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Ergonomics — Accessible design — A method for estimating minimum legible font size for people at any age

Ergonomie — Conception accessible — Taille de police lisible minimale pour les personnes de tout âge

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Characters are widely used almost every time displays, documents, and other media for visual information are involved. Accessibility to printed or displayed text is one of the critical issues in this age of mass information, especially for older people. However, methods for designing and evaluating the legibility of characters have not been well established yet.

Most of the problems with legibility are concerned with appropriate font size to read text in various conditions. This problem is worse for older people whose visual acuity decreases with age, especially at near viewing distances. Provision of legible characters to older people at any viewing condition is becoming more important to enhance safety and comfort in their social activities.

The legibility of text has two major problems. One is concerned with legibility of single characters and the other one is for words and sentences where inter-character spacing or inter-line spacing is additionally investigated. The former one is the basic problem of legibility and can be extended to the legibility for words or sentences.

While there exist many factors that affect legibility of single characters, a limited number of critical factors can be identified as vision-related ones, which include age of the viewer, viewing distance, luminance and contrast. A method for estimating legible font size using these critical factors can be developed and generally applied to a wide range of practical cases. There can exist other critical factors concerning with physical aspects of presenting characters such as display characteristics and their environments[1], but these effects can be evaluated once the basic method based on human vision factors is established.

The legibility for people who have pathological disorders like low vision are not addressed in this document due to a lack of scientific resources as well as due to large individual differences in visual abilities among people with different types of impairments.

This document is based on principles of accessible design from ISO/IEC Guide 71[2] and on data from ISO/TR 22411[3].

Ergonomics — Accessible design — A method for estimating minimum legible font size for people at any age

1 Scope

This document provides a method for estimating minimum legible font size for single characters, but not for words or sentences, in self-luminous or reflected mode, used in documents, products labels, signs, and displays for people at any age and in any viewing condition in which viewing distance, luminance and contrast are varied.

This document applies designing and evaluating legibility of single characters for people at any age who have no pathological disorders in their eyes, but not for people with visual impairments such as low vision. The application is specifically directed to, but not limited to, the cases of printed materials where fixed font size is used.

Applicability of the method to other languages is given in Annex F.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 24502, *Ergonomics — Accessible design — Specification of age-related luminance contrast for coloured light*

3 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:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
visual acuity
V
<qualitatively> capacity for seeing distinctly fine details that have very small angular separation <quantitatively> any of a number of measures of spatial discrimination such as the reciprocal of the value of the angular separation in minutes of arc of 2 neighbouring objects (points or lines or other specified stimuli) which the observer can just perceive to be separate

[SOURCE: CIE S 017/E:2011]

3.2
viewing distance
D
distance between the eye and the object to look at

Note 1 to entry: Expressed in meters in this document.

3.3
luminance correction coefficient
coefficient for correcting the effect of luminance on *visual acuity* (3.1) relative to the acuity at the 100 cd/m^2 level

3.4
minimum legible font size
character size, expressed in unit of point, for a single character under which the character is not legible with less than 80 % probability at the specific viewing condition

Note 1 to entry: The unit of point is defined in this document as 1 pt = 0,351 4 in, which is used mainly in the US and Japan. Another definition is 1 pt = 1/72 inch = 0,352 77 in, mainly used in the EU. The difference is too small to have any influence on legibility.

Note 2 to entry: Minimum legible font size is a baseline of legibility and not at the comfort level of legibility (see Annex H)

4 Application conditions

For the application of the method for estimating the minimum legible font size, the following viewing conditions shall be specified:

a) age: the age of a person shall be from 6 years old to 90 years old;

b) viewing distance: the viewing distance shall be between 0,2 m and 100 m;

c) luminance: the luminance shall be between 0,01 cd/m^2 and 3 000 cd/m^2.

NOTE Luminance means the luminance of the surrounding area, not of the font, for the positive font type where a character looks darker than the background. In case of negative font type, where a character looks lighter than the surrounding area, luminance means that of the character.

d) contrast: the contrast, positive or negative, shall be between 0 % and 100 %, defined by Michaelson Contrast (see NOTE in Clause 6).

5 Estimation of minimum legible font size

The minimum legible font size shall be calculated by the following procedure. Calculation examples and application are given in Annexes C, D and E.

a) Select a visual acuity, V_0, at the luminance level of 100 cd/m^2 for a specified observer's age and for a specified viewing distance from Annex A.

b) Select a luminance correction coefficient, k, for a specified luminance, L (in cd/m^2), of the viewing condition from Annex B, and correct visual acuity to the one under the specified luminance using Formula (1).

$$V = kV_0 \tag{1}$$

where

V is a visual acuity under the specified viewing condition;

k is a luminance correction coefficient;

V_0 is the visual acuity at the luminance of 100 cd/m^2.

c) Calculate a size factor, S, using Formula (2).

$$S = D/V \tag{2}$$

where

S is the size factor;

D is the viewing distance (m);

V is the visual acuity under the specified viewing condition.

d) Calculate the minimum legible font size, P_{min} (in points), using Formula (3) with the size factor and coefficients given in Table 1 (see Annex G).

$$P_{min} = aS + b \tag{3}$$

where

P_{min} is a minimum legible font size (in points);

S is the size factor;

a and b are the formula coefficients given in Table 1.

Table 1 — Formula coefficients *a* and *b* in Formula (3)

Font type	*a*	*b*
Serif	8,2	2,6
Sans-serif	6,4	3,0

6 Correction by contrast effect

Formula (3) is based on the ideal case in which the contrast between character and background is 100 %. For practical cases where the contrast is less than 100 %, P_{min} obtained in Formula (3) shall be corrected by Formula (4) using a contrast correction coefficient, r, given in Table 2 (see Annex G).

$$P_{min,c} = r\,P_{min} \tag{4}$$

where

$P_{min,c}$ is the contrast corrected minimum legible font size (in points);

r is the contrast correction coefficient.

Table 2 — Contrast correction coefficients (font size multiplier) for different contrast levels in positive and negative contrast

Contrast	Positive-contrast	Negative-contrast
100	1,00	1,00
90	1,04	1,05
80	1,09	1,11
70	1,15	1,18
60	1,23	1,28
50	1,33	1,40

Table 2 *(continued)*

Contrast	Positive-contrast	Negative-contrast
40	1,46	1,57
30	1,66	1,84
20	2,01	2,32
10	2,89	3,68
5,0	4,45	6,62
2,5	7,75	17,99

For a coloured character and a background, the estimation of contrast shall follow ISO 24502.

NOTE Contrast in Table 2 is the modulation contrast defined as $(L_{max} - L_{mim})/(L_{max} + L_{min})$ where L_{max} and L_{min} mean the higher and the lower luminance of the modulation. The positive contrast means that luminance of a character is lower than that of the surrounding area and the negative-contrast is the opposite.

Annex A
(normative)

Visual acuity data as a function of age and viewing distance

A.1 Data table for visual acuity

Table A.1 provides numerical data of visual acuity for variable age of an observer and viewing distance at the reference luminance level of 100 cd/m^2. Age is expressed in year and given in rows, and viewing distance is expressed in meter and given in columns. Data are taken from JIS S 0032[5] and extrapolated to 6 years and to 90 years of age.

Table A.1 — Visual acuity as a function of age and viewing distance

Age years	Viewing distance m											
	0,2	0,3	0,5	1	2	3	5	10	20	30	50	100
6	1,498	1,621	1,726	1,810	1,853	1,867	1,879	1,871	1,866	1,865	1,864	1,863
8	1,361	1,512	1,645	1,752	1,808	1,827	1,842	1,831	1,825	1,823	1,822	1,821
10	1,237	1,411	1,567	1,696	1,764	1,787	1,806	1,792	1,785	1,783	1,781	1,779
12	1,125	1,316	1,493	1,641	1,721	1,748	1,770	1,754	1,746	1,743	1,741	1,739
14	1,022	1,228	1,423	1,589	1,679	1,710	1,735	1,717	1,707	1,704	1,701	1,700
16	0,929	1,146	1,356	1,538	1,638	1,672	1,701	1,680	1,669	1,666	1,663	1,661
18	0,844	1,069	1,292	1,488	1,598	1,636	1,667	1,644	1,633	1,629	1,626	1,623
20	0,767	0,998	1,231	1,441	1,559	1,600	1,634	1,609	1,597	1,593	1,589	1,587
22	0,697	0,931	1,173	1,395	1,521	1,565	1,602	1,575	1,562	1,557	1,553	1,551
24	0,634	0,869	1,117	1,350	1,484	1,531	1,570	1,542	1,527	1,522	1,518	1,516
26	0,576	0,810	1,065	1,307	1,448	1,498	1,539	1,509	1,493	1,488	1,484	1,481
28	0,524	0,756	1,015	1,265	1,412	1,465	1,509	1,477	1,461	1,455	1,451	1,448
30	0,476	0,706	0,967	1,224	1,378	1,433	1,479	1,445	1,428	1,423	1,418	1,415
32	0,433	0,658	0,921	1,185	1,344	1,402	1,450	1,415	1,397	1,391	1,386	1,383
34	0,393	0,614	0,878	1,147	1,311	1,371	1,421	1,384	1,366	1,360	1,355	1,352
36	0,357	0,573	0,836	1,110	1,279	1,341	1,393	1,355	1,336	1,330	1,325	1,321
38	0,325	0,535	0,797	1,075	1,248	1,312	1,366	1,326	1,307	1,300	1,295	1,291
40	0,295	0,499	0,759	1,040	1,218	1,284	1,339	1,298	1,278	1,271	1,266	1,262
42	0,268	0,465	0,723	1,007	1,188	1,256	1,312	1,270	1,250	1,243	1,237	1,233
44	0,244	0,434	0,689	0,975	1,159	1,228	1,286	1,243	1,222	1,215	1,209	1,205
46	0,222	0,405	0,657	0,944	1,131	1,201	1,261	1,217	1,195	1,188	1,182	1,178
48	0,201	0,378	0,626	0,913	1,103	1,175	1,236	1,191	1,169	1,161	1,156	1,151
50	0,183	0,353	0,596	0,884	1,076	1,149	1,211	1,166	1,143	1,136	1,130	1,125
52	0,166	0,329	0,568	0,856	1,050	1,124	1,187	1,141	1,118	1,110	1,104	1,100
54	0,151	0,307	0,541	0,828	1,025	1,100	1,164	1,117	1,093	1,085	1,079	1,075
56	0,137	0,287	0,516	0,802	1,000	1,076	1,141	1,093	1,069	1,061	1,055	1,050
58	0,125	0,267	0,492	0,776	0,975	1,052	1,118	1,070	1,046	1,038	1,031	1,027
60	0,114	0,249	0,468	0,751	0,951	1,029	1,096	1,047	1,022	1,014	1,008	1,003

Table A.1 *(continued)*

Age years	Viewing distance m											
	0,2	0,3	0,5	1	2	3	5	10	20	30	50	100
62	0,103	0,233	0,446	0,727	0,928	1,007	1,075	1,025	1,000	0,992	0,985	0,981
64	0,094	0,217	0,425	0,704	0,906	0,985	1,053	1,003	0,978	0,970	0,963	0,958
66	0,085	0,203	0,405	0,681	0,884	0,964	1,033	0,982	0,956	0,948	0,942	0,937
68	0,077	0,189	0,386	0,660	0,862	0,942	1,012	0,961	0,935	0,927	0,920	0,915
70	0,070	0,176	0,368	0,638	0,841	0,922	0,992	0,940	0,915	0,906	0,900	0,895
72	0,064	0,165	0,351	0,618	0,821	0,902	0,973	0,920	0,895	0,886	0,879	0,874
74	0,058	0,154	0,334	0,598	0,800	0,882	0,953	0,901	0,875	0,866	0,860	0,855
76	0,053	0,143	0,318	0,579	0,781	0,863	0,935	0,882	0,856	0,847	0,840	0,835
78	0,048	0,134	0,303	0,560	0,762	0,844	0,916	0,863	0,837	0,828	0,821	0,816
80	0,044	0,125	0,289	0,543	0,743	0,826	0,898	0,844	0,818	0,810	0,803	0,798
82	0,040	0,116	0,275	0,525	0,725	0,808	0,880	0,826	0,800	0,792	0,785	0,780
84	0,036	0,109	0,262	0,508	0,708	0,790	0,863	0,809	0,783	0,774	0,767	0,762
86	0,033	0,101	0,250	0,492	0,690	0,773	0,846	0,792	0,765	0,757	0,750	0,745
88	0,030	0,095	0,238	0,476	0,673	0,756	0,829	0,775	0,748	0,740	0,733	0,728
90	0,027	0,088	0,227	0,461	0,657	0,739	0,813	0,758	0,732	0,723	0,717	0,712

Annex B
(normative)

Luminance correction coefficient to visual acuity

B.1 Data table for luminance correction coefficient

Table B.1 provides the luminance correction coefficient which is used to obtain visual acuity at different level of luminance from the reference level of 100 cd/m^2 by using Formula (1). Table B.1 is given for the luminance range from 0,01 cd/m^2 to 3 000 cd/m^2. Data are taken from JIS S 0032[5].

Table B.1 — Relative visual acuity as a function of luminance normalized at the 100 cd/m^2 level (luminance correction coefficient)

Luminance cd/m^2	Luminance correction coefficient	Luminance cd/m^2	Luminance correction coefficient
0,01	0,028	10	0,757
0,02	0,101	20	0,830
0,03	0,144	30	0,873
0,04	0,174	40	0,903
0,05	0,198	50	0,927
0,06	0,217	60	0,946
0,07	0,233	70	0,962
0,08	0,248	80	0,977
0,09	0,260	90	0,989
0,1	0,271	100	1,000
0,2	0,344	200	1,036
0,3	0,387	300	1,057
0,4	0,417	400	1,072
0,5	0,441	500	1,083
0,6	0,460	600	1,093
0,7	0,476	700	1,101
0,8	0,491	800	1,108
0,9	0,503	900	1,114
1	0,514	1 000	1,119
2	0,587	2 000	1,155
3	0,630	3 000	1,176
4	0,660		
5	0,684		
6	0,703		
7	0,719		
8	0,734		
9	0,746		