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Optics and photonics — Quality evaluation of optical systems — Determination of distortion

Optique et photonique — Évaluation de la qualité des systèmes optiques — Détermination de la distorsion

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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 2.

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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 9039 was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 1, *Fundamental standards*.

This second edition cancels and replaces the first edition (ISO 9039:1994) which has been technically revised.

Introduction

Generally, the function of rotationally symmetric optical systems is to form an image that is geometrically similar to the object, except for some particular systems, such as fish-eye lenses and eyepieces, where this condition is deliberately not maintained. Ideally, this function is accomplished according to the geometry of perspective projection. Departures from the ideal image geometry are called distortion. The distortion is a position-dependent quantity which generally has a vectorial character. In a given image plane (which may also lie at infinity), this vector, representing the difference between theoretical and real image position, has a radial and a tangential component. In optical systems, the tangential component is basically conditioned by imperfect rotational symmetry. The systems manufactured in accordance with the present state of the art have a negligible tangential distortion. A tangential component of the distortion appears, however, as primary aberration in the case of electromagnetically focused electro-optical systems. This International Standard deals only with the radial distortion. For special systems, e.g. certain electro-optical systems, an expansion may become necessary to include vectorial representation.

Optics and photonics — Quality evaluation of optical systems — Determination of distortion

1 Scope

This International Standard specifies methods of determining distortion in optical systems for the purposes of quality evaluation. It applies to optical imaging systems in the optical spectral range from 100 nm to 15 000 nm which, by their design, aim at a rotationally symmetric image geometry. It is applicable to electro-optical imaging systems provided that adequate rotational symmetry of the image is guaranteed. It does not, therefore, apply to anamorphic and fibre optic systems.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
distortion
measure of the deviation of the extra-axial image points from the ideal image points in a given plane lying parallel to the reference plane of the system

NOTE If the image plane is at infinity, the image positions are given in terms of tangents of field angles.

2.2
reference plane
plane corresponding to a physical feature of the device under test which is used for alignment, e.g. a mounting flange or a fixture specially mounted for that purpose

2.3
absolute distortion
V_a
distance in the radial direction between the observed image point and the ideal image point, expressed in millimetres or micrometres

2.4
relative distortion
V_r
distance in the radial direction between the observed image point and the ideal image point, expressed as a percentage of the ideal image height h'_0

NOTE With the image at infinity, relative distortion is the difference between the tangents of the observed field angle and the ideal field angle, expressed as a percentage of the tangent of the ideal field angle ω'_0.

2.5
object height
h
distance between an object point and the axis of rotational symmetry of the test specimen, expressed in millimetres