

Colour Management for Open Colour Communication Systems

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Abstract

The paper will describe the following aspects of modern colour management together with relevant International Standardization;

1. Background and needs of colour management in the Internet
2. Market needs and market acceptance
3. Technical aspects of colour characterization of colour printers and colour related electrotechnical equipment by colour measurements
4. Technical aspects of colour management by making use of the characterization data for equipment independent colour production and reproduction
5. The state of the art of International Standardization in the field of colour management in the open colour communication systems such as the Internet.

Finally it will discuss on worldwide collaboration in the field of Intenational Standardization by introducing an structure and function of a Technical Committee (TC100) of the IEC.

Introduction

It has long been foreseen that faithful production and reproduction of colour information in global digital network environment such as the Internet since invent of a virtual information infrastructure called World Wide Web over the TCP/IP. The faithful production and reproduction is important, because the Web is open system for everybody, who produces colour images anytime which will be received by anonymous people who will display, make prints or store for future use. Because of lack of alternative information infrastructure for global communication with colour information, the Web-based communication should be increased provided that bandwidth of communication will support the increase. In this context, one needs management scheme in terms of faithful production and reproduction of colour information, which will closely relate to colour information products and systems manufactured and put in to the worldwide market place. The colour management scheme will provide a target for design for manufacturers and evaluation criteria for test houses and consumers.

To meet the needs of markets, consensus in international level is necessary in the area of

1. colour measurement and characterization of relevant equipment such as colour scanners and digital cameras, colour displays and projectors, and colour printers,
2. a standard colour representation by digital data, in other words digital colour space used for equipment-independent colour communication,
3. methods to tune equipment-dependent characteristics to the standard digital colour space, or colour management, and finally,
4. objective methods to evaluate a degree of attainment of colour management.

Approach

In order to realize an open colour communication system, Technical Committee 100 of the International Electrotechnical Commission (IEC) took a decision to establish a Project Team on colour measurement and management in multimedia systems and equipment in Dresden in September 1996. IEC/TC 100 asked the Project Team to develop a series of International Standards in IEC 61966 series in parallel by means of a new process of standard development in use of modern way working within the Project Team. The team has been make use of “virtual meetings” in which every interested expert is invited to participate to contribute his/her idea in use of e-Mail, ftp and the Web. There were no physical limitation of apparent budgets, meeting places, rooms, and occasion for the virtual meetings. Required are share the time and knowledge of participants who aim at the common target; International Standards.

The virtual meetings are possible with clear and strong support of its parent Technical Committee and Chief Executive Officer of the IEC together with actual face-to-face meetings (physical meetings in contrast with virtual meetings) which will be so frequent.

Possible Architecture for Colour Management in Open Systems

Specific aspects of open systems like Web over the Internet is that effectively anonymous creators and users are involved and that objectives of colour communication are

not specified; some are for remote learning/education, some are for e-commerce/e-business and some for remote diagnostic of patients; they will range from entertainment to professional applications. The open colour communi-cation system will be composed of equipment of acquisition of colour information such as colour scanners and digital still/movie cameras by which information is digitized and put to the Internet; additional equipment of reproduction of colour information retrieved or received from the Internet such as colour image displays and projectors manufactured by varieties of technologies and colour printers for hardcopies. The combination of these two classes of equipment via the Internet will not known in advance, however, creator and consumer of colour images and electronic documents which contain colour image always wish they are appropriately used, viewed and reproduced.

A model of the open colour communication system is shown in Figure 1 where any combination of input and output equipment is possible.

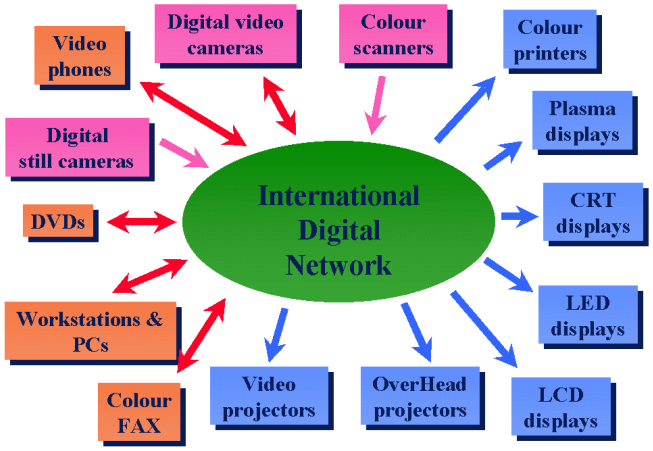

Figure 1. Model of an open colour communication system

International digital network is not always "international," but it could be regional, national or local area network. The important aspect of this model is a source site does not know a destination where what kind of equipment is in use; equipment model, technology used, manufacturer, and date of manufacturing. Nevertheless, both parties are apt to expect faithful colour reproduction. How can we realize a colour management system to answer their expectations? One answer will be based on communication with a header of description of colour information coding such as the ICC Profile format. In this case every creator of colour information in digital form should prpare the header to be attached to the images. Consumers side, the header should be appropriately interpreted and processed in reproduction. It will cause increase of the size of colour information and computational complexity to handle the information contained in the header, normally pixel-by-pixel interpre-tation. The other is to introduce default method of digitizing colour information based on an internationally standardized method. In this case, there will be no header attached. No additional pixel-by-pixel computation will be required, if equipment for colour information are designed to accept the standardized colour encoding scheme. It will provide benefit for consumers, manufactures and even Internet service providers from the point of view of reduced amount of information transfer between two parties.

Results of International Standardization in IEC/TC 100

As the result of international standardization activities by *Technical Area 2: Colour measurement and management* of IEC/TC 100 based on the second model in the last section, i.e., introduction of a default RGB colour space for colour communication in open system, the following International Standards in IEC 61966 series have been established.

- IEC 61966-2-1: 1999, Multimedia systems and equipment – Colour measurement and management – Part 2-1: Colour management – Default RGB colour space – sRGB
- IEC 61966-3: 2000, Multimedia systems and equipment – Colour measurement and management – Part 3: Equipment using cathode ray tubes
- IEC 61966-4: 2000, Multimedia systems and equipment – Colour measurement and management – Part 4: Equipment using liquid crystal display panels
- IEC 61966-5: 2000, Multimedia systems and equipment – Colour measurement and management – Part 5: Equipment using plasma display panels
- IEC 61966-9: 2000, Multimedia systems and equipment – Colour measurement and management – Part 9: Digital cameras

There are active Project Teams for IEC 61966-2-0 (Colour management), IEC 61966-2-2 (Extended RGB colour space – sRGB64), IEC 61966-2-3 (Default YCC colour space – sYCC), IEC 61966-7 (Colour printers), IEC 61966-8 (Multimedia colour scanners) under Technical Area 2 (TA 2). Standardization on projectors (IEC 61966-6), based on request from industry, is expected to be started.

All information of the activities of IEC TC 100/TA 2 will be available from the IEC Web site maintainded by IEC/TC 100 at
http://www.iec.ch/tc100/txt/100struc_ta2.htm
and detained additional web site maintained by TA-manager at http://www.map.tu.chiba-u.ac.jp/IEC/100/TA2.

How Colour Management Be Realized

The colour management is based on characterization of relevant equipment which will have potentiality be used for colour communication in the open system, in other words, to be connected to the Internet in one or the other methods; and the incorporation to the standard RGB colour space.

A scheme to make use of date obtained in the process of characterization of a specific colour production and

reproduction equipment will be modeled as shown in Figure 2 and Figure 3.

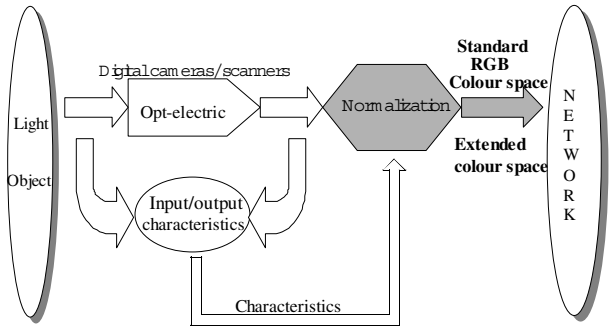

Figure 2. Colour management scheme for colour image production

In figure 2, opto-electric conversion is the core function of colour image production whose input (light or object) to output (data) characteristics should be acquired by the common methods specified by IEC 61966-8 for digital cameras and by IEC 61966-8 for multimedia colour scanners.

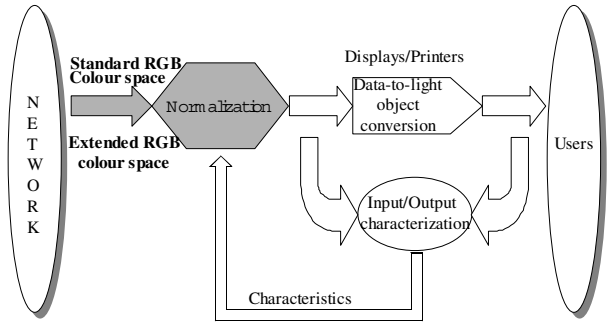

Figure 3. Colour management scheme for colour image reproduction

In Figure 3, data-to-light/object conversion is the core function of colour image reproduction whose input (data) to output (light or object) characteristics should be acquired by the common methods specified by either IEC 61966-3 (CRT display), IEC 61966-4 (LCD display), IEC 61966-5 (PDP display), IEC 61966-6 (Projection system) or IEC 61966-7 (colour printer) depending on the actual type of equipment.

Conclusion

In this short paper, the author outlined the basic idea of colour management necessary for open colour communication systems and the approach to the idea. The activity of International Standardization was initiated by the Japanese National Committee of IEC/TC 100 in 1997, but now it is one of the major projects of IEC/TC 100. In Mach 2000, the frame work of the parent technical committee was changed to purely project based work by a small project team corresponding to each approved project. However, existing projects on colour measurement and management have been allocated under a newly established Technical Area supervised by Technical Area Manager (TAM) and Technical Secretary (TS). IEC/TC 100 is now disbanding all Working Groups and Sub-committees and restructuring to a new organization. This restructuring will be successful in terms of even more speedy and market relevant International Standardization for not only colour measurement and management, but also other areas of multimedia systems and equipment.

The author would like to express his appreciation, first of all, to Japanese National Committee of IEC/TC 100 and Japanese Standards Association for encouragement and support of the activity of International Standardization.

International consensus creation and development of International Standards are possible only by collaboration in true sense of meaning. In this regard, he also owes thanks to Prof. ir. A.J. Stienstra, former Secretary of IEC/TC 100, who understood the importance of the activity at the very beginning. The author is graceful with project leaders, Mr. Michael Stokes (IEC 61966-2), Mr. Shoji Suzuki (IEC 61966-4) and Mr. Fumio Nakaya (IEC 61966-7), and many experts who participate to develop the series of International Standard 61966, together with liaison representatives from relevant organizations; the officers of IEC/TC 100, Dr. Shoei Kataoka (Chairman), Mr. Henk Kolk (Secretary), Mr. Theo Laans (Assistant Secretary, as well as Technical Secretary of TC 100/TA 2) and Mr. Wim Honig (Assistant Secretary).

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7. IEC 61966-9 Ed. 1.0: 2000, Multimedia systems and equipment – Colour measurement and management – Part 9: Digital cameras (2000).
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Biography

Hiroaki Ikeda received his M.Eng. degree in Electrical Engineering from Graduate School of Chiba University in Japan in 1968 and a Dr. Eng. from Tokyo Institute of Technology in 1979. Since 1968 he has been with Faculty members of Chiba University. His works and interests have been research and education in the field of electronic circuits, automated instrumentation, information technology and now colour engineering in the division of multimedia systems: He is Full Professor of Chiba University as well as an officer of several ISO and IEC committees; Secretary of IEC/SC 3C, Technical Area Manager of IEC/TC100/TA2, Project Leader of some projects under TA 2, Convener of ISO/IEC Joint Working Group on basic principles of graphical symbols. He received IEC Load Kelvin Award in 1999.