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TECHNICAL REPORT

3D display devices –
Part 41-1: Holographic display – General information

colour inside

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CONTENTS

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FOREWORD

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IEC TR 62629-41-1, which is a technical report, has been prepared by IEC technical committee 110: Electronic displays.

The text of this technical report is based on the following documents:

Draft TR	Report on voting
110/1019/DTR	110/1066/RVDTR

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62629 series, published under the general title *3D display devices*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

This document is intended to gather technical information on holographic displays and to identify optical measurement items that would be required to characterize their performance.

3D DISPLAY DEVICES –

Part 41-1: Holographic display – General information

1 Scope

This part of IEC 62629 provides general information for the standardization of holographic displays.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
holographic display
three-dimensional display that generates light converging to each point of a three-dimensional image in space by light diffraction

3.1.2
complex amplitude
complex value representing the amplitude and phase as the light wave

3.1.3
wavefront
locus of spatial points that share the same phase of the light wave

3.2 Abbreviated terms

EOTF	electro-optical transfer function
FOV	field of view
FWHM	full width at half maximum
MTF	modulation transfer function
NA	numerical aperture
ROI	region of interest
SBP	space bandwidth product
SLM	spatial light modulator

4 Holographic display technologies

4.1 General

Holographic displays are considered as one of the promising displays that can present three-dimensional images with a natural sense of depth. Despite their potential advantages, requirements for high performance optical devices, especially spatial light modulators, and real-time computational power have delayed their development and commercialization. Recent advances on those optical devices and newly emerging potential applications, including augmented reality eyewear displays, vehicle head-up displays, and table-top displays, however, are stimulating active research and development activities in academia and industry. As of 2017, not only the research institutes but also many major companies [1 to 4][1] are developing holographic display techniques in various applications to prepare for their commercialization.

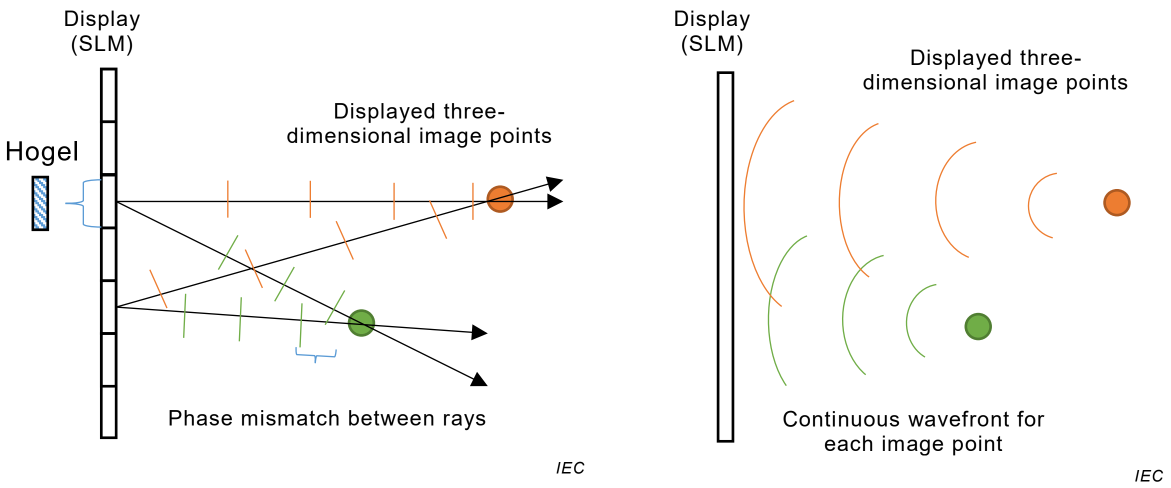
The properties of the holographic displays are largely different from other three-dimensional displays due to the fundamental difference in the image forming principle and thus standards on those three-dimensional displays cannot be applied to the holographic displays. Existing standards on holograms, for example ISO 17901-1 [5] and ISO 17901-2 [6], focus on the recording of analogue static holograms and the diffraction efficiency of their reconstructions and thus they do not cover the display aspect of the holographic displays.

A holographic display can be defined in different ways, for example:

1) display that generates light converging to each point of a three-dimensional image in space by light diffraction (see 3.1.1; this is the definition in a wide sense); or
2) display that generates a wavefront converging to each point of the three-dimensional images (this is the definition in a strict sense).

In the wide sense meaning, the holographic display includes a holographic stereogram that reconstructs different views of three-dimensional images while the strict sense meaning only includes displays that reconstruct the complex amplitude of the three-dimensional images in such a way that an individual image point is formed by the converging wavefront. The difference between the holographic stereogram and the holographic display in the strict meaning can be found in the continuity of the wavefront for each image point as illustrated in Figure 1. In the case of the holographic stereogram, the wavefront converging at the three-dimensional image point is continuous only piecewise while it is fully continuous in the holographic display in the strict sense. Since the wavefront is continuous only piecewise, the holographic stereogram can also be considered as a light field display that reconstructs light rays. However, this document covers both holographic display types as they share many optical characteristics in common.

[1] Numbers in square brackets refer to the Bibliography.



a) b)

Figure 1 – Holographic stereogram (a) and holographic display in a strict sense (b)

The characteristics that distinguish holographic displays from other autostereoscopic three-dimensional displays are as follows:

- the light source is coherent or at least partially coherent with limited linewidth;
- light modulated by an SLM is diffracted to form three-dimensional images, and this diffracted light is captured by the user's eye;
- the modulating pattern loaded to the SLM is not a single view or a combination of multiple views of a three-dimensional image, but an encoded pattern to diffract the incident coherent light to the desired directions. It can be the interference pattern between the incident light and the complex amplitude of the three-dimensional image, the phase pattern of the complex amplitude, or other patterns depending on the modulation type of the SLM and the encoding technique used.

Displays that are sometimes called "holographic displays" but are not considered in this document are:

– displays that use a static hologram to merely control the light path from the usual two-dimensional displays such as LCDs and OLEDs. Eyewear displays using holographic optical elements or diffractive optical elements are examples. In this case, the image is not a three-dimensional but a flat two-dimensional one. The light diffraction does not contribute to the formation of the three-dimensional image but is only involved in the control of the light path from the display to the user's eye. Autostereoscopic three-dimensional displays based on directional backlight implemented using pixelwise grating are not included in this document because the grating is a fixed element and does not contain information on the image;

– displays that form a real or virtual image of a display panel by using a partially reflecting mirror or imaging optics so that the display panel looks as if it is floating in space. In this case, the floating image is still two-dimensional;

– displays that focus a high power laser beam at a designated position in space to create laser plasma excitation with spontaneous emission. These types of displays can use holographic display techniques to create multiple focal spots in space simultaneously. However, these displays are not considered in this document because the diffracted light is not captured by the user's eye but the secondary emission from the laser plasma is captured, giving optical characteristics of the displayed images very different from those of the holographic displays covered in this document;

– displays that project diffracted light from the SLM to a diffusing screen, presenting a large two-dimensional image on the screen. These types of displays are classified into laser projection displays which are covered in other documents.