STANDARDS UPDATE

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This issue of the Update focuses on the CIE and the ICC, two groups which play a critical role in imaging.

CIE 26th Quadrennial Session

The China National Committee of the CIE, is hosting the 26th Quadrennial CIE Session in Beijing, China, July 4-11, 2007.

This meeting is intended to provide an ideal platform for showcasing and exchanging information about the latest achievements in the international lighting field. In addition to the plenary sessions, Divisional meetings, Technical Committee meetings, seminars, shows etc. a variety of social and cultural activities are also planned in the Session's program.

Beijing, the Session's venue, is the capital of China with a history of over 3400 years and famous for the Great Wall, the Forbidden City, the Temple of Heaven and many other historical sites and places of interest. Beijing is also the Nation's political and cultural center and international communication hub. Thanks to the nearly 5 years' strenuous efforts in construction and renovation to greet the 2008 Beijing Olympic Games, the ancient capital has emerged as a completely new and dynamic city.

Information about the meeting is available at www.cie2007.org.cn. CIE information in general is available at http://www.cie.co.at/.

New CIE Report Announced

CIE has announced the availability of CIE Publication 179:2007, Methods For Characterising Tristimulus Colorimeters For Measuring The Colour Of Light

The purpose of this technical report is to provide an objective means for evaluating the properties of tristimulus colorimeter heads that are to be used to measure the color of light sources. Several properties that determine the performance of tristimulus colorimeters can be quantified by numerical assessments. There are some properties, however, which have not been possible to quantify, where only a qualitative description is possible. Several sources of measurement error are also described.

The report is intended to serve as a guide for a potential user who wishes to make color measurements of sources using a tristimulus colorimeter, and for manufacturers or users of instruments who need to specify or assess the quality of these instruments. The factors that make up the evaluation may also serve as a guide to manufacturers in the development of improved colorimetric instruments.

The report is written in English, with a short summary in French and German. It consists of 19 pages with 4 figures, and, it is readily available at the national CIE organizations or via the website of the Central Bureau of the CIE (www.cie.co.at).

The price of this publication is EUR 38, (Members of the national CIE organizations get 50% discount).

International Color Consortium

Phil Green, the Technical Secretary of the ICC, recently put together a presentation on Recent developments in ICC color management. He graciously gave me permission to summarize this presentation and include it in the Standards Update. Since slides are much more graphic than words, I hope that I do it justice.

Background

In an ICC color managed workflow, profiles are used to transform between a source and destination color space. The source profile defines the transform input device data into the Profile Connection Space (PCS), while the destination profile defines the transform from PCS values to output device data. ICC profiles use a tagged format. A profile is made up of a 128-byte header, followed by a tag table and a series of individual tags. Tags can be informational (text) or numeric, and, depending on the profile class, may also be optional or required. The profile version (Version 2 or Version 4) is located within the profile header.

The current version (version 4.2) of the specification was published in late 2004. This version was introduced into ISO by TC 130, approved, and published as ISO 15076-1:2005. The ISO publication incorporated minor errata, some of which had already been published by ICC. ICC then re-published version 4.2 to incorporate the errata, resulting in the version available from ICC being identical to ISO 15076-1.

Why Version 4

Why was a Version 4 revision of the specification necessary? It had become apparent that the Version 2 specification gave rise to a number of problems. The main issue was that different color management systems could produce different results, depending on the particular vendor's interpretation of the specification.

This was particularly a problem with the perceptual rendering intent, where the specification was not clear on how to handle gamut differences between source and destination.

There were also different interpretations of how to handle the PCS illuminant and media white point, particularly for display profiles. It was generally agreed that the specification also had a number of minor ambiguities which needed to be resolved.

During the preparation of Version 4 there was a thorough review of the specification to remove all of the ambiguities (that were found).

Some of the changes

The colorimetric rendering intents were now required to be based directly on the measurements from which the profiles were generated, without the 'tweaks' that were seen in some profiles.

For n-color profiles, it is now a requirement to specify the CIELAB values of all the device colorants. New extended tag types for color look-up tables were introduced, together with a more flexible parametric specification for curves.

A reference color gamut was defined for perceptual rendering intents, so that a destination profile can map from a known gamut instead of having to make a guess as to the source gamut, as was the case in Version 2.

In display profiles, which commonly transform to the D50 PCS from a different illuminant, Version 4 introduced the requirement to specify the chromatic adaptation matrix so that the CMM can 'undo' the transform if necessary.

For CRT displays, the simple matrix-based type of profile was generally adequate. With the move to other display technologies, the assumptions of a Matrix/TRC profile do not hold, and a look-up table will often give better results. Version 4 profiles can include both LUT and matrix-based transforms, and can also include multiple intents. This is useful especially in the case where the profile generator wishes to provide a different rendering intent for the colorimetric and perceptual intents.

The same flexibility has been extended to input profiles (for cameras and scanners). Unicode was added for text types to assist in providing multi-language versions of profiles.

A profile ID is a more or less unique identifier for each profile, and this is useful in checking which profile is used, especially in cases where two profiles have the same name but different content. Finally, some Version 2 tags were in practice almost never used and it was agreed to simplify the specification by removing them.

Perceptual Rendering

What do we mean by a 'perceptual rendering'? A perceptual rendering is where our goal is to produce a pleasing reproduction of an original (the source) on some destination output medium. This is also known as a 'preferred reproduction'. Note that the reproduction in this case is not required to be an exact match to the original, although if the original image state is output–referred (i.e. the data represents a pleasing reproduction of the image on some output medium), then the artistic intent of the rendering to output-referred originals should be maintained.

The perceptual intent of an ICC profiles can also be used to color-render scene-referred images (i.e. images where the device data represents the original scene colorimetry, not an interpretation of the image rendered to an output medium). Preferred (or 'perceptual') reproduction transforms address differences in source and destination media capabilities and user preferences, as well as viewing conditions.

The Version 2 format limited the ability of the profile to provide suitable transforms between different image states. Different vendors had different interpretations of the transforms between device data and the PCS, particularly affecting the perceptual rendering intent. Although the ICC PCS is D50 output-referred, most input profiles performed minimal little color re-rendering to the PCS.

On the output side, profiles had no information on the source color gamut, and vendors made different assumptions about the source gamut when mapping into the output medium gamut.

With Version 4, the source profile perceptual intent transform is intended to color render or re-render to a reference color gamut, and similarly the destination profile transforms from the reference gamut. The Perceptual Reference Medium Gamut (PRMG) is based on the maximum gamut of real surface colors. A full specification, including data on the gamut surface and primaries, is given in ISO 12640-3:2007.

The PRMG amendment to the ICC specification provides tags for the perceptual and saturation rendering intents that identify whether the PRMG was used in rendering to or from the PCS.

Graphic Arts Workflows

There are no major changes to the specification for graphic arts workflows. The Device Link profile class has been part of the specification for some time and is important in many graphic arts workflows, particularly where the user needs to preserve the channel intent of an original. For example, if a graphic or text is specified in CMYK amounts, it is often undesirable to convert to the PCS and then back to CMYK using the final destination profile, as the colorant amounts may change.

A Device Link profile is normally generated by constructing a look-up table from the AToB and BToA LUTs present in a pair of profiles used as source and destination, although a Device Link profile can also be constructed from a series of profiles.

One limit on further adoption of Device Link profiles was that such a profile contains insufficient information on the profiles used to construct the Link. The profile sequence identifier tag allows this to be recorded within the profile.

The Profile Registry is not a change to the specification but a new resource for color management users. The Profile Registry is for profiles which correspond to registered printing conditions, and it supports both manual and automated location of profiles.

Manual selection is supported through a list of registered profiles and the printing conditions they correspond to. The registry main page shown here gives basic details of the printing process and the organization providing the profile, and further information is available for each registered profile.

Automated location of profiles is needed by PDF/X-4 and PDF/X-5, which allow users to include links to resources rather than including the resource itself within the PDF file. Not having to include the profile within each file reduces overall file size and avoids duplication. This is particularly important in variable data workflows.

ICC has added a further tag to the specification (the Colorimetric Intent Image State tag) which allows the image state to be defined when using the Colorimetric rendering intents. The CIIS amendment adds an Image State tag to the specification.

The scene-referred signatures are scene colorimetry estimate, scene appearance estimate and focal plane estimate. In addition, signatures are available for photographic hard copy originals and print-referred output.

If an image has the appropriate profile assigned, there is a choice of subsequent conversions: to give a colorimetric reproduction, to map the scene adopted white to the output medium white, or convert to a scene-referred working space.

Digital Motion Picture

Color management is increasingly important in the Digital Motion Picture industry. Here the workflow involves converting to a working space for editing, and then to either DPX for final putput or to a theatre preview.

The Digital Motion Picture workflow requires that transforms can be perfectly inverted. The particular form of the transforms, particularly tone reproduction curves, means that transforms cannot be performed precisely as a result of the precision of the processing elements in the ICC profile format, and quantization errors can result.

A second issue for Motion Picture is that in the ICC specification device data is bounded to media white, while motion picture scenes commonly incorporate over-range scene data

The PCS encoding range is also bounded but there are situations where device values may exceed the encoding range allowed or may be negative.

The Floating Point Device Encoding Range addresses these limitations by providing a new, optional set of transforms, which are known as DToB and BToD transforms. The data type for these transforms is a signed, 32-bit floating-point encoding.

Associated with this new type of transform is the option to specify a sequence of processing elements, instead of using a fixed sequence as in the current look-up table types.

The processing elements permitted by the amendment can be any sequence of matrix, curve and look-up table, but other elements may be added in the future to provide a more flexible an extensible color processing architecture.

These multi-processing elements are one of the features which can be used by a smart CMM. In a static workflow, which is most common today, all the adjustments required for viewing conditions, gamut mapping and preferred renderings are in the profile itself, and the CMM merely performs the conversion specified within the processing elements of the profile.

The basic concept of the smart CMM is that additional transforms can be performed by the CMM, depending on the properties of the source and output media. This allows optimization of the transform for the particular gamuts and viewing conditions involved, and also allows re-rendering based on color appearance rather than colorimetry.

The smart CMM also allows user selection or adjustment of transforms at run-time.

Rather than a simple dichotomy between static and smart workflows, there is in fact a continuum between the static workflow on the one hand, in which all the smarts are in the profile, and the fully programmable workflow with dynamically configurable transforms on the other, in which the CMM selects which transform elements to use.

Examples of the operations which can be supported by this smart CMM include: function inversion, image state rendering and re-rendering, automatic black point compensation, gamut mapping, color appearance, scaling, black generation, channel preservation and any proprietary operations.

The Future

The Version 4 specification has established an architecture for interoperable and unambiguous communication of color between devices.

As we look into the future, we recognise that there are a number of challenges for ICC color management. First, the context for color management is extending well beyond the traditional print-centric graphic arts. While many of the recent Version 4 amendments have been directed at extending the architecture to support the workflows of new types of device and media, there may be further work to do in order to make the ICC profile the preferred method of color conversion.

More importantly, the challenge today is to promote universal adoption of the Version 4 specification together with the recent amendments. The addition of multi-prcessing elements to the specification significantly extends the range of color processing models which can now be supported by the ICC architecture.
Finally, as color transforms become more configurable it becomes especially important to address the way in which applications present choices to the user, in order to maximize the usability of color management in the future.

Please visit the ICC web site (www.color.org) for more information.

For suggestions for (or input to) future updates, or standards questions in general, please contact the author at mcdowell@npes.org or mcdowell@kodak.com

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