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Ergonomics of human-system interaction —

Part 960:
Framework and guidance for gesture interactions

Ergonomie de l'interaction homme-système —

Partie 960: Cadre et lignes directrices relatives aux interactions gestuelles

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

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

Introduction

Tactile and haptic interactions are becoming increasingly important as candidate interaction modalities in computer systems such as special purpose computing environments (e.g. tablets), wearable technology (e.g. tactile arrays, instrumented gloves), and assistive technologies.

Tactile and haptic devices are being developed in university and industrial laboratories in many countries. Both the developer and the prospective purchaser of such devices need a means of making comparisons between competing devices and common design of interactions.

This document focuses on gestures and identification of gesture sets as a specific type of tactile/haptic interaction. It explains how to describe their features, and what factors to take into account when defining gestures.

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 9241-920 provides basic guidance (including references to related standards) in the design of tactile/haptic interactions.

ISO 9241-940 (under preparation) is to provide ways of evaluating tactile/haptic interactions for various aspects of interaction quality (such as haptic device attributes, logical space design and usability).

Ergonomics of human-system interaction —

Part 960:
Framework and guidance for gesture interactions

1 Scope

This document gives guidance on the selection or creation of the gestures to be used in a gesture interface. It addresses the usability of gestures and provides information on their design, the design process and relevant parameters that are to be considered. In addition, it provides guidance on how gestures should be documented. This document is concerned with gestures expressed by a human and not with the system response generated when users are performing these gestures.

NOTE 1 Specific gestures are standardized within ISO/IEC 14754 and the ISO/IEC 30113 series.

NOTE 2 Input devices such as tablets or spatial gesture recognition devices can capture gestures in 2D or 3D. All human gestures are 3D.

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 9241-910, *Ergonomics of human-system interaction — Part 910: Framework for tactile and haptic interaction*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9241-910 and the following apply.

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

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

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

3.1
feedforward gesture information
information provided by the *gesture interface* (3.4) to maintain consistency of a body part's movement with predicted single or multiple gesture trajectories

EXAMPLE A gesture might be visualized through inking the trajectory on the display. Several choices of possible future trajectories can be inked, thereby helping the user to complete the gesture.

Note 1 to entry: Feedforward gestural information improves self-explanation of the gestural interface.

3.2
gesture
movement or posture, of the whole body or parts of the body

Note 1 to entry: Operation of a physical keyboard is not addressed in this document.

[SOURCE: ISO/IEC 30113-1, 3.1]

3.3
gesture command
instruction to the system resulting from a gesture input by the user, e.g. select, move, delete

[SOURCE: ISO/IEC 14574:1999, 4.5]

3.4
gesture interface
user interface that provides information and controls for a user to accomplish specific tasks with the interactive system by his/her *gestures* (3.2)

[SOURCE: ISO 9241-171:2008, 3.29 — Modified]

3.5
gesture set
grouping of gestures and their mapping to *gesture commands* (3.3)

EXAMPLE The conductor of a virtual orchestra uses a gesture set for a music performance.

3.6
intentional gesture
movement of the body or parts of the body to achieve a purpose

3.7
stroke gesture
intentional gesture (3.6) consisting of a movement trajectory of any part of the body

Note 1 to entry: As with other gestures, the definition refers to the movement itself, rather than its effect. Different gesture commands, including direct manipulation, could be defined for a stroke gesture.

Note 2 to entry: The gesture command is not dependent on the extent of the movement trajectory.

Note 3 to entry: Pressure can be used as a parameter of the gesture.

3.8
direct manipulation
dialogue technique by which the user has the impression of acting directly on objects on the screen; for example by pointing at them, moving them and/or changing their physical characteristics (or values) via the use of an input device

[SOURCE: ISO 9241-16:1999, 3.6]

4 General

4.1 Need for a standard on gesture usability

When pointing devices such as the mouse were developed in the 1960s, movement of the human hand became part of interactive systems. It took until the mid-1980s for the mouse to become standard in the office context. With the advent of multi-touch displays and 3D cameras, gestures appear to be a highly usable alternative to a tiny keyboard on a mobile device. The wide use of gestural interfaces makes it important to consider their usability.

4.2 Usage

Gestures may accompany language in order to strengthen what has been said. Such gestures are described in linguistics as “deixis” (pronounced “dīk-sis” or “dāk-sis”). The term “deixis” refers to words such as in “Put that there” which require contextual information provided by pointing in order to be fully understood. Gestures may convey their own meaning inherent to the actual movement of some body part and independent of some tangible physical object such as a pen or mouse. When using a pointing device while gesturing, the information and communication technology (ICT) system often restricts the movements because of limitations in the ability of the movement-tracking device. Gestures, like language, are culture-specific and misunderstandings may arise from inappropriate use of them.

4.3 Intentional and unintentional gestures

In designing gesture sets, emphasis is often placed on adopting gestures that are intentional or unintentional with respect to the system. A typical example of an intentional gesture is pointing at an object in order to select it, or waving your hand in front of a door to open it. Unintentional gestures in this context are gestures made for some other purpose (e.g. walking towards an automatic door, sitting down in the driver seat of a car), or gestures made subconsciously (e.g. body language). Such unintentional learnable gestures are particularly suited to general situations where the user might not be trained, when the user must learn the system quickly, or when the user must use the system under conditions of stress (e.g. time pressure).

Intentionality in gestures could also enable increased discriminability between them, thereby reducing inadvertent activation. For example, when it is desired not to activate an automatic door, many people stand still and avoid gesturing in front of the doors, knowing they are prone to open unintentionally.

4.4 Matching gestures and functionality

A gesture is the result of the user's intention to create a message for a recipient or computer while mapping it to the movement of the body or parts of the body, typically the upper limbs. Figure 1 illustrates variations of the intention applicable when gestures are expressed to an ICT system. The user on the left is interacting with a gesture interface on the right, using a selection of gestures from a gesture set. The user has an intention to transmit, and can make use of posture and movement. His choice of gestures may be intentional, or unintentional, depending on the situation. The gesture interface could provide feedback on the system's interpretation of the gesture, or even feedforward information to aid the user in completing the gesture (see 6.2 for further guidance on gesture features).

There is a continuum between interpreting gestures when controlling physical artefacts, such as directly manipulating a slider, and interpreting a gesture as some abstract symbol. Another continuum of mappings exists between matching gesture sets with the functionality of an interactive system overall and its context of use.

Identification of unintentional gestures is often avoided by requiring the user to signal the start and end of a gesture explicitly through some technical approach such as touching/releasing a screen with the fingers. All such touches will be interpreted as intentional gestures.

Mappings should take existing manual operations such as handwriting into account. Simple handwriting might be applicable to gestural interpretation but, typically, handwritten language is far more complex than a gesture vocabulary.

The matching process is applicable to user-centred design principles and, therefore, evaluation methods can be applied. ISO 9241-940 provides guidelines on how to evaluate gestures to be used with tactile/haptic devices. Some user groups can have special needs. In addressing them, a special set of gestures might be required, or completely different input alternatives might be needed.

EXAMPLE 1 A multi-touch gesture consisting of circulating thumb and forefinger around each other while touching a screen can be interpreted as a gesture command to change the orientation of an image. However, it can also be seen as the direct manipulation of the image's orientation if its presentation is updated continuously.

EXAMPLE 2 Switching between intentional and unintentional gestures occurs commonly on haptic devices. Blind people read braille with a finger while touching a braille display. At the same time such finger movements can express some intentional or unintentional gesture, if the braille display is touch sensitive. Technically, disambiguation can be based on the position or speed of movement of the finger over the tactile display. On one hand the reader can read braille being not aware of any such monitoring, on the other hand the intention can be formed to turn reading movements into gestural input.

NOTE The overall gestural interaction between the user and the ICT system is not discussed here and requires further guidance.

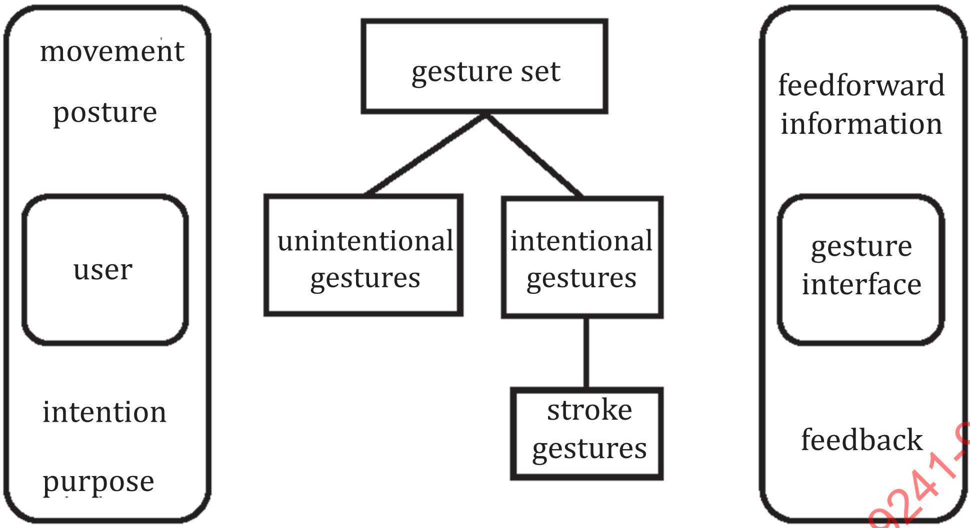


Figure 1 — Overview of gestures made by a user for a gesture interface

5 Ergonomics of gestures

5.1 Ergonomic constraints and features

Gestures that are performed repetitively should not create unnecessary fatigue in the body parts which are to be posed or moved during the gesture.

a) Users should be involved in determining the need for such repetitions.

b) If repetitive gesturing is unavoidable, hazard identification, risk estimation, risk evaluation and risk reduction should be performed in order to avoid musculoskeletal disorders.

NOTE 1 On vertically mounted touch-screens the "gorilla-arm-syndrome" can be observed after long periods of gestural input. The gorilla-arm-symptom refers to fatigue in placing and moving the unsupported arms in front of the body.

NOTE 2 Children and those with reduced dexterity and joint mobility might produce less pronounced gestures.

5.2 Device capabilities

A device for receiving gestures should have the capability of detecting the trajectory of a stroke or a pose within all conditions imposed by the environment. The gesture set is defined for the entire context of use.

NOTE A single touch or multiple touches at the same time are examples of poses to be recognized by all devices capable of recognizing gestures.

5.3 Device constraints

A device for receiving gestures can restrict the trajectory or pose that a human intends to form. The user should be made aware of these restrictions.

NOTE 1 Digitizing pens can be designed to write when the tip approaches a surface and delete if the opposite end of the pen is used (eraser end). The reference point for pen gestures is either the tip of the pen or the eraser. The user can be made aware of the spatial volume within which the gesture could be performed by designing the grip of a pen symmetrically or asymmetrically.

NOTE 2 When using a camera based system for 3D gesture recognition, the user benefits from being made aware of the area the camera is able to cover.

6 Guidance in defining gestures

6.1 Process for gesture definition

6.1.1 General

The process for gesture definition shall follow the guidance provided by ISO 9241-210 and should consider the principles outlined in ISO 9241-110 where appropriate.

Gestures have particular benefits and drawbacks with respect to the seven ergonomic principles expressed in ISO 9241-110 and which are illustrated in the following.

a) Gestural input could be the only style of interaction with a system suitable for completing tasks (the primary task).

b) Gestural interfaces can support self-descriptiveness by, for example, feedforward of gestural information, but they often require memorization.

c) Gestures should be suitable for learning and may become procedural knowledge. However, gestures tend to be forgotten if not used regularly. This might be addressed by documentation of gesture sets, or by a training sequence whereby gestures might be learned with the system in “safe” mode.

d) Controllability of gestural interaction is often limited, since an aborted gesture is an incomplete gesture and hence no gesture command can be determined. A gesture set may be combined with accompanying feedback supporting gesture formation in order to improve the usability of the interaction.

e) Consistency of gestures could depend on the context of use and the device when gestures are being used. Consistency can be improved if pre-existing gestures can be utilized in designing an interactive system.

f) Gestures are suitable for individualization, for example, by accepting user-defined gestures and by provision of mechanisms to change the mapping of gestures and gesture commands. Individualization can also be achieved by designing several gestures for the same purpose.

g) In order to achieve error tolerance, users should be made aware of the device's ability to process intentional gestures.

6.1.2 Exploring the design space

6.1.2.1 Explore design space generally

The potentially available design alternatives, including the design rationale, should be explored for the intended users and contexts of use.

6.1.2.2 Widely explore human movements

a) The investigation should include not only the hands, but also limbs, and full body movements as well as head and eye movements and other facial expressions.

b) The gesture interface typically needs to be useable for a wide range of users. Alternative body parts for gestures, range of motion, tolerance of tremors, ability for simultaneous action, and ability to walk should be considered for better accessibility.

EXAMPLE 1 Often, the forefinger of the dominant hand is considered for pointing. However, the use of thumb or forefinger of the non-dominant part might be used for pointing equally well. In some cultures, pointing with the chin is common and natural.

EXAMPLE 2 To repeat sound information, a pointing gesture (click on a button) can be applied, but shaking a hand-held device might be used instead.

EXAMPLE 3 To get information about a location, you might click on a point of interest in a map, while an alternative way to request the same information is to walk to the location in question.

EXAMPLE 4 A drawing can be generated with a hand-held pen (hand gestures) while a person without hands may use their foot to accomplish the same task.

EXAMPLE 5 On-screen gestures designed for two-handed use may be performed in a one-handed manner by a person holding an object in the other hand.

6.1.2.3 Explore single and synchronized simultaneous movements

Exploration of gestures should consider not only movement of single body parts but also synchronized coordinated movements of multiple body parts.

EXAMPLE 1 A multitouch gesture, such as dragging fingers together, may be more suitable for grouping than dragging items individually using single touch.

EXAMPLE 2 A multitouch gesture such as pointing by the forefinger and tapping by another finger can allow blind people to explore a mobile device by spoken feedback and to subsequently select an item.

EXAMPLE 3 Using two hands (e.g. clapping) can be an intuitive gesture of command (e.g. attention).

6.1.2.4 Explore simultaneous and sequential movements

Exploration of gestures should consider both simultaneous and sequential movements.

EXAMPLE A user communicating with an assistive robot may first point to an object of interest, then gesture for the robot to "fetch" the object.

6.1.2.5 Explore movements made by multiple users

a) The design should include consideration of gestures performed by multiple users independently as well as gestures formed collaboratively by two or more users.

b) Social acceptance of gestures should be considered. Gestures performed in the personal space might be considered inappropriate.

EXAMPLE 1 A handshake can be used in a gestural interface between a user and a system that is aware of social signs or formalities.

EXAMPLE 2 Social robots can be programmed to perceive, interpret, and return a head-bowing gesture.

6.1.3 Identifying purposes

Developers shall identify the purposes for which humans need to express gestures in relation to the ICT system.

EXAMPLE The volume of a TV might be changed by a gesture; other functions such as channel changing, muting or initiating recording could be considered.

6.1.4 Designing gestures and gesture commands

6.1.4.1 Developer-defined gestures

Developers should identify at least one gesture for each gesture command based on the following sources of gestures, in order of descending priority:

a) pre-existing gesture in the culture;

b) internationally standardized gestures;

c) gestures suggested by one or many users;

d) gestures suggested by the context of use;

e) gestures from other contexts of use;

f) gestures typical to the devices being used;

g) gestures suggested within a design team.

People sharing the same culture or social setting often share the same gestures. When designing a gesture set, these pre-existing gestures should be identified and considered for inclusion in a gesture set.

NOTE Gestures may serve different purposes in completing a task depending on different social or cultural contexts. Most gestures do not have invariable or universal intention.

6.1.4.2 User-defined gestures

User-defined gestures can be used as alternatives for pre-defined gesture commands or as additional gestures for other outcomes/actions/functions.

User-defined gesture sets should be available over a wide range of contexts of use and across devices when appropriate.

NOTE 1 User-defined gestures support accessibility in that they allow users to tailor the gestures to their abilities and needs.

NOTE 2 Some users might want to modify the range of movements to be considered within a gesture set.

6.1.4.3 Identify variability of gestures

The error tolerance of the gesture movement should be determined and shall be commensurate with 6.6.4.

EXAMPLE A database of gestures recorded from users in a particular context might be analysed to identify the similarity of each gesture. Variability is often related to differences in speed of movement, size, orientation, and the body parts involved.

6.1.5 Organizing gesture sets

Gestures may be organized into a gesture set according to guidance in 6.6.

6.1.6 Evaluating gestures

Developer-defined gestures shall be evaluated to ensure they meet the needs of the intended users within the intended contexts of use.

NOTE ISO 9241-940 provides further information on evaluation of tactile/haptic interaction.

EXAMPLE 1 A gesture is effective if users are able to identify the purpose of the gesture.

EXAMPLE 2 When developing new stroke gestures, low-fidelity prototyping, such as painting gestures by fingers, might be utilized to identify the gestures.

EXAMPLE 3 Video sketching allows recording a mock-up of gesturing together with spoken commands, such as the explanation “next page”.

EXAMPLE 4 A "Wizard of Oz" study allows mocking up of gesturing together with the system response mimicked by a human.

6.1.7 Iterating the gesture interface

The design process of the gesture interface should be iterative according to ISO 9241-210, taking both the interactive system and its context of use into account.

6.1.8 Documenting gestures

Documentation of gestures should be suitable for the intended users and contexts of use (see 6.7).

6.1.9 Explaining gestures

Gestures and gesture commands shall be described in documentation available to the user. This documentation should be offered at the initialization of the gestural interface.

Training users in gestures

a) Users should be able to explore gestures without adversely affecting system content.

b) Users should be able to explore the possible trajectories or poses involved in a gesture.

NOTE A training mode is a useful tool to allow the user to explore the gestures available in a system.

6.2 Features of gestures

6.2.1 Mapping of gesture commands to functions

Designers of gestures should ensure that the mapping of the gesture command to a function is consistent with user expectations.

NOTE 1 Multiple gestures may be assigned to the same function.

NOTE 2 The same gesture may have different purposes in different contexts within the application.

NOTE 3 A gesture might modify the application context for one or more following gestures.

EXAMPLE 1 A pointing gesture may mean “bring that object” or “go there” depending on context or modality.

EXAMPLE 2 A single stroke gesture could be used to change pages or to move an object, depending on the application context.

6.2.2 Nested gestures

In pursuing a secondary task, specific gestures might be performed while a primary task is underway (or halted).

NOTE This might lead to micro gestures if the palm is already grasping some object and only fingers can be moved.

EXAMPLE 1 In the primary task, a user might be touching a virtual globe using a finger while performing eye gestures to control zooming in a secondary task.

EXAMPLE 2 When controlling, for example, a steering wheel, the arm/hand combination might already be creating some force on the grip while a finger on the same hand creates gestures for choosing options in a menu.

EXAMPLE 3 In accessibility, reading braille may be combined with gestures to end reading movements and initiate spoken feedback. In this example, the hands may even change their role in pursuing the primary and secondary tasks.

EXAMPLE 4 In sign language, hand signs are combined with facial expression in order to disambiguate the hand signs.

EXAMPLE 5 A conductor might simultaneously use gestures to continually communicate tempo and coordinate introduction or emphasis of particular instruments.

6.2.3 Feedback for stroke gestures

If feedback is generated for a gesture, the user should be made aware of strokes not recognized as part of a gesture.

NOTE 1 The user might not need feedback from the application, such as from visualizing its trajectory, if kinaesthetic feedback is sufficient.

NOTE 2 Typically up to 95 % of stroke gestures are recognized correctly in existing systems.

EXAMPLE A gesture might accompany other input methods such as speech, such that erroneous recognition of the gesture command is reduced by combining the processing of speech with the gesture.

6.2.4 Continuous feedback for gesture commands

Continuous gesturing should not require interruptions or pauses in the movement in order to gain feedback.

EXAMPLE Conducting a virtual orchestra with one's hands is a continuous sequence of command gestures.

NOTE Audio response to a symbolic gesture is typically determined within 100 ms. Other modalities might require faster feedback.

6.2.5 Use of feedforward information for stroke gestures

When designing feedback for stroke gestures, information should be considered from the feedforward feature. Figure 2 a) shows inking for a stroke gesture. A feedforward response speeds up the completion of a gesture by anticipating the next part of the gesture [see Figures 2 b) and c)]. In addition, once the gesture interface identifies a gesture command, the user should not be required to continue the gesture to the end of the movement.

a) b) c)

Figure 2 — Stroke gesture with feedforward information

NOTE Users would be able to explore alternatives when receiving feedforward information while forming a gesture.

6.2.6 Parameters of gesture commands

Variations of gestures can be used as modifications of a gesture command. Users should be able to identify such parameters.

EXAMPLE 1 The direction of drawing of a circle might zoom the scale of a map in or out. The user could identify the two variants of circle gestures as “right” and “left”, or “clockwise” and “counter-clockwise”, or “zoom-in” and “zoom-out”.

EXAMPLE 2 Tapping the hands against the thighs could be used to communicate “come here”, tapping them several times may signify “come quickly” (as in “come here now!”).

6.3 Timing and speed

6.3.1 Recognition of a gesture at different speeds

A device should be able to recognize the same gesture made at different speeds.

6.3.2 Use of the speed of a gesture

The duration of a gesture should not affect its functionality, unless speed is included as a parameter of the gesture.

NOTE Gestures having different dynamic or kinematic features can invoke different functions.

EXAMPLE There is a speed difference between a flick and a stroke, as a flick might involve rotating the hand along the arm's axis while a stroke only bends the elbow in order to move a finger. A flick on a panel in a computer display could cause it to fill the screen, while a stroke of the panel could merely move it about the screen.

6.4 Tolerance of gesture interface

The gesture interface should be designed to support a sufficient variety of movements while being able to distinguish between intentional and unintentional gestures.

NOTE 1 Training could change the speed of gestural input and/or decrease the size of the trajectory.

NOTE 2 6.6.4 also identifies the need for discriminability.

6.5 Sequences of gestures

6.5.1 Beginning a gesture

Users should be able to indicate the beginning of an intentional gesture clearly, so that the user is able to avoid the unintentional start of some functionality of the interactive system.

6.5.2 Feedback on gesture initiation

The ICT system’s ability to interpret gesture commands should be clearly indicated to the user.

6.5.3 Completing the purpose of a gesture

The user should be made aware of the completion of the gesture command.

6.5.4 Feedback on gesture completion

Feedback for gestures may be ongoing during the gesture’s movement.

6.5.5 The need for transition between gestures

If the device for gestural input needs to be reset to its initial state for further gestural input, the user should be made aware of any extra movements needed.

6.5.6 The effect of transitions between gestures

Extra movements that form a transition between gestures should be considered.

EXAMPLE 1 When combining continuous movements to form two stroke gestures, such as a circle followed by a swipe, a circular movement might be continued until the proper starting point for the second stroke is reached.

EXAMPLE 2 When using an instrumented glove, a simple hand posture or button-press may be used to indicate the beginning or end of a gesture.

6.5.7 Overlapping gestures

Gestures can be overlapping if multiple body parts are involved in the process of performing them.

EXAMPLE Arm movements may indicate "follow me" with one arm, while another gesture could indicate distance of follow (near or far).

6.5.8 State changes

Where changing states impact the functionality of a gesture, the system should notify the user that the state has changed and provide the user with a means of identifying the current state of the system.

NOTE It is important this information is made available in the same modality as other feedback for gestures.

EXAMPLE 1 An alarm clock might be turned off by a gesture only after the alarm has been triggered. An ongoing alarm signals the specific mode of this device and at the same time readiness for gesture processing.

EXAMPLE 2 A gesture recognition system provides an alert if the source of power (e.g. battery) is low.

6.6 Gesture sets

6.6.1 General

Gestures can be identified by eliciting them from many sources including users themselves. Gestures should be grouped within a gesture set. A gesture set improves consistency of gestures. Often, its mapping to gesture commands is domain-specific. If the user is allowed to individualize gestures, alternative gestures can extend the gesture set and specify further gesture commands.

6.6.2 Purpose of a set of gestures

Each gesture within a gesture set should be designed for a purpose (see 6.1.3), a device and a context.

NOTE Gesture sets consisting of the same gestures can be designed for multiple devices and several contexts.

EXAMPLE Gestures designed for use by military personnel (e.g. to control robots) could use the same gestures used for person-to-person communications.

6.6.3 Consistency among gestures

Gestures within a gesture set should be sufficiently similar so that remembering one gesture should enable the ready recall of another gesture in the set.

NOTE Documentation of gesture sets can make it easier to recall gestures from that set (see 6.7).

6.6.4 Discriminability of gestures

Gesture sets should be designed to allow the user to discriminate between gestures.

NOTE The required level of discriminability is determined by evaluation with users having a wide range of capabilities. Several types of evaluation with users are possible — test tasks in a lab setting, observation in normal use, and others.

6.6.5 Subsets within a gesture set

Some gestures may be reserved for certain purposes, ensuring consistency of gestures across multiple applications.

6.6.6 Alternative subsets within a gesture set

Alternative gestures should be provided for the needs of specific users.

NOTE 1 People with a disability, such as people with tremor, might require alternative subsets.

NOTE 2 Subsets might be enabled by gestures common between subsets.

6.7 Documentation of gestures

6.7.1 Documentation

The documentation of each gesture should include

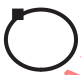
- the name of the gesture,
- a visual description of the shape of the gesture, e.g. drawing, animation or video,
- a textual description of how to form the gesture, and
- a description of the gesture's mapping to the purpose.

NOTE A framework of gestures could be applied to describe such a mapping.

EXAMPLE 1

Name: Zoom

Shape:



Description: This stroke gesture is started by touching a display. It consists of a continuous circular movement made by one finger and performed either in a clock-wise or anti-clockwise direction. The size of the circle can be small if only the finger is moved or large if both finger and hand are moved. The speed is approximately constant. The circle may be started at any point and this starting point is also approximately the end point.

Purpose: This gesture command changes the scale of a map. Clockwise movement decreases the scale, anti-clockwise movement increases the scale.

EXAMPLE 2

Name: Freeze

Shape:

Description: This posture-based gesture can be made from a variety of starting points. Recognition of the gesture is based on alignment of the arm, straight from the shoulder, and bent upward from the elbow, with the hand forming a fist.

Purpose: This gesture communicates the message to stop movement immediately. In this case, the gesture is communicated to tactile belts worn by other users.

6.7.2 Naming a gesture

a) The name should be:

— specified in the language of the intended users;

— unambiguous within the context of use;

— easy to learn and memorize;

— concise.

b) The name may reflect the purpose of the gesture.

6.7.3 Visualization of gestures

Visual documentation of gestures should indicate:

— a start point;

— an end point;

— the trajectory of any motion in the gesture;

— the direction of any motion along the trajectory;

— which body parts are involved;

— the sequence of any forces involved in the gesture.

NOTE A posture has the same start and end points.

6.7.4 Textual documentation of a gesture

a) Textual documentation of a gesture should include:

— the physical interaction considered as the start of the gesture;

— the physical interaction components (e.g. body parts or device manipulated by the users) involved in this gesture, including:

  — their physical relationships;

  — their temporal relationships;

— a description of the movement and forces involved:

  — start points and end points;

  — the trajectory of a gesture and the direction of motion along the trajectory;

  — timing (including speed, pauses, acceleration);

  — force, if appropriate;

  — variability of these properties,

— additional information as appropriate, e.g. ergonomic and technical capabilities influencing the gesture.

b) A description of a gesture should be described from the user's perspective in compliance with the characterization of orientation and direction of movements as described in ISO 1503.

c) A description of a gesture may include reference to the limitations or capabilities of a device.

d) If there are intellectual-property ownership factors to consider with any gestures not defined by the users themselves, documentation of gestures should include information on such ownership.

NOTE A taxonomy might help to develop a consistent textual documentation. See Annex B and the bibliography for typical taxonomies of gestures.

6.7.5 Describing the purpose of the gesture

The expected response or outcome of the system in response to the gesture should be described in the documentation and comply with the purpose identified according to 6.1.3.

6.7.6 Documenting a gesture set

a) Where applicable gestures should be grouped into appropriate sets according to 6.6.

b) Where applicable, all gestures within a gesture set should be identified and made available to the user.

c) A gesture set should have a meaningful and unique name within the context of use.

6.7.7 Documenting gestures with common movements

If gestures within a gesture set have commonalities in their trajectories, the documentation should indicate clearly both the commonality and how each gesture within the gesture set is unique.

Annex A
(informative)

When to use applications of gestures and gesture commands

A.1 Gestures in art and creativity

A.1.1 General

Gestures are an essential part of arts. From dance to the playing of musical instruments or conducting, gestures communicate information. Different devices and sensors might be used to detect these gestures and eventually issue gesture commands.

A.1.2 Acting

The motion of the human body allows not only dance and dramatic expression but also the mapping of such gestures to animated characters. Thus, full-length films with virtual actors can be produced with life-like action, since the actions were indeed translated from the motions of actual actors.

A.1.3 Music

Musical instruments have evolved with the aid of electronics and utilize gestures. While traditional stringed and woodwind instruments require manipulation with the arms, hands and fingers, novel instruments might be stroked, banged or plucked to produce a wide range of sounds. One musician might wield a “T-stick”, a one-metre rod equipped with accelerometers and pressure points that can produce synthesized sound in response to rod movements in translation and rotation. Another might use her hands to manipulate and distort the electromagnetic field around a theremin, producing haunting sounds especially suited to a certain genre of science fiction film. Others might strike the keys of a thumb piano (flexible steel bars projecting into the user's workspace) or finger-trace doodles on a tablet computer to produce rhythmic sounds (as a “sound blip” races around the doodled figures).

A.1.4 Painting

Gestures can be used in painting, but in a way that is different from the performing arts. A number of programs allow the equivalent of finger painting on tablet computers. With such a gesture interface, a user can create digital paintings using finger strokes over a photo image. Such strokes might be termed haptic gestures. Similar movements are involved in digital sculpture, using tools such as “Digital Clay” software with either a 3-DOF haptic interface or motion sensors that recognize hand gestures in free space.

A different use of the term “gesture” is found in “gesture drawings” — sketches that set out the basic layout of a planned painting — the pose of the face, the orientation of the backbone of a human figure, for example. Such a usage falls outside the scope of the present standard, but the digital brush strokes themselves might be termed gesture commands, especially if made on a touch tablet computer interface as opposed to the manipulation of a standard computer mouse.

A.2 Gestures in gaming

A.2.1 2D gesture commands

Many of the gestures within the gaming technology have arisen to emulate pre-technology gaming gestures, as found in actions such as hitting or throwing a hypothetical ball (e.g. “pong”) or aiming/shooting (e.g. “centipede”). Such early computer-interaction gestures arose with early technology such as a roller ball or mouse. Gesture-based controls allow, for example, a transition from the highly prescribed 2-D gestures of mouse/roller ball control to more freeform 2-D touchscreen-based gestures (e.g. "polar bowling", "angry birds") available on any smartphone. Specialized gaming controllers enable whole-body gestures for gaming control. Accelerometer-based controllers include devices that are held by the user [e.g. Wii[1)]] or worn (e.g. haptic glove), that assess 3-D aspects of user movement, and usually are based on arm and hand gestures. Motion-sensing clamps can be attached to everyday objects, thus creating a gesture-based controller. These devices, hand-held or worn, may be augmented by floor-based sensors allowing additional assessment of leg and foot movements (e.g. dance-based games).

A.2.2 3-D Gesture commands

3-D camera technology enables more fine-grained assessment of whole-body movements [e.g. Kinect[1)]]. Such technology integrates depth sensors, multi-array microphones, and high-fidelity RGB (red/green/blue) cameras to better assess movement characteristics. This allows even more emulation of realistic movements (e.g. golf, bowling, archery, etc.). This technology also enables movement-based diagnosis, training and rehabilitation of whole-body movements.

Thus, gestures in gaming reflect the progression from more prescribed technology-limiting movements to more complex and free form movements. These range from short, linear 2D movements of a single hand or finger, to multi-limb 3D coordination involving aspects of tempo over time.

A.2.3 Training gesture commands

In gaming, the aspects of realism affect gestural characteristics. A motion may be complex, involving coordination and training, and yet reflect the intuitive nature of gesture, as generalized from familiar context, and therefore will enable ease of expression. Transfer of training is from prior experience, particularly of gestures in first-person gaming scenarios (e.g. actor-based). Such gestures would be complex and yet intuitive.

In gaming, aspects of performance and competition affect the nature of gesture development and use. gestural control that, while at first simple, may require increased precision and complexity. In this case, the nature of the gesture in itself contributes to the experience of entertainment.

Transfer of training of gesture-based controls may also generate new applications for control gestures used in gaming technology. Training and experience with game controllers has resulted in a ready population of experienced game controllers. This expertise has then generalized to the design of operational robotic controllers across a range of occupations.

Key considerations in the design of gesture-based gaming controllers in general are the ease of learning and the ease of use. Principles generated for implementation in gaming environments apply also to gesture control in general.

A.3 Gestures in mobile devices

A.3.1 Mobile environment

Mobile devices are used in a wide range of different contexts. Whenever a person wants to do something, the action takes place in the current context. ISO 9241-210 defines context of use as "Users, tasks, equipment (hardware, software and materials), and the physical and social environments in which a product is used". People rely on their abilities and experiences to handle different situations in the here and now. Mobile use situations can vary widely, and circumstances that put users and systems to the test are far from extraordinary. Users move quickly and effortlessly from situation to situation and from context to context, and mobile products and services need to be designed for user experiences that are equally dynamic. Thus, the mobile context presents a whole range of challenges. When testing mobile devices, one needs to identify the particular challenges relating to the contexts relevant for the specific product to be tested, but there are also general challenges anyone needs to consider.

1) This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

A.3.2 Attention/cognitive load

It is rare to find a product used in a situation where the users are able to focus exclusively on using the product. Instead, there are people and/or things in the environment that require attention and cognitive effort — the device is a part of an activity, not the goal of the activity. This also means that the context (including other applications on the same device) may require all of the user's attention, something every mobile application or service needs to be able to handle.

A.3.3 Visual interference

Vision (or really the inability to see what is on the screen) ties in with attention. When you attend visually to the environment you cannot look at the screen at the same time. But there are also other environmental factors like sunshine, rain or dust that can make it hard to see details on the screen.

A.3.4 Noise

Many office environments are quiet (especially if you have your own room and can close the door), but this is not true for many other situations where maps and location-based services are used. Traffic, trains and other people create a noisy environment — but there may also be sounds one needs to attend to. In addition, there are situations where sounds coming from a device are disturbing.

A.3.5 Shaking or vibrations

External vibrations or shaking can make it hard to interact and sense the feedback. In mobile situations this is very common — on public transport, in cars, while walking or cycling you experience vibrations or shaking that limit your ability to feel and interact.

A.3.6 Limitations to the ability to manipulate

Situations that limit a user's ability to manipulate a device are quite common. If you hold a child by the hand, push a pram, carry a bag, hold an umbrella, carry a mug of coffee or hold and eat an ice cream your ability to interact with a device is limited — in particular two-handed interaction gets difficult.

A.3.7 Factors influencing the ability to touch the device

Holding things in your hand limits your ability to touch the device — but one also needs to consider that the device is not always held. It can be in a pocket or in a bag. If it is cold the user may also be wearing gloves.

The mobile situation is also inherently dynamic, and users quickly switch between different situations and contexts. Any testing of mobile designs also needs to pay close attention to the dynamics of mobile usage.

A.4 Gestures in accessibility and by the elderly

A.4.1 General

Research on the usability of gestures for elderly people is still at its beginning. In older people, for example, the movement of hands may be less precise and the speed behaviour might be different. Allowing longer time for pointing, more variability, reduced space, or more freedom in choosing the technology (free space vs. touch) might be desirable.

Gestures are in use by people with a disability, and specific preferences arise from special needs.

A.4.2 People who are deaf

Gestures have led to a well-recognized silent language in many language communities. Often, sign language follows a spoken language. Although discontinued in the education of people who were deaf in the 19th century, it has been taught again since the 1970s. In addition, sign language has for the last few decades been studied for its linguistic features, and in many countries it is accepted as an official language (for example, in a court of law). Some sign languages are based on spelling alphabetic characters, but more common is a signing vocabulary with grammatical rules for signing. This includes transitions between signs, establishing references points for pronouns and creating proximity within the signing space.

A.4.3 People who are deaf-blind

While sign language generally requires no touch, people who are deaf-blind do touch their dialogue partner. Several gestural vocabularies are in place for communication. In Germany, USA, Netherlands, Czech Republic, the speaker's forefinger touches the receiver's hand at different positions once or twice, or wipes over it in lines and circles to perform spelling (after Hieronymus Lorm, 1821-1902). Developed in Norway, the Tadoma system requires the receiver to touch the lips, cheek and neck to observe a speaker. The Nissen-Alphabet is performed by gesturing on the back of the hand. In other countries, tapping on the back of the receiver is preferred.

A.4.4 People who are blind

As gestures do not necessarily require visual feedback, people who are blind utilize them in interactive systems. Reading braille might have to be distinguished from gesturing, as is typical for situations where touch might trigger unintended gesture commands (also known as "Midas touch"). (Midas was a mythological person who would turn objects to gold on touching them, making them useless for their intended application.)

Multitouch operation of touch displays enables blind people to explore the display contents, or receive spoken feedback corresponding to the position of the touch. Input similar to a mouse click may be triggered by tapping only with a second finger while pointing with another finger. This ensures that the reference point is maintained. Many approaches allow blind people to gesture by referring to the physical shape of the display, such as gesturing along the edges of a touch display. Depending on the smart phone screen reader, swiping gestures may be used extensively in order to step though the controls and content on the display. Gesture recognition within tactile braille displays allows, for example, speeding up the hand movement towards the end of the braille line, and interaction continues with spoken feedback after the hand is lifted from the touch sensitive tactile display.

A.4.5 People with a physical disability

Gesturing with rehabilitation robots allows severely disabled wheelchair users to control the robot's operation and manipulate physical objects. Hand gestures or even head gestures may reduce stress when operating some types of input device. The shape of gestures is trained with a particular user in order to capture the user's motor behaviour. In this context, the (invisible) strengthening of muscles has been utilized for gestural control of input to computers. Detecting such gestures is typically achieved through bio signals detected on the human skin.

A.5 Gestures in robotic control

A.5.1 General

The use of gesture-based controllers for robot control follow, in large degree, the advancements built into gaming controllers. Their technology reflects the progression from keyboard-based controllers to hand-held controllers involving more complex haptics. Current robot control devices apply many of the same features and configurations as game-based controllers.

Further advances in technology enable more complex gesture-based control, to portray direction information (e.g. pointing), through use of wearable (e.g. haptic glove), hand-held, or camera-based technology.

A.5.2 Telepresence

While gestures have been used for control of overall robot movement, haptic and gesture-based controls also enable more fine-grained control of robot components (e.g. robotic arm). There, emulation of movement and pressure enable naturalistic control of movements such as grasping, lifting, or pouring.

While gestures and corresponding gesture recognition capabilities can be said to be ever-increasing in complexity, it can be argued that the goal for robot control is to enable a natural experience of telepresence. The user perceptions and use of gesture control ought to enable the experience of first-person control, with no need for repetitive training. First-person control might be achieved by wearing goggles with a display as well as by recognizing arm gestures in order to achieve a high level of immersion, for example, when operating a remote lever.

While gestures for other purposes may elicit effort (e.g. experience of fatigue) for purposes such as training, rehabilitation or entertainment, gestures for robot interaction must consider realism (e.g. minimization of cognitive effort) with physical or psychomotor demand. Gestures that are physically or cognitively effortful, albeit natural and discoverable, while suitable for short-term use, may need modification for sustained operations.

Many challenges abound, and it is likely that the use of gesture-based cues will be integrated into a multisensory context, including speech. For example, speech would be an intuitive and complementary means of conveying a message such as “Go to the second building of the three straight ahead on the left, and hide on the southwest corner facing the east”. Gaze recognition will also likely be integrated, such that the robot will use both user head orientation and gaze-based cameras to better translate gestural, spoken and video-based cues. In this case, gestures will likely predominate to indicate direction and movements, such as “stop”, “go there”, or “come here”, such that the user and the robot will recognize the start, content, ending, and meaning of a particular gesture, with minimal effort.

A.6 Gestures in smart home environments

A.6.1 General

3D gestures unaided by hand-held devices are beneficial in a smart home environment. Many devices beyond mobile phones and tablet computers are suitable for gestural interaction in a Smart Home.

A.6.2 Smart TVs

Operating a Smart TV by 3D gestures reduces the need to look for a remote control. Gestures in front of a TV with an infrared camera can control volume or switch channels. Gestures made by the forefinger can navigate among detailed menu options while a gesture performed by the thumb makes a selection. If multiple users are in the same room face recognition can help to disambiguate the user in control of the TV from other people present.

A.6.3 Smart security devices

A smoke alarm is temporarily disabled by waving an arm when cooking is foreseen to give rise to some short-term smoke. This type of sensor could be further connected to other types of security sensors, for example for detecting intruders. Gestural interaction and in particular pointing can be supported to distinguish arming/disarming some of these sensors individually.

NOTE See, for example, ISO/IEC 27001 and ISO 39001 for information on the terms “safety” and “security”.

A.6.4 Interaction with ubiquitous computing

Controlling light for its intensity and colour is also suitable to 3D gestural interaction. This could include control of window blinds, as it is more and more common to motorize these.

Designing gestures for ambient intelligent systems requires the harmonization of many gesture sets created for different devices built into a house but of which the user is possibly unaware.

