Intuitive Interaction: Tapping into body skills to find rich and intuitive interaction methods for Virtual Reality

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Abstract
Intuitive interaction is strongly rooted in embodied skills. We propose to take a human-centered approach to explore potential intuitive interfaces and interaction metaphors that also offer a rich interaction experience. Here, human-centered denotes the systematic exploration of the full body, i.e. all human senses and all control option people have in daily life. We describe a highly intuitive example, the ChairIO, and propose a possible neurobiological explanation of why intuitive interfaces like the ChairIO are perceived as such.

Keywords
Human-centered HCI, Virtual Reality, body skills, embodiment, embodied interaction, enactivism.

Introduction
Intuitive Interaction is strongly connected to embodied interaction. An interaction method can be called intuitive, if a user, without priming, explanation, or help, can instantly, successfully and unconsciously utilize it. For this, the method has to tap into prior knowledge and help to unconsciously apply this knowledge for effective interaction. Prerequisite for this is that this knowledge is 'embodied', i.e. deeply

internalized and *actively* learnt [4]. Varela et al. called this "enactivism", describing the experience-based coupling of interactions with our world, i.e. the praxis of our living, shaping interconnected sensorimotor networks that are eventually the basis for cognition [9]. The classical neurobiological concept of efference copy is closely related to this interwoven nature of sensation and action [5]. For this purpose, an internal copy of a motor command is used to predict the resulting sensation, which of course is influenced by our experience and body shape. This quite nicely points out the requirements for an intuitive Virtual Reality (VR) interaction method: the sensation elicited by an action should also hold in an immersive virtual environment.

Virtual Reality interaction methods as a general case
Especially in VR scenarios, where people are surrounded by stereoscopically projected 3D worlds, intuitive interaction is a rarely achieved goal. No help menu can aid users in acquiring understanding about the possible interaction. There is no common interaction set or interaction metaphor like keyboard and mouse for desktop PCs, other than what we know from our everyday life interaction with reality. Arguably, our VR worlds are not yet technologically capable to mimic the Star Trek's holodeck and provide a 1:1 copy of action in the real world. Also, VR is often used by novices and every installation is different, both concerning the technology/devices utilized and the story/interaction metaphor used. Therefore, especially VR interaction methods have to be designed to be intuitive, preferably self-explaining, while we as designers are not being able to rely on learnt standard methods and tools. Results that work in immersive VR settings will almost certainly work in general.

Our research approach

Our approach to finding suitable interaction methods for VR is to look into the full human potential to actively control the environment. Jacob et al. describe four different aspects to look for such knowledge, i.e. naïve physics, body-, environmental-, and social awareness and skills [6]. We do this by systematically exploring into all senses and control options people have in pursuit of discovering suitable embodied knowledge that then can be utilized to create intuitive interactions and interfaces providing rich user quality and feedback. This approach is strongly related to actively working with the sensorimotor loop and the mind, increasing the presence of people by enaction and by purposefully guiding the mind [2].

Over the last years, we explored the visual, auditive, haptic, and olfactory presentation of information to people and surveyed full body-related ways to control the environment. Walking in place techniques for navigation, tangible devices for interaction, and tables covered with granules for playing in a sandbox are some examples. We also conducted perceptual studies to understand the adaption of a virtual body as our own. In contrast to the rubber hand experiments [3] and tools that extend our body [8], a virtual body is not connected to our own body. Even though, conflicting visual and tactile stimuli can introduce a notion of ownership of the avatar in the user [7].

All this research is aiming for a better understanding of rich and intuitive HCI. We found that physical, passive and implicit feedback, enaction, plus purposeful, directed body movements greatly enrich the experience and, through that, provide intuitive and joyful adventures, merging user and virtual environment.

In the following, we will exemplarily describe one of the results from our research, a chair-based interface for navigation in VR that has proven to be highly intuitive and even complex movements with it need nearly no learning.

Figure 1. Use of the ChairIO in a first-person shooter game as intuitive navigation method completely controlled by implicit body skills.

The ChairIO

The ChairIO is a chair-based computer interface consisting of a flexible office stool, the commercially available Swopper™ by aeris, extended with sensors. The seat has a rotatable, 360° pivot point, height and damping adjustment, and a linkage arm consisting of a spring/shock combination. The seat can be tilted in any direction and rotate freely. Further, the spring/damper system allows the user to bounce. Sensors record the stool's movements transmitting them to a computer that in turn translates this information into movements. The ChairIO can equally be employed for desktop systems as well as for large projections. While navigating through the virtual world sitting on a chair, several factors influence the user's experience:

- The chair's current position and the user's body itself inform about his physical position in space, providing natural, not artificially induced feedback.
- The user seated on the chair controls the chair's movement with his body and through this merges with the interface and interaction to a harmonious ensemble.
- The chair's movement activates the whole body and boosts the body's mobility. Its combination with a computer to control an application encourages those kinds of movements actively. The whole human being is actively engaged and inspired to move.

We employed the ChairIO in different navigation applications of virtual worlds and games (see Fig. 1) [1], as well as in many of our VR studies. In a formal study and while observing over 1.000 people until now, we found that users literally merge with their movement through virtual space. They are part of the installation and receive immediate feedback. Action and Reaction are fully integrated, while the control device fully blends with the body and is not perceived as such. Users frequently do not need any explanation for operating the seat. They immediately start using it for controlling even highly complex movements. We think that this is because users utilize their internal embodied model of how to operate their own motion in the everyday environment (FORWARD-BACKWARD, LEFT-RIGHT, ROTATION), which always involves moving the hips through space as on the seat. Furthermore, they do not even think about the device they sit on. A chair is an everyday tool. Its existence as a sitting support is well internalized and not disturbing. It is immediately integrated as a tool into the body scheme. The connection to operate the hips on the chair, then, is made automatically by combining all these familiar concepts, resulting in a correctly predicted sensation (e.g. for the visual flow).

In summary, the ChairIO is an example of a highly intuitive navigation method exploiting well our body knowledge, in this case of motion direction.

Thoughts on the Creation and Principle of Intuitive Interaction Methods

The ChairIO came to existence while systematically and creatively exploring into all senses and control options of people for interacting with a computer. We call this *human-centered VR* to denote the exploration focus to

be on people, their needs, capabilities, and body skills, rather than on technology only. For this newly identified potential interaction method to then also be intuitive it is required that:

1. the interaction method connects to a well placed embodied metaphor,
2. this metaphor is appropriate and expected in the current setting,
3. the interaction device, if any, signals appropriate and inherent affordances,
4. any skill and knowledge about the usage of the interaction device was acquired (embodied) previously, such that it is now perceived as a well known tool, possibly as an extension to one's body ([8] and [3]).

All of the four require to tap into well internalized knowledge of our world, our body and the interplay of both; i.e. embodied knowledge.

Neurobiological explanation for intuitiveness

The conjectured explanation for the overwhelming acceptance of the ChairIO and intuitive interaction methods in general can be ascribed to a neurobiological concept. To discriminate sensory input stemming from external stimuli in the environment (exafference) from sensory stimuli caused by voluntary actions (reafference) a copy of the motor signal, i.e. the efference copy, is needed [5]. This efference copy can be used to make predictions about the resulting sensory feedback. For the rotation movement of the ChairIO it easily can be seen, that this prediction will result in virtual sensory feedback (visual flow) almost identical to experiences gathered on real-world chairs. Hence, it is immediately intuitive. For the forward, backward, left and right actions we have embodied concepts and expectations in what those movements should result in (relying on the direct application of body schemata). When performing these actions they straightaway lead to the expected outcome enabling an intuitive navigation behavior. This potentially explains the success of the chair-based interface and how intuitive, embodied interaction functions in general.

Citations

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