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Ergonomija medsebojnega vpliva človek-sistem - 310. del: Vidljivost, estetika in ergonomija napak svetlobnih točk (ISO/TR 9241-310:2010)

Ergonomics of human-system interaction - Part 310: Visibility, aesthetics and ergonomics of pixel defects (ISO/TR 9241-310:2010)

Ergonomie de l'interaction homme-système - Partie 310: Visibilité, esthétique et ergonomie des défauts de pixel (ISO/TR 9241-310:2010)

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Ergonomics of human-system interaction - Part 310: Visibility, aesthetics and ergonomics of pixel defects (ISO/TR 9241-310:2010)

Ergonomie de l'interaction homme-système - Partie 310: Visibilité, esthétique et ergonomie des défauts de pixel (ISO/TR 9241-310:2010)

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

The text of ISO/TR 9241-310:2010 has been prepared by Technical Committee ISO/TC 159 “Ergonomics” of the International Organization for Standardization (ISO) and has been taken over as FprCEN ISO/TR 9241-310:2015 by Technical Committee CEN/TC 122 “Ergonomics” the secretariat of which is held by DIN.

This document is currently submitted to the Technical Committee Approval.

Endorsement notice

The text of ISO/TR 9241-310:2010 has been approved by CEN as FprCEN ISO/TR 9241-310:2015 without any modification.

TECHNICAL REPORT

ISO/TR 9241-310

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2010-06-15

Ergonomics of human-system interaction —

Part 310: Visibility, aesthetics and ergonomics of pixel defects

Ergonomie de l'interaction homme-système —

Partie 310: Visibilité, esthétique et ergonomie des défauts de pixel

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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.org
Web www.iso.org

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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.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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/TR 9241-310 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*.

ISO 9241 consists of the following parts, under the general title *Ergonomic requirements for office work with visual display terminals (VDTs)*:

— *Part 1: General introduction*

— *Part 2: Guidance on task requirements*

— *Part 4: Keyboard requirements*

— *Part 5: Workstation layout and postural requirements*

— *Part 6: Guidance on the work environment*

— *Part 9: Requirements for non-keyboard input devices*

— *Part 11: Guidance on usability*

— *Part 12: Presentation of information*

— *Part 13: User guidance*

— *Part 14: Menu dialogues*

— *Part 15: Command dialogues*

— *Part 16: Direct manipulation dialogues*

— *Part 17: Form filling dialogues*

ISO 9241 also consists of the following parts, under the general title *Ergonomics of human–system interaction:*

— *Part 20: Accessibility guidelines for information/communication technology (ICT) equipment and services*

— *Part 100: Introduction to standards related to software ergonomics [Technical Report]*

— *Part 110: Dialogue principles*

— *Part 129: Guidance on software individualization*

— *Part 151: Guidance on World Wide Web user interfaces*

— *Part 171: Guidance on software accessibility*

— *Part 210: Human-centred design for interactive systems*

— *Part 300: Introduction to electronic visual display requirements*

— *Part 302: Terminology for electronic visual displays*

— *Part 303: Requirements for electronic visual displays*

— *Part 304: User performance test methods for electronic visual displays*

— *Part 305: Optical laboratory test methods for electronic visual displays*

— *Part 306: Field assessment methods for electronic visual displays*

— *Part 307: Analysis and compliance test methods for electronic visual displays*

— *Part 308: Surface-conduction electron-emitter displays (SED) [Technical Report]*

— *Part 309: Organic light-emitting diode (OLED) displays [Technical Report]*

— *Part 310: Visibility, aesthetics and ergonomics of pixel defects [Technical Report]*

— *Part 400: Principles and requirements for physical input devices*

— *Part 410: Design criteria for physical input devices*

— *Part 420: Selection of physical input devices*

— *Part 910: Framework for tactile and haptic interaction*

— *Part 920: Guidance on tactile and haptic interactions*

The following parts are under preparation:

— *Part 143: Form-based dialogues*

— *Part 154: Design guidance for interactive voice response (IVR) applications*

Requirements, analysis and compliance test methods for the reduction of photosensitive seizures and evaluation methods for the design of physical input devices are to form the subject of a future part 411.

Introduction

This part of ISO 9241 summarises information that ISO/TC 159/SC 4/WG 2, *Visual display requirements*, collected on pixel defects and their impact on aesthetics and ergonomics during preparation of ISO 13406 and other parts in the ISO 9241 "300" subseries. It uses terms and definitions from ISO 9241-302 and VESA FDPM[20].

It is based on research and reports that were available at the end of year 2005. The annexes contain information upon which the Working Group could not reach consensus, as well as some additional information, collected during the year 2006, that did not undergo the same review and analysis process as the earlier material.

Ergonomics of human-system interaction —

Part 310: Visibility, aesthetics and ergonomics of pixel defects

IMPORTANT — The electronic file of this document contains colours which are considered to be useful for the correct understanding of the document. Users should therefore consider printing this document using a colour printer.

1 Scope

This part of ISO 9241 provides a summary of existing knowledge on ergonomics requirements for pixel defects in electronic displays at the time of its publication. It also gives guidance on the specification of pixel defects, visibility thresholds and aesthetic requirements for pixel defects. It does not itself give requirements related to pixel defects, but it is envisaged that its information could be used in the revision of other parts in the ISO 9241 series.

2 Terms and definitions

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

2.1
pixel
smallest addressable spatial unit of a display that can show all the colours of the display

NOTE 1 Typical pixel heights for single-user displays range from 0,05 mm to 0,40 mm. Multi-user displays viewed from a distance use bigger pixel sizes.

NOTE 2 Adapted from ISO 9241-302:2008, definition 3.4.29.

2.2
subpixel
independently addressable unit of a pixel, the smallest addressable unit of a display, used for spatial dithering to change colour or luminance

2.3
pixel fault
defective pixel or subpixel that is visible under the intended context of use

[ISO 9241-302:2008]

2.4
pixel defect
pixels that operate improperly when addressed with video information

EXAMPLE A pixel addressed to turn black could remain white. If it never changes state, it is said to be a stuck pixel. If it changes state without the proper addressing signal, it could be intermittent.

[VESA FPDM 303-6]

2.5
stuck on pixel
bright pixel on a black background

NOTE A stuck on pixel can be observed using a black screen.

[VESA FPDM 303-6]

2.6
stuck off pixel
dark pixel on a white screen

NOTE A stuck off pixel can be observed using a white screen.

[VESA FPDM 303-6]

2.7
stuck dim pixel
grey pixel independent of a white or black background

NOTE A stuck dim pixel can be observed using a white and then a black screen.

[VESA FPDM 303-6]

2.8
defective column/row
complete column or row of pixel defects

[VESA FPDM 303-6]

2.9
partial
pixels or subpixels that have defective sub area of defects

EXAMPLE Part of the pixel is stuck on or off but the rest of the pixel works properly.

[VESA FPDM 303-6]

2.10
temporal and intermittent defect
(sub)pixel defect that exhibits temporal variations not related to any steady-state video input

NOTE Temporal defects can be intermittent, exhibit a sudden change of state, or be flickering. They can be observed using a white and/or a black screen.

[VESA FPDM 303-6]

2.11
defect cluster
more than one defect present in a cluster of pixels of a defined size, e.g. 5×5 pixels

[VESA FPDM 303-6]

2.12
fill factor
amount of the area producing useful luminance compared to the amount of the area allocated to the (sub)pixel

[VESA FPDM 303-3]

2.13
mura
Japanese word meaning blemish that has been adopted in English to provide a name for imperfections of a display pixel matrix surface that are visible when the display screen is driven to a constant grey level

NOTE Mura defects appear as low contrast, non-uniform brightness regions, typically larger than single pixels. They are caused by a variety of physical factors. For example, in LCD displays, the causes of mura defects include non-uniformly distributed liquid crystal material and foreign particles within the liquid crystal. Mura-like blemishes occur in CRT, FED and other display devices.

[VESA FPDM 303-8]

3 Review of research

3.1 Detection of spots

3.1.1 General

Detection of spots is somewhat different to detection of spatially periodic targets. The vision research on spatially periodic targets is more extensive than the research on spots. The main factors affecting the visibility of small spots are spot size, spot duration, interaction of size and duration, the oblique effect, light adaptation, location in the visual field and spatial uncertainty.

Reading research [25] showed that the human being has three contrast channels suitable for reading; luminance contrast, Red-Green contrast and Yellow-Blue contrast. In normal reading, the signal from the contrast channel with the strongest signal is used and the two other channels are ignored. Since reading is dependent on detection of character features, it can be assumed that the same mechanism is valid for spot detection.

Effects of defect colour on spot detection can thus be analyzed for the three contrast channels separately and the spot will be visible if one or more of the three contrast channels produces a signal that exceeds contrast threshold.

3.1.2 Spot size

3.1.2.1 General

For small spots the visibility threshold decreases as the target area increases (spatial summation). There are five different types of spatial summation to consider in the study of pixel defects: Piper's Law, Ricco's Law, S-cones and M- and L-cones.

Spatial summation explains why stuck on defects on a black background are more visible than stuck off defects on a white background. On a black background the bright spot is summed with its black background and the contrast between the summed area and its background remains high enough to be visible. On a white background the black spot and its bright surround are summed and the contrast between the summed area and its background rapidly becomes less than threshold, when the size of the summed area increases.