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Optics and optical instruments — Quality evaluation of optical systems — Assessing the image quality degradation due to chromatic aberrations

Optique et instrument d'optique — Évaluation de la qualité des systèmes optiques — Estimation de la dégradation de la qualité de l'image due à des aberrations chromatiques

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15795 was prepared by Technical Committee ISO/TC 172, *Optics and optical instruments*, Subcommittee SC 1, *Fundamental standards*.

Annex A of this International Standard is for information only.

Introduction

Aberrations due to the variation of the refractive index with wavelength (dispersion) are usually termed “chromatic aberrations”. Originally, this wording was based on the fact that, in the presence of these aberrations, the image of objects such as points, lines and edges, exhibit coloured fringes in addition to the variation of luminance.

From this point of view, the concept of the point spread function (PSF) and the related optical transfer function (OTF), see ISO 9334, is basically a luminous (or more general radiative) transfer of optical information. There is only one signal regarding wavelength which is the result of the spectral transmission and sensitivity of the transmission chain, even if the latter is not identical to the relative luminous sensitivity of the human eye.

Nowadays, the terms “colour” and, more specifically, “chroma” in the domain of physical science are well defined by colorimetry according to CIE Publication Nr. 15.2 (see reference [1] in the Bibliography) and are restricted to that region of the electromagnetic spectrum, which is accessible to the normal (trichromatic) human observer.

However, when concerned with aberrations due to the dispersive behaviour of electromagnetic waves, it is necessary to take into account that the spectral region of the optical waveband is by far wider than the limits of sensitivity of the human eye. This region may extend from the UV to the medium IR. In such applications, the human visual process is not involved or, if so, only by means of certain translations of the information into the visual waveband.

Nevertheless, the fact of variation of the form and position of the point or line spread function with wavelength or with some spectrally weighted wavebands is still given. To characterize this dispersive behaviour, one has not to deal with colorimetry, but should describe the position and extent of the spread function relative to that of a certain reference wavelength or reference spectral weighting.

In this sense, the present International Standard will not deal with colour sensations, but the term “chromatic aberrations” is used in a purely physical manner to describe the wavelength dependent properties of such aberrations.

The variation of the spread function with wavelength in a given image plane of an optical system may be characterized by a lateral translation and additionally by a variation in form and width.

The lateral translation of a typical coordinate point of the spread function will be called lateral chromatic aberration, whereas the form and extent can be characterized by two numbers derived from a weighting procedure over the spread function (edge width).

The longitudinal chromatic aberration indicates the axial position of the best image plane for a certain wavelength or waveband with respect to a reference plane and for a defined focusing (or image quality) criterion.

Optics and optical instruments — Quality evaluation of optical systems — Assessing the image quality degradation due to chromatic aberrations

1 Scope

This International Standard defines terms relating to chromatic aberrations and indicates the mathematical relationships between those terms.

It also gives general guidance for the measurement of chromatic aberrations and is valid for optical imaging systems which are constructed to be of rotational symmetric imaging geometry. It is also valid for optoelectronic imaging systems.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 9334:1995, *Optics and optical instruments — Optical transfer function — Definitions and mathematical relationships*

ISO 9335:1995, *Optics and optical instruments — Optical transfer function — Principles and procedures of measurement*

ISO 9039:1994, *Optics and optical instruments — Quality evaluation of optical systems — Determination of distortion*

ISO 11421:1997, *Optics and optical instruments — Accuracy of optical transfer function (OTF) measurement*

3 Symbols and units

Symbol	Meaning	Unit	Specified in
λ	Measurement wavelength	nm, µm	4.2.1
λ_r	Reference wavelength	nm, µm	4.3
$W(\lambda)$	Weighted spectral distribution	dimensionless	4.2.2
$W_R(\lambda)$	Weighted spectral reference distribution	dimensionless	4.3
$u(\lambda)$	Local image field coordinate for measurement wavelength	µm	4.5
$u(\lambda_r)$	Local image field coordinate for reference wavelength	µm	4.5
$u(W)$	Local image field coordinate for weighted spectral measurement distribution	µm	4.5