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Information technology — Office equipment — Measurement of image quality attributes for hardcopy output — Monochrome text and graphic images

Technologies de l'information — Équipement de bureau — Mesurage des attributs de qualité d'image — Texte monochrome et images graphiques

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Foreword

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This document was prepared by ISO/IEC JTC 1, *Information technology*, Subcommittee SC 28, *Office equipment*.

This first edition of ISO/IEC 24790 cancels and replaces ISO/IEC TS 24790:2012 and ISO/IEC 13660:2001, which have been technically revised.

Introduction

This document is designed to help a quality control engineer evaluate the image quality of prints from office imaging systems.

In traditional imaging systems (such as ink-on-paper printing), an image is evaluated by comparison to an original or master version of that image. In many electronic imaging systems, however, the image is created digitally within the system. There is no hardcopy master and so there can be no evaluation by comparison in the ordinary way.

Often, those who operate electronic imaging systems ensure good image quality by controlling the imaging process. They use test targets and reference images to evaluate the performance of the system.

If it is not possible to control image quality by controlling the imaging process and if no test target or reference image is available, we can rely only on direct evaluation of properties of the image itself.

To perform intrinsic evaluations of image quality, consider the nature of an image that is an output. An image is some organization of information in space. We assume that these signals have some purpose or are making some attempt at communication. Good image quality means that the image is legible (the organization and information can be interpreted) and that it has a pleasing appearance.

Our goals in developing this document were to compile a list of image quality attributes that (taken together) correlate to human perception of print quality and to develop measurement methods for these attributes that can be automated and carried out on a simple system.

Legibility and appearance have several aspects:

— detail can be detected easily;

— image elements are well isolated from the background;

— the image has a minimum of gross defects;

— the imaging system has good geometric fidelity.

Not all these factors can be covered by evaluation of intrinsic, quantitative image quality attributes. Many of them have a large psychological or cultural component that is difficult to evaluate.

A print made with large optical reduction or one that is out of focus can still have excellent edge quality (and be totally lacking in gross defects, banding, noise, etc.) and yet be illegible. This could occur primarily because of the high process gamma (contrast) that is characteristic of many xerographic processes. Thus, the process can produce apparently sharp edges in spite of the loss in resolution. Without a resolution target of some kind, the extent of the resolution loss, and hence legibility, may not be known.

The purpose of this document is to present a set of objective, measurable attributes that give some correlation to the perceived quality of an image to a human observer at a standard viewing distance. This document allows a user of printed material to sort samples into several groups, from excellent to bad.

The attributes and methods for their assessment are based on several assumptions:

— the image represents an attempt at communication;

— there is uniformity within identifiable image elements;

— character images, symbols and graphic elements are regular (that is, they are intended to be identical when they have multiple, similar occurrences);

— samples with extreme gross defects have been screened out.

This document applies to monochrome images made up of text, graphics and other image objects with two tone levels of a single colour (typically black image on white paper) or halftones, images with more nominal gray levels. This document does not cover continuous tone images, colour images and so on.

Image quality measurement can be thought of as divided into diagnostic (high resolution) and visual scale (low resolution) procedures. Diagnostic measurements typically use precision test targets and instrumentation and are key to much engineering work. The present procedure, by contrast, is limited to phenomena visible to the naked eye and does not permit test patterns.

The working group has taken the approach of selecting simple and (in our judgment) effective metrics, rather than attempting to prove that our method of doing a given job will always be the most exact.

How will this document actually be implemented? A complete evaluation system has four components: an image capture device, evaluation software, application-specific quality standards and sampling plan. The end user may choose to develop all these parts himself or he may choose to purchase one or more components from a commercial supplier.

Any equipment capable of gathering data appropriate to these measurements is understood to have a complex instrument function. Rather than attempting to explore the relationship among these instrument functions, the working group has defined reference images and target values for them. If these target values are achieved by an instrument, calibration will be acceptably good.

This is not an attempt to break new ground in image science. It is an attempt to provide suppliers and customers for copies/prints with a practical and objective way to communicate about basic image quality parameters.

ISO/IEC 13660 was developed and standardized by the point of view described above. ISO/IEC 13660 is currently the only available systematic image quality attribute measurement standard. ISO/IEC 13660 has had a great influence on related industries and image quality measurement instruments based on ISO/IEC 13660 are already marketed. However, due to the limited development time, it was standardized with many issues unresolved and therefore, ISO/IEC 13660 has not been adopted as widely as expected. The main issues are listed as following:

a) the test chart and methods for measurement system conformance are only specified for some of character and line attributes. For large area graphic image quality attributes, neither test charts nor methods are specified. Eight items of image quality attribute for character and line image and six items of image quality attribute for large area graphic image are defined, and each measuring method is specified. Of the 14 image quality attributes, the conformance test method, the conformance test chart and the targeted value for measurement apparatus conformance are specified for only four of the character and line image quality attributes, leaving 10 of the image quality attributes with no conformance specifications;

b) physical measures (line width, large area voids) and psychophysical factors (darkness, graininess, etc.) are intermingled and are all defined as image quality attributes;

c) the goal values for measurement system conformance are available for only four character and line attributes, and the allowances are very large;

d) when one measures the character and line image quality attributes according to ISO/IEC 13660, the resulting values have large variation and they do not correspond well with subjective evaluations.

This document added the following content to ISO/IEC 13660 to resolve the issues which ISO/IEC 13660 had and to improve the measurement accuracy.

a) Banding which is a common image quality defect of the hard copy output in a printer or a copying machine is added as one of the image quality attributes of a large area graphic image.

b) Conformance test charts and the goal values for measurement system qualification are specified for three character and line image quality attributes and seven large area graphic image quality attributes.

c) The fundamental resolution of the scanner for measurement was increased from 600 spi to 1 200 spi to reduce the measurement variation.

d) Nearly all of the image quality attributes defined in ISO/IEC 13660 have been redefined in ISO/IEC 24790 to eliminate intermingling physical measures and psychophysical factors.

e) In order to improve the correspondence between image quality attributes and subjective evaluations, an image quality attribute measurement evaluation experiment was conducted on seven items (graininess, mottle, banding, line width, character darkness, blurriness and raggedness) of image quality attributes to select prediction algorithms for image quality attributes that have the highest correlation with subjective evaluation. The measurement evaluation experiment was conducted by five countries which includes Japan, U.S.A, China, South Korea and the Netherlands.

According to the measuring method of the image quality attributes chosen in the measurement evaluation experiment, the conformance chart was revised and a measurement tool which can measure automatically all the image quality attributes specified in this document was developed. An initial set of conformance chart goal values were defined using those tools, and ISO/IEC TS 24790 was published in 2012.

Experience with the use of the published Technical Specification over the following three years led to a second revision of the conformance chart, a revision of the conformance evaluation methods and a revision of the measurement tool. An international conformance chart measurement experiment was conducted to refine the conformance chart goal values and to establish realistic measurement tolerances for these goal values. This document is the result of this collective development and measurement experience.