Embedding and referencing ICC profiles

To ensure that the colour data in an image or document is correctly interpreted, many file formats permit an ICC profile defining the image source or destination to be embedded into the file or referenced by means of a Uniform Resource Indicator (URI). Profile embedding has the advantage that the profile is permanently associated with the file and this association will not be lost during subsequent image processing or file management operations.

ICC profiles can be embedded or referenced in a wide range of file formats. This paper summarises the mechanical details of such operations, and provides pointers to sources of more detailed or comprehensive information.

The profile header incorporates a flags field that contains flags indicating whether a profile exists as an independent file or has been embedded into an image or document file. This flag is intended to provide hints for the CMM for purposes such as distributed processing and caching. A 1 in bit position 0 indicates the profile is embedded, and a further 1 in bit position 1 indicates that the profile cannot be used independently of the colour data of the image file it is embedded within.

Embedding a profile does not guarantee that it will be used when the image is processed, as this will depend on whether the application is colour management aware and any colour management run-time settings which may affect processing choices.

Image file formats that permit profile embedding fall into two types: those that define the procedure for profile embedding within the file format specification, and those that do not. In the latter case, ICC provides the necessary information in Annex B of the ICC specification. This applies to PICT, EPS, TIFF, JFIF (JPEG), and GIF formats.

All types of ICC profile except Abstract and DeviceLink profiles can be embedded into image files. When a profile is embedded, the complete file must be embedded without modification.

Embedding profiles in EPS, TIFF and JPEG files

Annex B of the ICC specification describes how an ICC profile can be associated with an EPS preview or page description. Within the page description, a %%BeginICCProfile: comment is used to mark the start of an embedded profile, with an %%EndICCProfile comment used to mark the end of the profile. Each line of profile data then begins with a % sign followed by a space, so that the profile is treated as a PostScript language comment.

An ICC profile is embedded in a TIFF file as a private tag, as described in detail in Annex B of the ICC specification. The profile is stored as an an Image File Directory (IFD) entry in the IFD which contains the image data. The IFD entry defines the tag identifying the tagged element as an ICC profile, together with the size and byte offset of the profile data.

The JPEG standard ISO/IEC 10918-1 allows an ICC profile to be stored as one or more application specific data segments., using the APP2 marker and beginning the profile data with the byte sequence "ICC_PROFILE". Large profiles cannot be stored in a single segment, so are stored as a sequence of chunks.

JPEG files also support the specification of an image colour space using the Exchangeable Image File Format (EXIF) Color Space tag. The profiles themselves are not stored, the Color Space tag providing an indication of suitable profiles to use in interpreting the image data. Currently only sRGB and Adobe RGB (1998) are defined for this tag, but since multiple profiles can exist for a single colour space, there can be some ambiguity in the use of the tag. When a JPEG file is opened, if the reader does not decode the tag in which the profile is stored correctly the profile is likely to be damaged or removed when the file is resaved.

Details of embedding ICC profiles in JPEG2000 files are given in ISO/IEC 15444-2 and Colyer and Clark (2003).

Embedding profiles in DNG files

The Digital Negative (DNG) file format, defined by Adobe Systems, provides for the embedding of an ICC profile in two locations: an AsShotICCProfile (for profiles embedded by the camera manufacturer) and a CurrentICCProfile (for profiles embedded by a raw file editor). Both profiles can be used in conjunction with a matrix which is applied before the profile.

The DNG format provides an extensive range of colour calibration tags, which are intended to specify the conversion from the sensor data stored in the DNG file and a scene-referred colorimetric colour space. The ICC profile additionally provides any tone and gamut mapping required to convert the scene-referred image data to an output-referred colour encoding.

Embedding and referencing profiles in PDF documents

Methods of including ICC profiles in PDF files are described in ISO 32000.

In PDF version 1.3 and above, ICCBased color space is included in the CIEBased colour space family. This enables an ICC Device or ColorSpace profile to be embedded to define the source colour space of an object in a PDF document. Each object within the PDF file can be associated with an ICC profile in this way.

Except when used in compositing, only the AToBx transform is used to interpret the source colours. The rendering intent specified in the ICC profile is ignored since the rendering intent for the document is specified elsewhere in the PDF file.

An ICCBased colour space is specified within the PDF file as an array: [/ICCBased stream]. The stream requires entries defining the number of colour components and an alternate colour space (needed only when the PDF consumer may not be able to interpret the profile, such as when the ICC version of the profile is higher than that supported by the PDF version), followed by the embedded profile itself. PDF version 1.7 supports ICC v4, while earlier PDF versions 1.3 – 1.6 support various versions of ICC v2.

An example of an ICCBased colour space embedding an ICC profile is given in 8.6.5.5 of ISO 32000).

PDF versions 1.4 and above also support inclusion of Output Intents. These are included for the document rather than for individual graphic objects, and define the intended destination colour space of the file. For the output intent subtype used in PDF/X files, an OutputIntent dictionary includes:

- the Output Condition string

- the OutputConditionIdentifier string, which should normally correspond to a printing condition registered in the ICC Characterization Data Registry.

- the RegistryName string, which gives the URI where the description of the registered printing condition can be found

- an Info string providing further details of the intended output device (required if the OutputConditionIdentifier does not correspond to a registered printing condition)

- the DestOutputProfile, which consists of an ICC output profile encoded as described for the ICCBased color space. The DestOutputProfile is only required if the OutputConditionIdentifier does not correspond to a registered printing condition.

Examples of output intent dictionaries are given in 14.11.5 of ISO 32000.

PDF/X files have a single Output Intent, in which the S key of the OutputIntents array is set to GTS_PDFX. PDF files conforming to PDF/X-1a and above should include either the name of a registered printing condition in the OutputConditionIdentifier key, or an output profile in the DestOutputProfile key.

PDF files conforming to PDF/X-4p and PDF-5pg include a DestOutputProfileRef key instead of a DestOutputprofile key. The DestOutputProfileRef key includes

the profile description, one or more URIs from which the profile can be downloaded, a 16-byte MD5 hash value for the profile and the profile data colour space. Full details are given in the parts of ISO 15930 corresponding to the PDF/X version.

OpenXPS

OpenXPS is the XML-based document format, originally based on the Microsoft XML Paper Specification, now undergoing standardization by the European Computer Manufacturers Association (ECMA). Each colour object in an OpenXPS document has a source colour space, defined either as sRGB, scRGB or an ICC profile associated with the object. As well as RGB, gray, CMYK, N-channel and Named Colour spaces are supported.

Images which are part of an OpenXPS document can have an embedded profile, using the method of embedding defined by the image file format specification. Images and vector objects can also have an associated ICC profile, which may be identified as an external resource through a URI.

When associating a profile with an image the syntax is:

<ImageBrush ImageSource=

"{ColorConvertedBitmap

../Resources/Images/image.tif

../Metadata/profile.icc}" ... />

where ../Resources/Images/image.tif is the URI of the ImageSource

and ../Metadata/profile.icc is the URI of the profile.

More details of embedding ICC profiles in OpenXPS documents is given in the Open XML Paper Specification, available from ECMA.

Interpreting images with embedded profiles in html documents

Most current browsers support embedded profiles in both v2 and v4 formats, the principal exception being Internet Explorer. The extent of such support varies between browsers: in one case colour management must be explicitly enabled by the user, while in another images in colour spaces other than RGB are supported.

Cascading Style Sheets (CSS) are used in conjunction with HTML and XML to provide descriptions of how pages should be rendered. At the time of writing the proposed CSS3 defines a color property via HTML and SVG keywords and RGB hex values. In an earlier CSS3 Candidate Recommendation a 'color-profile' property was defined, together with a 'rendering-intent' property, but these are not included in the current working draft (they may be included in future levels of CSS).

There are resources on the ICC web site for checking the extent to which browsers and other applications support colour management, embedded profiles and the current specification version. See http://www.color.org/version4ready.html for details.

References

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