Mapping, in human-computer systems

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Mapping, in human-computer systems

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In the technologic and scientific fields connected to Enactive Interfaces, the term mapping is used in a variety of situations, with various meanings. These cover for example the very technical memory mapped protocol (mmap) for inputs/outputs of a computer CPU from/to its devices, the data mapping between data models or categories of data (for an example, see [→ Sonification]), the mapping between different modalities, etc.

This item deals with another category of mapping particularly important in the context of Enactive Interfaces: the mapping of human gestures onto a computer process. It is provided in the continuity of the theoretical definition in [→ Mapping]. Here, the mapping's domain is the human gesture, or more precisely a data stream acquired from a gesture transducer, and the mapping's codomain is the computer process. Also, one defines a mapping strategy as a set of general guidelines and instructions useful to design the mapping. The choice of an appropriate mapping strategy is particularly important, and difficult.

This being said, the item reviews such human gesture mapping in three more specific cases.

Mapping (of human gesture) in HCI

In classical human computer interaction, and more generally in ergonomics, the mapping concept has long been seen as being of a major importance. Hence, in [Norman, 88], mapping, and associated mapping strategies, are presented as one of the 5 most important things to carefully consider when designing a system usable by a human being (either a graphical computer interface, a telephone, a plane cockpit, etc.), along with mental models, affordances [→ Affordances], constraints and visibility/feedback.

Examples of well-designed mapping are the mapping of wheel to power steering in cars (it is easy to learn…), and the logarithmic-based mapping of the potentiometer to the power in audio amplifiers (which is well adapted to loudness, i.e. to the human perception of sound power).

In the case of traditional man-computer interfaces, especially graphical interfaces, the domain is typically made of the mouse trajectories, or further of the motion of a graphical slider (or more generally widget) that accompanies the mouse on screen, and the codomain is the interface at hand, or more precisely various of the state parameters of the core system above which the interface is built. Here, the chosen mapping strategy not only affect the naturalness of the handling of the interface through the relatively poor device available (keyboard and mouse). In some case, it can also dramatically reduce the complexity of the whole interface. For example, implementing a well-chosen mapping can allow replacing numerous sliders, each of which would control a unique parameter in the system, by a unique control which state is mapped onto various parameters in the model (through a one-to-N mapping), allowing obtaining the desired effect much more easily.

Mapping, when using Motion Capture

In this context, mapping comes as an issue when interfaces are used to map the motion of particular points of the body onto an artificial display. Here, the mapping's domain is made of the moving points trajectories captured on the real body in earth frame, and the codomain is the motion in the virtual space in the interface.

To design the mapping, the designer has first to choose specific points on the body, that could be end effectors or limbs, or joints, or any variable calculated from these basic elements. Second a particular mapping strategy has to be defined.

The mapping strategy may, for example, map the captured points in a smaller or a larger dimensional space (e.g., a surface instead of a volume), delayed or not in time, via a possible transformation linear or non linear, keeping or not symmetry, keeping or not redundancy of the original inputs, scaling, etc. One can also imagine mapping onto a different space, for example from physical space to phase space.

In this context, the possibility of an adaptation (of the user) to mapping is an important issue.

The study of adaptation to such mappings is classical in experimental psychology and neurosciences. It originates in the study of adaptation to prismatic goggles that imposed a constant angle rotation of the environment, enabling a new spatial relationship between the "non rotated" tactile or proprioceptive information and the rotated visual layout. However, this area of study still lacks a systematic or theoretical treatment, and the effects of variation in mappings are often underestimated.

Particular mappings of body motion onto visual interfaces quite systematically changed the measured behavioural adaptation (which led to misunderstand divergent results between apparently similar experiments) and sometimes simplified notably the learning and execution of otherwise difficult coordination tasks [Flaugloire et al, 2004] [Mechsner et al, 2001] [Swinnen, 1996] [Swinnen et al 1997]. This line of research may well pave the way for rehabilitation interfaces.

Mapping, in the context of Synthesis

Mapping is also a very important issue in computer-based (sound and/or visual) synthesis. Here, the domain is the gesture signal sensed on a gesture device (a musical keyboard, a motion capture system, etc.), and to codomain is made of the parameters of the synthesis model at hand.

In this context, the concept of mapping is progressively made more and more objective, as a new area of research toward better (more expressive, more interesting, more diverse, etc.) synthesis systems. The item "mapping, in digital musical instruments" discusses further the various benefits of the mapping concepts in the case of digital musical instruments, but can be generalized from sound synthesis to the general case of synthesis [→ Mapping, in digital musical instruments].

However, despites the substantial benefits of the generalization of the mapping paradigm, a couple of drawbacks can be discussed. The item "mapping and control vs. instrumental interaction" goes further on this discussion [→ Mapping and control vs. instrumental interaction].

References

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Related items

Affordances
Human computer interaction
Mapping
Mapping and control vs. instrumental interaction
Mapping, in digital musical instruments
Sonification