STANDARDS

Standards Update

David Q. McDowell, Editor

This issue of standards update departs somewhat from my traditional pattern. I want to alert you to, and discuss, a new book on evaluation of image quality that I believe can provide significant direction to both the industry and the standards activities.

Image Quality

In developing specifications and standards for imaging, one of the key drivers for almost all of the work we do is the issue of image quality. It impacts everything - color spaces used for encoding, compression, file formats, viewing conditions, and on and on. Unfortunately, very little work has been done to standardize image quality tests, procedures, or methodologies. As a result we all draw on our experience, guess what is best and base our conclusions on some mutual, unverified, assumptions.

A search of the ISO index of both in-work and published standards reveals that there are only eight projects that are associated with the key words "image quality". Of these, only ISO 20462, *Photography--Psychophysical experimental method to estimate image quality*, in preparation by TC42 (Photography), appears to address the issue of subjective image quality.

Although there have been many papers and books that have looked at specific issues within image quality, there seems to be little that provides a common framework for the exchange or comparison of image quality specifications and evaluations.

I was therefore pleased to recently receive the announcement of a new book - Handbook of Image Quality, by Brian Keelan of Eastman Kodak Company. I have known Brian (and many of his associates who contributed to the book) during my tenure at Kodak and have admired their work. (Yes, I am prejudiced.) I am also pleased that the Kodak Research Laboratories have been willing to let this book be published because it represents a real contribution to the imaging industry and its need for a common framework in which to effectively exchange specifications and evaluations.

While this book does not, and should not, provide a detailed listing of image quality attributes and quality correlates, it does provide the tools and framework by which image quality can be characterized in a quantitative fashion. It includes schemes for classifying perceptual attributes into various categories, and a working definition of image quality is developed from consideration of the correlations between the resulting categories.

Brian is already working as part of ISO/TC42/WG18 to apply some of the principles described in this book to the development of ISO 20462 mentioned above. I am sure that as others study the approach outlined, this work will find broad application in any number of imaging areas as well as in the development of new standards and specifications that are sorely needed.

A little about the book

It is *Handbook of Image Quality, Characterization and Prediction* by Brian W. Keelan (Marcel Dekker, Inc., Optical Engineering Series #75, ISBN: 0-8247-0770-2, $195.00)

I think that the best description that I can provide of the book is to provide a couple of quotes from the book itself. First from the preface:

"In general, the benefits of computer modeling are at least threefold:

1. Cycle time compression and cost savings through reduced prototyping and experimentation;
2. Identification of unexpected solutions that might be missed by empirical testing over a restricted range;
3. Education and training of practitioners through virtual experimentation.

At Eastman Kodak Company, prediction of image quality through computer modeling has proved to be of great value in all three regards and has been regularly used in formulating business strategies, guiding design decisions, establishing product aims, budgeting system tolerances, supporting advertising claims, and benchmarking competitors' offerings.

Despite such local successes, it is widely assumed that image quality, being a subjective attribute, is not amenable to quantitative analysis.

This misconception is difficult to overcome because of several factors:

1. The infrequency of coverage of pertinent topics, such as psychometrics, in academic curricula;
2. The absence of a published, integrated approach to image quality characterization and prediction;
3. The scarcity of non-proprietary examples of image quality modeling that could be shared among the industrial and academic communities."

From the Introduction:

"To create a computer model capable of predicting the image quality that would be produced by a hypothetical imaging system, researchers at Eastman Kodak Company have taken the following steps:

1. Establishment of a numerical scale of image quality that is anchored to a set of physical standards (images) and is calibrated in perceptually useful terms that facilitate its interpretation (just noticeable differences);
2. Development of a psychometric measurement technique efficiently yielding reproducible results that are calibrated in terms of the standard scale of image quality from Step #1;
3. Elucidation of a theory for the prediction of the overall (multivariate) quality of an image from a knowledge of its individual quality attribute levels (e.g., sharpness, graininess, etc.);
4. Investigation of a selected set of subjective image quality attributes (as in Step #3) using the psychometric technique from Step #2, leading to the definition of objective metrics (e.g., granularity) bearing a known relationship to calibrated assessments of the subjective attributes;
5. Implementation of propagation models (e.g., linear systems theory) that, from key properties of system components, predict the corresponding properties of final images, in support of computation of the objective metrics from Step #4;
6. Definition of measurement protocols for determining the key component properties of Step #5, and identification of engineering models that allow estimation of the same from basic design parameters;
7. Integration of the above, as well as system usage information derived from customer intercept studies, into a comprehensive Monte Carlo simulation for prediction of image quality distributions.

The outline of this book closely parallels the steps listed above."

And from the conclusion:

"Thinking back upon the question raised in the first chapter, namely, whether image quality can even be quantified, it is apparent how far we have come. Not only can image quality be quantified, but also it can be understood in detail, and can even be predicted from the fundamental properties of an imaging system."

I believe that Brian an his associates have provided and excellent guide that covers the theory and at the same time provides a very practical and workable framework for the modeling and quantification of image quality - something that we sorely need in the imaging standards arenas.

Some Standards Notes:

The following standards are in review and ballot and your input is invited:

ISO 5-3, Photography and graphic technology — Density measurements – Part 3: Spectral conditions, prepared by ISO/TC42/JWG21, is currently in committee draft (CD) ballot in both TC130 and TC42.

This part of ISO 5 is one of a series, which specifies the spatial and spectral conditions for optical densitometry as practiced in black-and-white and color imaging applications. 5-3 specifies the spectral conditions for both transmission and reflection density measurements.

In this revision of ISO 5.3 it has been recognized that today the more common method of "measuring" density makes use of computations based on measurements of the spectral reflectance factor or spectral transmittance of the sample under study. The spectral products, reported at 10 nm intervals in earlier versions, have been interpolated to 1 nm intervals, normalized to 100 and will replace the coarser tables of spectral products as the definition of density.

These tables of 1 nm data now define the various types of density, which have been standardized. However, for practical work, weighting functions have been computed from these 1 nm tables to be used with data at 10 and 20 nm intervals.

ISO 22028-1, Photography and graphic technology — Extended color encodings for digital image storage, manipulation and interchange — Part 1: Architecture and requirements, prepared by ISO/TC42/JWG23, is currently in committee draft (CD) ballot in both TC130 and TC42.

This is Part 1 of a multi-part standard. This part defines an image state architecture and specifies a set of requirements to be met by any color encoding that is to be used for digital photography and/or graphic technology applications involving image storage, manipulation and/or interchange. Subsequent parts of this standard will define at least one scene-referred extended-gamut color encoding and at least one output-referred extended-gamut color encoding.

To review or comment on TC42 standards contact isotc42@i3a.org

ANSI/IT8.7/4, Graphic technology – Input data for characterization of 4-color process printing of packaging materials, (prepared by ANSI/CGATS/STF2), is currently in committee review.

IT8.7/4 is intended to supplement the current IT8.7/3:1993, *Graphic technology – Input data for characterization of 4-color process printing*, (also standardized as ISO 12642:1996 with the same title) target. IT8.7/4 defines 938 unique combinations of CMYK data sets, or approximately 100 more than in the IT8.7/3 standard. For ease of organization there are 12 redundant patches, in the default layouts provided, leading to a total of 950 patches.

Although this work is still in development, potential users and in particular developers of color management profiles and profiling tools are encouraged to evaluate and comment on this draft standard. Copies of the text as well as image files may be found in the standards workroom at www.npes.org.

The significance of this standard to vendors of color-management software is that all characterization data, provided as part of the standards activities, will be based on either this CMYK data set (as finalized) or the data set contained in IT8.7/3.

Send comments on IT8.7/4 to me or to mabbott@npes.org.

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

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in other industrialized countries. The extensive set of color illustrations ranges from color separations for four-color printing to principles of many types of printing and auxiliary operations. Executives in various sectors of the graphic arts industry or government, as well as university professors, may wish to purchase copies for their own personal use. Students in engineering, management or artistic aspects of the graphic arts will also find the book very rewarding.

The sturdy, high-quality, near-opaque paper and equally sturdy binding ensure that the *Handbook* will withstand rough handling, including even accidental dropping from a table to the floor. A person's toe or ankle that may be under the falling book is likely to suffer more damage than the book will. The CD-ROM, weighing about 20 grams, is only 1/150 the weight of the book, 3 kilograms (6.5 pounds). A student or traveling executive is more likely to carry a laptop computer and the CD-ROM than ever to move the book from the office or library where it is kept.

The *Handbook of Media: Technologies and Production Methods* is available by visiting the bookstore at http://www.imaging.org. Member price: $99.00; Non-Member price: $175.00.

Louis Rosenblum is an engineer and applied mathematician who has devoted many years to technical aspects of photographic systems and graphic arts equipment. Early contributions at Polaroid Corporation ranged from quality control of WWII military devices to mathematical analysis of precision camera shutters. Later achievements include development of high-quality, high-speed photographic typesetting; its application to Greek, Arabic, Hebrew, Russian, and Chinese writing forms and the several alphabets used in India; and the manufacture of Lumitype-Photon machines. For more than 30 years he has worked as a technical consultant. A long-time member of IS&T, Louis Rosenblum served for several years as Editorial Vice President. He is an active member of IS&T's Boston Chapter and a Trustee of the prestigious Museum of Printing in North Andover, MA.