INCITS W1.1 Standards for Perceptual Evaluation of Text and Line Quality

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Abstract

This paper describes the status and technical progress of the INCITS W1.1 Text and Line Quality *ad hoc* team. The team has defined the scope of the work and developed several perceptual sub-attributes which comprise the Text Quality and Line Quality attributes, together with preliminary drafts of test patterns suitable for their quantification.

Introduction

INCITS W1 is the U.S. representative of ISO/IEC JTC1/SC28, the standardization committee for office equipment. In September 2000, INCITS W1 was chartered to develop an appearance-based image quality standard.[1, 2] The resulting W1.1 project is based on a proposal[3] that perceived image quality could be described by a small set of broad-based attributes. There are currently five ad hoc W1.1 teams, each working on one or more of these image quality attributes. This paper summarizes the work of the W1.1 Text and Line Quality *ad hoc* team.

Scope

The W1.1 image quality standards are applicable to gray-level and full-color printing systems. They are intended to be both appearance-based and printing technology-independent. "Appearance-based" means that the evaluation is done by, or simulates, normal visual inspection without magnification, and any physical measurements need to be scaled to match human perception. "Printing technology-independent" means that the evaluation is applicable to the output of any of the major printing technologies, as diverse as, for example, electrophotography, thermal inkjet, and silver-halide. These standards address the performance of the entire printing system, not just the print engine.

For W1.1 Text and Line Quality, only positive text/lines on white background are considered. The quality of overlays on a colored background, and of negative text/lines, is considered to be a combined function of Text or Line Quality and the Adjacency attribute.

Line Quality

The Line Quality Attribute consists of three sub-attributes:

1. *Line Purity:* This refers to characteristics such as sharp, smooth and parallel edges, uniform width, and freedom from waviness and visible voids and breaks.
2. *Line Color:* This refers to the proper color, density or contrast to background, primarily for thick lines.
3. *Line Weight Progression:* This refers to the ability to produce a visually smooth progression of line weights.

Under Line Purity, smooth edges refer to freedom from both random variations (raggedness) and periodic variations (jaggedness).

Weight is the perceived aspect of width. For fine lines, small width at high density is indistinguishable from larger width at lower density. For thick lines, weight and width are equivalent.

Line Weight Progression proceeds from white (no line) to relatively high weight. Thus the smallest weight possible ("step-to-white") is implicitly included. Lines which are visibly broken are excluded from consideration, so broken fine lines could lead to higher "step-to-white". Good line weight progression, hence distinguishability of lines of slightly different width, is generally more important than accurate absolute width.

Since density and width are indistinguishable for fine lines, the Line Color sub-attribute applies primarily to thick lines. Line color rendition may be considered part of the W1.1 Color Rendition attribute, and is expected to be

dealt with by the corresponding *ad hoc* team. However, lines must at least be in the correct named color, e.g., red, green, blue, yellow, gray or black.

Line Quality Digital Test Patterns:

- Primary (C,M,Y,K) and secondary (R,G,B) horizontal and vertical colored lines at 100% and 50% coverage. These cover a linear progression of line widths.
- Angled black lines over a range of angles, including shallow angles.
- Concentric black circles at selected widths.
- Extended horizontal and vertical black lines at selected widths.
- Line spacing is maintained adequate to avoid measurement problems.

Text Quality

The Text Quality Attribute consists of three sub-attributes, analogous to those for Line Quality:

1. *Character Fidelity:* This refers to the visible faithfulness of the characters to the intended shape, including edge sharpness and smoothness, and freedom from plugging, voids, breaks, and erosion of serifs and corners.
2. *Text Contrast:* This refers to the perceived density or contrast to background, and to appropriate contrast between normal, bold and italic text.
3. *Text Uniformity:* This refers to the perceived uniformity of the text weight across characters of the same font, style and size.

Character Fidelity applies to errors in a given character. On the other hand, Text Uniformity and Text Contrast generally apply to groups of characters, such as a whole paragraph.

The term "typographic color" refers to the Text Uniformity and Text Contrast sub-attributes.

Text Quality Digital Test Patterns:

Draft digital test patterns are being developed. Currently, the test patterns have the following content:

- Emphasis is on 100% black text
- A complete set of alphanumeric and punctuation characters
- A range of text sizes, from 4pt to 12pt
- Custom serif and sans serif fonts with English, European and some Asian characters
- Normal, bold and italic text (no bold italic)
- A smaller selection of colored text is also included; primary (C,M,Y,K) and secondary (R,G,B) colored text at 100% and 50% coverage

The Text Quality of a printing system is affected not only by the print engine but also by the font data and the font renderer (or rasterizer). The proposed digital test patterns will allow testing of host-based printers with both the host fonts and custom fonts. Printers with an embedded emulation (such as PostScript or PCL) can, in addition, be tested with the printer resident fonts.

Measurement Techniques

Measurement techniques have not yet been addressed. Several instrumental measurement techniques for Line Quality are available, and these will be reviewed. Commonly available two-dimensional image capture devices such as scanners or cameras will be used if possible, rather than scanning microdensitometers. In order to make the measurements appearance-based, human visual models will be incorporated in the algorithms.

This team feels that instrumental measurement of Text Quality is virtually impossible. Visual measurement techniques will therefore be necessary, but with an emphasis on quantification. Specific visual evaluation procedures are being drafted. We expect that such evaluation will be done relative to "ideal" hardcopy versions of the test pattern, which will be developed.

Summary

The W1.1 Text and Line Quality team has defined the perceptual sub-attributes relevant to the Line Quality and Text Quality attributes. The essential features of the digital test patterns necessary to evaluate these attributes have been agreed upon, and draft versions of the test patterns have been generated. Measurement techniques have not yet been selected. Line Quality will be evaluated by instrumental measurement, while Text Quality will be evaluated by a visual method which will nevertheless yield quantitative results.

References

1. N. W. Burningham and E. N. Dalal, Status of the Development of International Standards of Image Quality, *Proc. PICS*, Portland, Oregon, 2000, p. 121-123.
2. E. K. Zeise and N. W. Burningham, Standardization of Perceptually Based Image Quality for Printing Systems (ISO/IEC JTC1 SC28 and INCITS W1.1), *Proc. NIP18*, San Diego, CA, 2002, p. 699-702.
3. E. N. Dalal, D. R. Rasmussen, F. Nakaya, P. A. Crean and M. Sato, Evaluating the Overall Image Quality of Hardcopy Output, *Proc. PICS*, Portland, Oregon, 1998, p. 169-173.

Biography

Edul N. Dalal chairs the INCITS W1.1 Text and Line Quality *ad hoc* team. He joined Xerox Corp. in 1983 with a Ph.D. in Materials Science. He is currently a Research Fellow as well as Technical Manager of the System Image Quality area at the Wilson Center for Research and Technology in Webster, NY. His research interests include Image Quality, Color Science, Polymer Physics and Surface Science.