Status of the Development of International Standards of Image Quality

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Abstract

Work is presently proceeding in a ISO/IEC subcommittee to JCT1/SC 28 to develop international standards of image quality for office equipment imaging. The task is being addressed at three levels, 1) identify the visual attributes that govern the perception of image quality for the devices being studied, 2) develop well defined objective measurement techniques for each key attribute, and 3) determine the sensitivity of variation in each parameter on perceived quality. The status and direction of this work is presented.

Introduction

The National Committee on Information Technology (NCITS) W1 is a technical standards committee that functions as the US Technical Advisory Group (TAG) to the International Standards Organization / International Electrotechnical Commission (ISO/IEC) JTC1, Information Technology, Subcommittee 28 on Office Equipment. The scope of W1 spans the standardization of scanners, printers, facsimile equipment, copiers and multi-functional devices. The Committee's activities focus on office equipment image quality, performance and usability. The committee membership, comprised of office equipment, test and evaluation firms and manufacturers, seeks to meet common standards to communicate the focus. The NCITS W1 develops the US positions for international test and evaluation office equipment standards. The standards provide a neutral benchmark for evaluating and communicating office equipment performance and quality.[1] The structure and functioning of W1 were recently described in a paper presented in the IS&T PICS conference held in Savannah, Georgia.[2]

One of the recent publications of W1 is ISO/IEC DIS 13660 Draft International Standard, "Office Equipment – Measurement of image quality attributes for hardcopy output – binary monochrome text and graphic images (final version to be released)". This standard is intended as a practical means of communicating objective measurements of attributes of image quality. While this publication represents a major step forward it has some important limitations and is narrow in overall scope.[3] Members of W1 are actively pursuing additions, corrections and clarifications to the procedures of ISO 13660. In addition, a new study proposal was approved in the Yokohama plenary session of the JTC1/SC28 to look at an approach to create a standard in which the most significant image quality attributes would be carefully specified, both with respect to a well defined methodology of objective measurement of the attributes and with a determination of the visual significance on perceived image quality of variation in the objective measurements. This work item will be presented at the next plenary session in Berlin as a new work proposal. It is fully expected that the proposal will be approved at the international level. Work is already underway among the committee member.

Work Proposal

Rationale

The foundation of this work was established in a series of open meetings held in conjunction with previous NIP and PICS conferences. In three such meetings helped in Portland, Toronto and Savannah, more than 150 individuals representing over 80 different companies discussed the need for an international standard that could promote an accurate and meaningful representation of the overall image quality of a color printer, in terms of a neutral, well defined set of image quality attributes. These discussions culminated in a decision to seek for standards organization support and governance for the effort. That official recognition has now been obtained under the auspices of W1. In addition, over 20 individuals, representing a broad range of companies, have volunteered to be active participants in accomplishing the work of the committee. A proposed working paradigm for the committee is based on a paper presented in the Portland PICS conference[3], whose content represents one approach for starting the standards work. This initial approach will be refined into a final format by the working group.

Technical Approach

Image quality has historically been evaluated in a variety of ways. Image quality metrics based on objective measurements of physical print characteristics, e.g. granularity, and visual measurement of the same characteristics, e.g. graininess, are often part of the

evaluation process. An overall assessment of image quality from the basis of the customer preferences is frequently a part of benchmark comparisons. Each type of approach can be used appropriately depending upon the question being asked. Objective metrics are often related to visual characteristics through models describing the functioning of the human visual system, and visual characteristics of image quality may be related to overall customer quality performance by system models. Of the many possible starting points for image quality standards work, we have selected the paradigm of Dalal et al[4] which is based on the concept of a high level set of image quality attributes that can provide a description of overall image quality.

Scope

The objective of the proposed standards activity is the definition of a finite set of quantifiable image quality attributes, as well as the methodology for quantifying them. This set of attributes, when taken together, should have the capability of adequately describing the overall image quality of the system. However, combining the attributes into a single value representing overall image quality is a process frequently viewed as proprietary, and is out of the scope of this work. Setting target values or tolerances for these attributes is likewise excluded.

At this stage the proposal is limited to evaluating printers with "paper-like" hardcopy output. Consequently copiers, digital input devices such as scanners and cameras, and video displays are specifically excluded from the present work. Extensions to cover additional domains are possible in the future.

Requirements

Agreement was reached in the three open meeting that any set of image quality attributes which is adopted should possess these properties:

1. They should form a minimal but sufficient set. They should be capable of describing all significant aspects of image quality, with as few attributes as possible.
2. They should form a goodness scale. Preference should increase monotonically with increasing attribute values. For example, absolute gloss level is not a good candidate for an attribute.
3. They should be appearance-based, rather than technology-based. Thus quantities such as engine dpi or color registration are not good candidates for attributes.

Proposed Image Quality Attributes

As a starting point for this work, we propose a set of image quality attributes that meets these requirements. These attributes comprise the DAC (Document Appearance Characterization) system, which was developed at Xerox in response to a need within Xerox to perform overall image quality evaluations consistently and reproducibly. Since 1995 it has been practiced at both Japan and USA, leading to consistent evaluations of internal technology and competitive products.

The DAC system consists of a set of attributes and images to characterize the overall image quality of color digital printers. It is an appearance-based system and many of the attributes are visually evaluated against a set of reference samples. Although the DAC system is not yet fully developed, it is a useful working tool, and should provide a good staring point for development of industry standards. The DAC system has been discussed by Dalal et al[4], and briefly reviewed below.

The DAC attributes are divided into two sets: (a) Basic Image Quality attributes and (b) Materials and Stability attributes, which are visually relevant attributes that can be evaluated from a single set of analytical images on a standard substrate. They are as follows:

1. Line Quality refers to the overall quality of lines in the images. It takes into account problems such as: jagged lines due to low printer resolution; fuzz or ragged lines due to ink bleed, toner splatter or poor registration; lines with inadequate density; and lines with poor width discriminability due to quantization.
2. Text Quality refers to the overall quality of text. This is influenced by all the factors relevant to Line Quality, together with issues such as reproduction of serifs and line placement accuracy.
3. Adjacency takes into account any defects associated with edges between two colors (including white). This includes problems such as trail edge deletion, inter-color bleed, edge enhancement, etc.
4. Micro-uniformity deals with non-uniformity in areas that are intended to be smooth and uniform, being restricted to problems that are visible in small areas (defined as an aperture of 6mm diameter).
5. Macro-uniformity deals with non-uniformity visible in large areas that are intended to be smooth and uniform.
6. Effective Resolution is related to pictorial sharpness, and refers to the ability to distinguish fine detail, especially at low contrast. It is related to but distinct from print engine resolution and addressability.
7. Effective Tone Levels refers to the quality of areas of smooth tonal variation, including freedom from contouring.
8. Color Rendition deals with the color quality of the image, and is clearly influenced by issues such as color management.
9. Process Color Gamut is directly related to the range of colors printable or a process color system.
10. Gloss Uniformity refers to the uniformity of the glossy or specular component of the light reflected off the image. It includes gloss variations within a nominally uniform area (micro-gloss) as well as gloss differences between base paper and image areas of various density levels.

Working members of the committee are presently involved in identifying areas in which they will focus their efforts. The first step is to select an individual objective metric of importance, one that can be carefully defined and

one for which a precise description of a measurement procedure can then be written. Included, as part of the measurement procedure is a description of an appropriate test image from which the necessary measurements can be made. The final data needed to characterize the metric is an understanding of how variation in the metric value relates to perceived quality.

There is much work to be done with many opportunities for those interested to make contributions to the development of international standards. Much of the committee work is accomplished by email. Periodic meetings are held when required to accomplish the defined tasks. Anyone who would like further information should contact the committee chair: Norman Burnigham, email nwb@hp.com

References

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