with the lightness between *L** =0 and *L** =100 and only the offset samples are defined or produced.

http://o2.ps.bam.de/INFVM03/8750/E4750-7N.PDF

http://o2.ps.bam.de/INFVM03/8750/E4750-7N.EPS

Remark 3: In an enlarged wide gamut colour space it is intended to store the CPR data within the digital olv* data range 127-50 = 77 and 127+50 = 177. Then there are two offsets 77 and 177. The advantage of such a space is that the colours more then twice the radial chromaticness can be stored without loss of information. Only 32 L* colours of the gray scale can be distinguished and 77 (the offset range) are stored which is twice the intended accuracy.