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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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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.

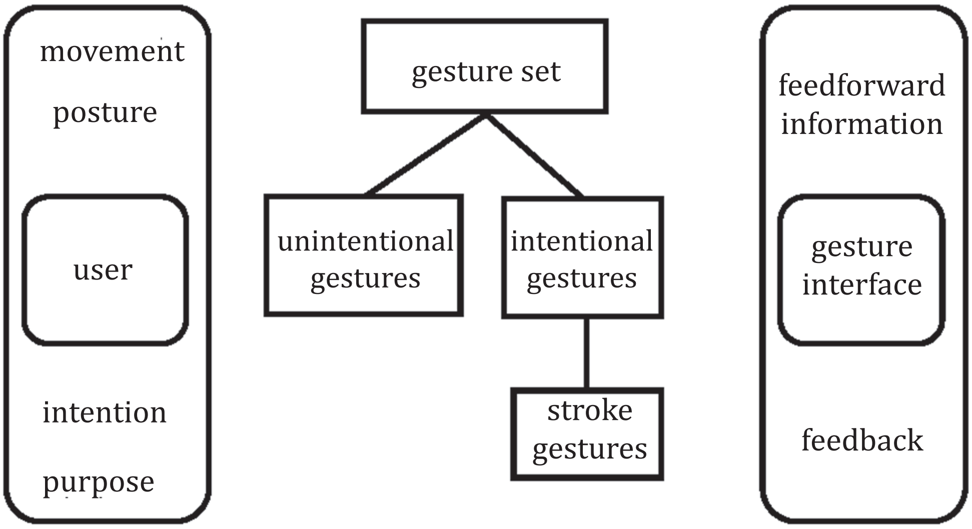

Figure 1 — Overview of gestures made by a user for a gesture interface

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.

