STANDARDS

Standards Update

David Q. McDowell, Editor

This issue of Standards Update focuses on CIE Division 8, Image Technology. It is based on the recent Division Activity Report prepared by the Division Editor. The work of Division 8 was last reported on in the March/April 2000 issue of the Reporter.

CIE Division 8

The current Division 8 officers are:
Director: Todd Newman (US)
Secretary: David McDowell (US)
Editor: Mike Pointer (UK)

The Division 8 web site (www.colour.org) provides information about the division as well as contact links to the officers and committee chairs.

Terms of Reference:

The Division "Terms of Reference" are: "*To study procedures and prepare guides and standards for optical, visual and metrological aspects of the communication, processing, and reproduction of images, using all types of analogue and digital imaging devices, storage media and imaging media.*"

Background

The Division aims to work primarily by electronic means in order to make efficient progress. This method of working has proved worthwhile and good progress is being made in several areas.

Since its inauguration in September 1998 at a CIE Meeting held in Baltimore, US, the Division has held meetings in Warsaw, Poland (1999) as part of the CIE Quadrennial meeting and in Derby, England (2000) in association with the conference Colour Image Science 2000. Several of the Technical Committees met before or after the IS&T Color Imaging Conference in Scottsdale, Arizona in November 2001, and an informal meeting of the Division was held. It is proposed that there be a similar arrangement at the 10th IS&T Color Imaging Conference to be held in Scottsdale, Arizona in November 2002. The next formal meeting of the Division will be held in conjunction with the CIE Quadrennial Meeting, 25 June - 2 July 2003, in San Diego, USA.

As part of the initial inauguration of Division 8, Technical Committees (TC) 1 through 4 were formed. The current status of the activities of the Division 8 committees is as follows.

TC 8-01 Colour Appearance Models for Colour Management Applications

The chair of TC8-01 is Nathan Moroney of Hewlett-Packard Laboratories, Palo Alto, CA, USA.

It's terms of reference are: "*To study, develop, and recommend a colour appearance model based on CIECAM97s for use in digital colour management and to develop clear usage guidelines for common applications. Consideration is to be given to colour and engineering requirements for open colour management systems.*"

After two physical meetings in the summer of 2001 in Rochester, New York and in the fall of 2001 in Scottsdale, Arizona great progress has been made and the number of major revisions to be finalized is down to one. The primary unresolved issue remains the selection of the linear chromatic adaptation transform. The entire committee agrees that the revised model should include a linear chromatic adaptation transform but there is still no consensus about which one to use. A significant accomplishment was to gain consensus on the chroma scaling. Additional analysis and experiments by the technical committee have supported a reduced chroma scale for the very near neutrals, although there are two possible means to implement this revision.

The committee participated in two surveys on which linear chromatic adaptation transform should be used and the votes were about evenly split between two transforms proposed by Luo, et al. and the transform proposed by Fairchild. There would appear to be a trade-off between a higher degree of backwards compatibility, the Fairchild transform, and an optimisation based on all or most available corresponding colour data sets, the Luo et al. transforms. The performance of all of the transforms is fairly similar so secondary considerations are being investigated. Analysis by Mahy revealed that there is no significant difference between the transforms based on error propagation. Hunt and Fairchild have prepared a summary document highlighting the differences between these transforms. The second survey resulted in a small preference margin for one of the Luo et al. transforms but there is still ongoing discussion of the topic.

During the physical meeting in Rochester, New York, Alessi shared her results from TC1-27 and follow-up discussions between Alessi and Fairchild have been shared with the committee as outstanding issues that will require additional consideration by TC8-01. These include possible image dependencies in the results and possible field-of-view surround effects.

The key accomplishment for the technical committee for the year was gaining consensus on the chroma scaling. Additional analysis and experimentation by Moroney suggested that the chroma magnification for near neutrals is not present in the raw LUTCHI scaling data and may be more a result of fitting the scale without forcing an intercept at the origin. Fairchild has proposed a solution by modifying the chroma equation while Hunt et al. have proposed a new non-linear post adaptation response compression that provides a good fit to the chroma scaling data and has a small intercept. This new non-linear function also addresses a problem of saturation changes with increasing illumination of the adapting field. While a significant revision, the new non-linear function has the advantage of addressing two outstanding issues. Regardless of which revision is used, all members of the technical committee have agreed on minimizing the intercept for the fit for the chroma scale.

In December of 2001 a sub-committee, consisting of Fairchild, Luo, Moroney and Newman, was formed in order to prepare a draft technical report for consideration by the entire committee. This sub-committee will attempt to reach some sort of compromise on the linear chromatic adaptation transform and the non-linear response compression.

TC 8-02 Colour Difference Evaluation in Images

The chair of TC8-02 is Dr. M R Luo of the Colour and Imaging Institute, University of Derby, UK.

It's terms of reference are: "*To study and recommend methods to derive colour differences for images*"

- A draft of the proposed technical report (Version 5) was distributed to TC members for comment in December 2001. It is expected to com-

plete a Version 6 draft by the end of January 2002. The report is only intended to include all possible methods for evaluating colour differences for colour patches and images.
- The TC will continue to generate test images, to perform psychophysical experiments in different sites and to evaluate the performance of various methods. A work plan will be distributed between members in January.

TC 8-03 Gamut Mapping

The chair of TC8-03 is Jan Morovic of the Colour and Imaging Institute, University of Derby, UK.

It's terms of reference are: "*To study, develop and recommend an optimal solution for cross-device and cross-media image reproduction. This solution will provide a standard procedure to calculate the colour gamut of an image, an imaging system, or its components, and either one algorithm, or a set of algorithms and rules for use in specific applications.*"

- A meeting of the TC took place on 8 November 2001 in Scottsdale, AZ with the focus being on finalising the Guidelines for the Evaluation of Gamut Mapping Algorithms (GMA) that the TC has been working on throughout 2001. In addition to discussing remaining issues with the guidelines, the publication of GMA source code and the provision of test images was also discussed.
- In the course of 2001 three revisions of the Guidelines were prepared based on discussions conducted via e-mail. The focus of most of the discussions was whether a single test image or a number of test images should be made obligatory in the Guidelines and changes were also made to the obligatory GMAs that the Guidelines specify.
- A checklist that is to help participants in coordinated research was prepared to allow for easy checking of whether a study complies with the Guidelines. Fujifilm Electronic Imaging Limited (UK) have made the image that is specified as obligatory in the guidelines available to the TC for its use and distribution to participants of the coordinated research. ACanon Development Americas (USA) and Sony (Japan) have contributed test images to the TC. ACurrent plans are to:
  - Complete Guidelines and publish them as CIE technical report.
  -Publish shorter version of guidelines at a conference or in a journal.
  - Commence coordinated research on the basis of the Guidelines.

TC 8-04 Adaptation under Mixed Illumination Conditions

The chair of TC8-03 is Naoya Katoh of the Sony Corporation, Tokyo, Japan.

It's terms of reference are: "*To investigate the state of adaptation of the visual system when comparing soft-copy images on self-luminous displays and hard copy images viewed under various ambient lighting conditions.*"

The TC completed a set of experimental guidelines in 2000. These were then used, during 2001, by Sueeprasan (UK) and Katoh (JP) to performed adaptation experiments. The results from these of two different laboratories showed a fair accordance in mixed adaptation ratio (ie 40-60%). This result is also in accordance with the past results of Katoh, Berns and Choh (US), and Shiraiwa et al. (JP). A TC meeting was held at 09-Nov-2001 at Sunburst Hotel, Scottsdale, AZ.

The TC also discussed the choice of a CAT (chromatic adaptation transform) matrix to be incorporated into a mixed adaptation model. However, the choice of a preferred CAT is now being discussed as part of the work of TC8-01. To insure compatibility, it was agreed that TC8-04 should follow the recommendation from TC8-01, since the differences being discussed are very subtle. With these results, it was agreed that TC should focus on preparing a technical report during 2002.

TC 8-05 Communication of Colour Information

TC 8-05 was established in 1999 and it's chair is Robert Buckley, Xerox Corporation, Webster, NY, USA.

It's terms of reference are:"*To standardise a minimal set of techniques that enable unambiguous and efficient communication of the colour information in images. Two fundamental approaches will be addressed:*

1. *The association with the image data of additional data that describes the colour space of the image data.*
2. *The representation of the image data in a standard colour space.*

The standard will also define a minimal set of standard colour spaces that addresses a wide range of imaging applications. Whenever possible, existing standard colour spaces will be used in preference to creating new ones. "

The last TC meeting was held November 5, 2001 in Scottsdale, Arizona. At this meeting, results were presented evaluating the sRGB, sYCC, e-sRGB, e-sYCC, ROMM RGB and PCS LAB colour spaces against the following colour encoding criteria:

I. Color Gamut Metrics
A Total Color Gamut Volume
B Comparison to target color gamuts
- real world surface colors
- optimal colors
- legal colors
- CRT colours
- photographic print colors
- photographic transparency colours (not complete)

II. Quantisation metrics
A Quantisation error for single code value change
- for colours inside all of the colour encodings
- for colours inside real world surface colour gamut

B Quantisation efficiency (# bits needed to achieve certain error level)

III. Complexity of transform to/from important colour spaces
A video preview
B PCS XYZ
C PCS LAB
D SWOP CMYK

A report of this work is available through the Division 8 web page.

TC8-05 took responsibility for coordinating the CIE Expert Symposium 2000 on Extended Range Colour Spaces, held November 11, 2000 in Scottsdale, Arizona. The Proceedings of this Symposium have been published and are available as CIEx021:2001, ISBN 3 901 906 10 X.

The next physical meeting of CIE TC8-05 is planned for November 2002, around the time of the IS&T/SID Color Imaging Conference in Scottsdale, Arizona.

TC 8-06 Image Technology Vocabulary

TC8-06 was established in 2000 and it's chair is J Schanda, University of Veszprém, Hungary.

It's terms of reference are: "*To liaise with other Division 8 Technical*

Committees and collate definitions of terms associated with image technology."

Up to November 2000, work was carried out by correspondence. The Chairman has submitted parts of several terminology documents to members to consider what should be included in a technical report. At the TC 8-06 meeting in Scottsdale on 11-Nov-2000 it was decided that the TC should collect terms and definitions from as many imaging related ISO TCs as possible and place them in a database. The construction of a database has been started and will be circulated to the Technical Committee members in 2002.

TC 8-07 Multispectral imaging

TC 8-07 is currently in the process of being established and receiving the approval of the CIE Board of Administration and member bodies. It's proposed chair is Dr. Patrick Herzog, Color AIXperts GmbH, Aachen, Germany.

The proposed Terms of Reference are: "*To study, develop, and recommend encoding techniques and data formats for the exchange of multispectral images, and to provide test procedures for the evaluation of multispectral imaging systems.*"

It is anticipated that the subjects to be covered will include:

- Spectral test sets including data sets for simulation and testing, definition and fabrication of an experimental spectral test chart, and a test chart of pairs of metameric colors.
- Definition of sets of color matching functions of typical human observers to be used in multispectral imaging systems for the definition of observer metamerism.
- Encoding of multispectral image data including linear encoding and quantization, nonlinear encoding and quatization, mixed spectral and spatial encoding.
- Definition of data formats for the exchange of multispectral image data
- Recommendations for the definition of quality of a multispectral system and test procedures

Summary

CIE Division 8 is involved in a very active program that has potential impact on many areas of the imaging community. If you would like to be involved in any of these activities, please contact the Chairman, Todd Newman, at todd@cra.canon.com.

If you are aware of work that should be undertaken by Division 8, and can identify a leader for such work, please also bring this to Todd's attention. As with any CIE Division, the leaders and participants must be identified before we can start a new Technical Committee, and we are always open to volunteers.

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