The GOTHI Model of Tactile and Haptic Interaction

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ABSTRACT

The paper presents the GOTHI model of tactile and haptic interaction. The GOTHI-05 workshop (October 2005) brought researchers together to develop a collection of ergonomic guidance and a framework for organizing this guidance. After a number of individual presentations, the participants worked together to develop a model of tactile and haptic interaction. The inaugural meeting of ISO TC159/SC4/WG9 further refined this model and adopted it as the basis for a new standard ISO 9241-920 Ergonomics of human-system interaction — Guidance on tactile and haptic interactions.

Categories and Subject Descriptors

H.5.2 User Interfaces, *Ergonomics, Haptic I/O, Input devices and strategies,* D.2.0 Software Engineering General, *Standards*

General Terms

Human Factors, Standardization

Keywords

Tactile, haptic, interactions, interface object, reference model, standards.

1. INTRODUCTION

The participants of GOTHI-05 (Guidelines on Tactile and Haptic Interactions) set about to construct a model that can be used to organize guidance on and development of various tactile and haptic interactions. They recognized that different models can apply depending on the perspective of their intended audiences. Procurers / buyers / managers need simple answers and want to apply the model without needing to understand it. Developers (including students learning to be developers) need to understand what is needed but may not want to be constrained to specific programming details. Programmers need specific programming details. The resulting model is aimed at the needs of developers and students learning to be developers. However, it is recognized that people fulfilling other roles may benefit from this organization of information.

This paper provides the first report of the model that they developed and which was reviewed and adopted, with minor enhancements, by ISO TC159/SC4/WG9 further refined this model and adopted it as the basis for a new standard ISO 9241-920 Ergonomics of human-system interaction — Guidance on tactile and haptic interactions.

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2. THE GOTHI-05 MODEL
The following model was developed for organizing guidance on tactile and haptic interactions. It can also be used to review whether or not all of these topics have been considered in the design of tactile / haptic interactions.

2.1 The High Level Model
The main components of the GOTHI-05 model include:

- Tactile/haptic inputs, outputs, and/or combinations
- Attributes of tactile/haptic encoding of information
- Content-specific Encoding
- Interaction Tasks
- Interaction Techniques

Additionally, it is recognized that there may be different requirements and recommendations that apply to specific haptic devices. However as yet, there is no clear classification of different haptic devices.

Likewise, while feedback is just a special case of output, it is important enough to present a separate category for consideration.

2.2 Tactile/haptic inputs, outputs, and/or combinations
This section organizes high-level and general considerations of tactile/haptic inputs, outputs, and/or combinations, including:

- General guidance
- Uni-modal use of tactile / haptic interaction, including the use of multiple tactile devices
- Multi-modal use of tactile / haptic interaction
- Intentional Individualization
- Unintentional user perceptions

2.3 Attributes of tactile/haptic encoding of information
Tactile/haptic interactions can be developed utilizing a rich variety of individual encoding techniques. Consideration of attributes of Tactile/haptic encoding of information can be divided into general guidance and attribute specific guidance.

General guidance can be further divided into:

- Using properties of objects
- Using spatial attributes
- Using temporal attributes
- Using perceptual attributes
- Combining attributes

Tactile/haptic interaction has a large number of attributes that may be used individually or in combination. Specific tactile/haptic attributes include:

- Force
- Shape
- Size
- Friction (including slipperiness and viscosity)
- Texture
- Mass / weight
- Hardness/softness (Compliance)
- Temperature
- Orientation
- Location
- Vibration
- Duration
- Motion
- Deformation

2.4 Content-specific Encoding
The selection of attributes can depend on the type of content to be encoded. Consideration of content-specific encoding includes:

- General tactile / haptic content encoding
- Encoding and using textual data
- Encoding and using graphical data, including:
  - Maps
  - Pictures
  - Figures / charts
  - Textures
  - Animations
- Encoding rhythms
- Encoding subjective data
- Encoding and using controls

2.5 Interaction Tasks
Tasks may require multiple different forms of interactions. There are three main types of interaction tasks: navigation, selection, and manipulation.

Navigation tasks include:

- Browsing / wayfinding – exploring
  - Exploring the structure of the environment
  - Exploring the object
- Targeting – going directly to the target
- Searching – with a search function
- Zooming – changing scale of space
- Reorienting – changing coordinates of space

Selection tasks include:

- Object selection
- Group selection (for a defined group)
- Space selection (user defined portion of total space)
- System property selection

Manipulation tasks include:

- Function Activation
- Creation and deletion

- Getting information, including
    - Objective / factual information
    - Subjective / feeling / motivation information
- Modifying information (Attributes & Relationships)
- Managing alternatives / Individualization / Personalization

2.6 Interaction Techniques

Interaction techniques deal with physical actions required of the user in order to accomplish various interaction tasks. There are five main types of interaction techniques:

- Moving relative to the object
- Moving the object
- Possessing the object
- Touching the object
- Gesturing

Moving relative to the object includes:

- Tracking (moving to / from / with / by the object)
- Tracing (moving across / around / along the surface of the object)
- Entering the object
- Pointing at an object

Moving the object includes

- Dragging
- Pushing / pulling
- Displacing the object (shaking / tilting / twisting/ rotating)
- Directing object motion

Possessing the object includes:

- Grabbing / grasping (e.g. on mouse down)
- Holding / gripping (e.g. continued mouse down)
- Releasing (e.g. on mouse up)

Touching the object includes:

- Tapping / hitting
- Pressing / squeezing / stretching
- Rubbing the object

While gesturing can be performed without physical contact, it should be considered when used with tactile devices, such as data gloves.

3. Application of the GOTHI-05 Model

The GOTHI-05 model has been used as the basis for a new standard ISO 9241-920 Guidance on Tactile and Haptic Interaction. The first working draft of ISO 9241-920 has used this model to structure 191 guidelines obtained from 40 research papers and 10 ISO standards.

The GOTHI model is the first model to identify the many dimensions of tactile/haptic output encodings and of tactile/haptic interaction tasks. Even without referencing the many ergonomic guidelines in ISO 9241-920, it can be used by developers to ensure that their analyses and designs have fully considered the possibilities and constraints of tactile/haptic interactions. Once they decide upon various encodings and interactions, this model can help them find the appropriate ergonomic guidance in ISO 9241-920 to support design and evaluation.