



**International
Standard**

ISO 9241-920

**Ergonomics of human-system
interaction —**

**Part 920:
Tactile and haptic interactions**

*Ergonomie de l'interaction homme-système —
Partie 920: Interactions tactiles et haptiques*

**Second edition
2024-10**

This document is a preview generated by EMS



COPYRIGHT PROTECTED DOCUMENT

© ISO 2024

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

	Page
Foreword	vi
Introduction	vii
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Applying ISO 9241-920	2
4.1 Recommendations.....	2
4.2 Conformance.....	3
5 Tactile/haptic inputs, outputs and/or combinations	3
5.1 General guidance on tactile/haptic inputs, outputs and/or combinations.....	3
5.1.1 Optimizing performance.....	3
5.1.2 Providing accessible information on tactile/haptic elements.....	3
5.1.3 Providing contextual information.....	3
5.1.4 Identifying system state.....	4
5.1.5 Minimizing fatigue.....	4
5.1.6 Providing alternative input methods.....	4
5.1.7 Maintaining coherence between modalities.....	4
5.1.8 Combining modalities.....	5
5.1.9 Presenting realistic experiences.....	5
5.1.10 Isolation of individual interface elements.....	5
5.2 Intentional individualization.....	6
5.2.1 Enabling users to change modalities.....	6
5.2.2 Enabling force feedback override.....	6
5.2.3 Force feedback control.....	6
5.2.4 Force feedback indication.....	6
5.2.5 Enabling users to limit force feedback.....	6
5.2.6 Enabling users to individualize tactile/haptic parameters.....	6
5.3 Unintentional user perceptions.....	7
5.3.1 Limiting acoustic output of tactile/haptic display.....	7
5.3.2 Limiting heat gain of contact surface.....	7
5.3.3 Avoiding sensory adaptation.....	7
5.3.4 Recovering from sensory adaptation.....	7
5.3.5 Avoiding unintended perceptual illusions.....	7
5.3.6 Preventing temporal masking.....	8
6 Attributes of tactile and haptic encoding of information	8
6.1 High level guidance on tactile/haptic encoding of information.....	8
6.1.1 Using familiar tactile/haptic patterns.....	8
6.1.2 Making tactile/haptic encoding obvious.....	8
6.1.3 Conformity to user expectations.....	8
6.1.4 Using sensory substitution.....	8
6.1.5 Using appropriate spatial addressability and resolution.....	9
6.1.6 Using tactile apparent location.....	9
6.1.7 Tactile display of high spatial resolution.....	9
6.1.8 Using higher addressability for trained users.....	9
6.1.9 Using tactile apparent motion.....	9
6.1.10 Preventing spatial masking.....	9
6.2 Guidance on specific tactile/haptic attributes for encoding information.....	10
6.2.1 Selecting properties for encoding information.....	10
6.2.2 Discriminating between attribute values.....	11
6.2.3 Limiting the number of attribute values.....	11
6.2.4 Combining properties.....	11
6.2.5 Limiting complexity.....	11
6.2.6 Encoding by object shape.....	11

6.2.7	Encoding information by temporal pattern.....	11
6.2.8	Encoding information using vibration amplitude.....	12
6.2.9	Encoding information by vibration frequency.....	12
6.2.10	Encoding by body location.....	12
6.2.11	Encoding by temperature.....	12
6.2.12	Encoding by thermal conductivity.....	12
6.2.13	Identifying information values.....	13
6.2.14	Encoding information using electrotactile amplitude.....	13
6.2.15	Encoding information by electrotactile frequency.....	13
6.2.16	Waveform for electrotactile feedback.....	13
6.2.17	Polarity of electrotactile output.....	13
7	Content-specific tactile/haptic encoding.....	13
7.1	Encoding and presenting text data.....	13
7.1.1	Text presentation speed.....	13
7.1.2	Text presentation layout.....	13
7.1.3	Text shape presentation.....	14
7.1.4	Text presentation surface contrast.....	14
7.1.5	Text presentation size.....	14
7.2	Encoding and presenting data through information haptification.....	14
7.2.1	Displaying information in tactile/haptic graphics.....	14
7.2.2	Complexity of information haptification.....	14
7.2.3	Maintaining orientation in information haptification.....	14
7.2.4	Perceivability of information haptification.....	15
7.2.5	Texture discriminability in information haptification.....	15
7.2.6	Consistency of information haptification.....	15
7.2.7	Combinations of text and graphics in information haptification.....	15
7.2.8	Learnability of information haptification.....	15
7.2.9	Using grids on tactile/haptic graphs.....	15
7.2.10	Using landmarks in tactile/haptic maps.....	15
7.2.11	Providing scales for tactile/haptic maps.....	16
7.3	Encoding and using controls.....	16
7.3.1	Using tactile/haptic controls.....	16
7.3.2	Using size and spacing of controls to avoid accidental activation.....	16
7.3.3	Use of electrodes.....	16
7.3.4	Avoiding difficult control actions.....	16
7.3.5	Using force to avoid accidental activation.....	16
7.3.6	Support user safety.....	17
7.3.7	Interacting with virtual controls.....	17
8	Design of tactile/haptic objects and space.....	18
8.1	Tactile/haptic display spaces.....	18
8.1.1	Ease of perceiving multiple tactile/haptic objects.....	18
8.1.2	Ease of identifying adjacent tactile/haptic objects.....	18
8.1.3	Maintaining separation between surfaces of objects.....	18
8.1.4	Separating tactile/haptic elements.....	18
8.1.5	Using consistent labels.....	18
8.1.6	Tactile/haptic label design.....	18
8.1.7	Avoiding empty spaces.....	19
8.1.8	Avoiding volume limits.....	19
8.1.9	Avoiding falling out of the tactile/haptic space.....	19
8.2	Objects.....	19
8.2.1	Using appropriate object size.....	19
8.2.2	Creating tactile/haptic symbols from visual symbols.....	19
8.2.3	Discriminating tactile/haptic symbols.....	19
8.2.4	Tactile/haptic object angles.....	20
8.2.5	Tactile/haptic object corners.....	20
9	Interaction.....	20
9.1	Navigating tactile/haptic space.....	20

ISO 9241-920:2024(en)

9.1.1	Providing navigation information.....	20
9.1.2	Supporting path planning.....	20
9.1.3	Providing well-designed paths.....	20
9.1.4	Making landmarks easy to identify and recognize.....	20
9.1.5	Providing appropriate navigation techniques.....	20
9.1.6	Providing navigational aids.....	21
9.1.7	Understanding the tactile/haptic space.....	21
9.1.8	Supporting exploratory strategies (procedures).....	21
9.2	Reconfiguration.....	21
9.2.1	Reconfiguring the tactile/haptic space.....	21
9.2.2	System-initiated reconfigurations.....	21
9.2.3	Maintaining user's sense of location during reconfiguration.....	22
9.3	Interaction techniques.....	22
9.3.1	Implementing interaction techniques.....	22
9.3.2	Avoiding unintended oscillation.....	22
Bibliography.....		23

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.

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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 122, *Ergonomics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 9241-920:2009), which has been technically revised.

The main change is as follows:

- The document has been updated to reflect newer research in tactile/haptic interactions.

A list of all parts in the ISO 9241 series can be found on the ISO website.

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

Tactile and haptic interactions have become increasingly important interaction modalities. Mobile interaction relies on gesture-based touch interaction and tactile/haptic control devices and can utilize vibration-based displays as one of several ways to provide information or experiences to the user. Touch, vibration and tactile/haptic interactions are also found in special-purpose computing environments (e.g. simulation, remote control or surgery) and in assistive technologies.

While considerable research exists, a lack of ergonomic standards in this area can possibly result in systems being developed without sufficient concern for either ergonomics or interoperability, leading to serious difficulties related to ergonomics for users of multiple incompatible or conflicting tactile/haptic devices or applications.

This document provides ergonomics requirements and recommendations for tactile and haptic hardware and software interactions, including guidance related to the design and evaluation of hardware, software and combinations of hardware and software interactions. The guidelines are not technology-dependent and will also be applicable to future technologies.

ISO 9241-910 provides a common set of terms, definitions and descriptions of the various concepts central to designing and using tactile/haptic interactions. It also provides an overview of the range of tactile/haptic applications, objects, attributes and interactions.

ISO 9241-940 provides ways of evaluating tactile/haptic interactions for their usability, the validation of requirements and the verification that systems meet the requirements.

ISO 9241-960 focuses on gestures as a specific type of tactile/haptic interaction and describes their features and usability requirements. Information on gesture-based interfaces can be found in the ISO/IEC 30113 series. Information on contactless gestures can be found in ISO TS 9241-430.

For guidance and recommendations on the accessibility of tactile/haptic interactions, including information on the use of braille, see ISO 9241-971. It does not provide recommendations specific to braille but can apply to interactions that make use of braille.

Ergonomics of human-system interaction —

Part 920: Tactile and haptic interactions

1 Scope

This document specifies requirements and recommendations for tactile/haptic hardware and software interactions. It provides guidance on the design and selection of hardware, software and combinations of hardware and software interactions, including:

- the design or use of tactile/haptic inputs, outputs and/or combinations of inputs and outputs, with general guidance on their design or use as well as on designing or using combinations of tactile and haptic interactions for use in combination with other modalities or as the exclusive mode of interaction;
- the tactile/haptic encoding of information, including textual data, graphical data and controls;
- the design of tactile/haptic objects;
- the layout of tactile/haptic space;
- interaction techniques.

The recommendations given in this document are applicable to a variety of tactile/haptic devices, representing the real world or virtual or mixed realities (e.g. exoskeletons, wearables, force feedback devices, touchables, tangibles) and stimulation types (e.g. acoustic radiation pressure, electrical muscle stimulation) and they can also be found in virtual and augmented environments.

This document provides general information about how various forms of tactile/haptic interaction can be applied to various user tasks.

This document does not include guidance on the role of walking in virtual or mixed realities for tactile/haptic interaction.

NOTE It is recognized that some interactive scenarios can be constrained by the limitation that a real workspace is to be modelled in a virtual environment. Objects can be in suboptimal positions or conditions for tactile/haptic interaction by virtue of the situation being modelled.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

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