Immersion in Movement-Based Interaction

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Abstract. The phenomenon of immersing oneself into virtual environments has been established widely. Yet to date (to our best knowledge) the physical dimension has been neglected in studies investigating immersion in Human-Computer Interaction (HCI). In movement-based interaction the user controls the interface via body movements, e.g. direct manipulation of screen objects via gestures or using a handheld controller as a virtual tennis racket. It has been shown that physical activity affects arousal and that movement-based controllers can facilitate engagement in the context of video games. This paper aims at identifying movement features that influence immersion. We first give a brief survey on immersion and movement-based interfaces. Then, we report results from an interview study that investigates how users experience their body movements when interacting with movement-based interfaces. Based on the interviews, we identify four movement-specific features. We recommend them as candidates for further investigation.

Key words: Movement-based interaction, exertion, immersion, engagement, flow, games, entertainment

1 Introduction

Moving our bodies for communication and interaction comes natural to us. We rely on our bodies to access our environment. In fact, it has been said, "all human actions (including cognition) are embodied actions" ([22], p. 692). Movement-based interfaces enable their users to employ active body movements as interaction modality. As such they can offer a more natural and richer interaction than traditional interaction techniques such as mouse and keyboard.

In particular in an entertainment context, exertion interfaces are becoming more and more popular. Wide-spread video game consoles such as Nintendo Wii, Sony Eye-Toy or Konami Dance Dance Revolution elicit exertion from their users. The Wii uses handheld controllers that the user has to wave and swing. The Eye-Toy captures the user‘s movements with a camera. To play Dance Dance Revolution the user has to jump and dance on a sensor mat. Apart from apparently being very entertaining, these games also offer a healthier interaction than traditional video games, by which we refer to video games that are steered via joystick, mouse and keyboard. These games promote sedentary behaviour and are seen as contributors to the growing obesity epidemic [10, 17]. Initial studies [16, 21] show that physical activity during gameplay increases energy expenditure significantly compared to sedentary games. They conclude that some exertion games exceed the cut-off for moderate intensity physical activity and are thus fit to contribute to recommended amounts of physical activity. But also ergonomic issues arise from this new type of interaction. Injuries and accidents related to exertion interfaces are described in [3, 8]. Accidents are often attributed to the fact that users get too immersed and forget the real world around them. In exertion games, injuries like overstraining can be caused by the fact that players do not see their gaming as sport and omit stretching or by playing for too long.

In this paper we discuss movement-based interfaces in the context of immersion. Immersing oneself into a virtual environment has been described as a highly pleasurable experience. In HCI research, models of immersion have been put forward that describe different types [11] and levels [4] of immersion that users can experience during interaction. Yet, there is no account for body movements in these models. We speculate that physical activity has an influence on immersion, based on findings in [2]. Here, it has been shown that body movements as an input device do not only increase video gamers“ levels of engagement, but also have an influence on the way a gamer gets engaged.

It is thus the aim of this paper to investigate if users immerse themselves differently in movement-based interaction and, if this is the case, which movement-specific features influence immersion. As there is only little existing knowledge on the relation between physical activity and immersion, our approach is an exploratory one: We interview users on their experiences with movement-based interfaces. Our aim is identifying features for further, quantitative investigation. A further goal is to point designers of movement-based interfaces to critical issues. For instance, how to make a movement-based game even more engaging for users and make them interact longer with the game and by that be physically active for longer periods of time.

The paper is structured as follows. We begin with a brief discussion of movement-based interfaces. This is followed by a description of the phenomenon of immersion and its modeling in HCI research. Our interview study and its outcomes are presented next. We then discuss the outcomes in the light of the existing immersion models. The paper concludes with an assessment of the current results and a call for further investigation.

2 Movement-based Interaction

Movement-based interfaces enable the user to interact by means of movements of the body. Here, the user is freed from the need to relay commands via mouse and keyboard. Instead, active body movements are employed, e.g., playing tennis with a hand-held controller that the user has to swing like a real tennis racket. Since communicating and interacting via body movements (e.g., non-verbal communication) comes natural to us, we can speak of a more natural way of interaction (given that the movements required are resembling movements from real life).

A number of different types of movement-based interfaces have been proposed. Judging them by the intensity of movement they require, we can distinguish a wide range of approaches. Only minuscule movements are required by interfaces that use eye movements [20] as input modality. Other movement-based interfaces use moderate arm movements as input modality. Such approaches have been in particular employed in virtual environments. By using their hands, users can select objects by pointing at them and e.g. relocate them by moving their hand or rotate them by twisting their hand. This type of interaction is a very natural one, as it closely resembles the manipulation of objects in real life. The upper end of the intensity scale is represented by interfaces that require significant physical activity and that have been dubbed exertion interfaces [24]. Exertion interfaces can be found mainly in an entertainment and games context. The first examples of exertion interfaces were exercise devices like treadmills and exercise bikes that were connected to entertainment equipment in order to entertain and distract the user from strain.

In this paper we focus on exertion interfaces. They require high amounts of movements and we are specifically interested in the influence of body movements on immersion. Once we establish movement specific items we can check if they also apply to areas where only small amounts of movements are necessary.

Immense potential to increase the efficiency but also the user experience lies in making movement-based interfaces 'intelligent'. Intelligent movement-based interfaces are able to sense the movements and possible exertion of the user in order to adapt to it. In task-oriented environments they can help raise the efficiency of task fulfillment, by offering task-sensitive support. In entertainment, intelligent interfaces can monitor the user's affective state and adapt the gameplay accordingly. As pointed out in [26], intelligent exertion interfaces should be persuasive, motivating, and rewarding.

A number of approaches have been presented for detecting, sensing, and interpreting physical activity and affective state of a user: In the ball game presented in [24], there is no direct sensing of body movements. Solely the outcome of the exertion, i.e. force and trajectory, are measured and used for the gameplay. A boxing interface using gesture recognition is described in [18, 27].

In [12], three types of adaptive responses of intelligent movement-based systems are envisioned: First, the system offers assistance if the user is frustrated. Secondly, the level of challenge can be adapted when the user is bored or demotivated. This applies in particular in a gaming context [6]. Finally, emotional displays can be inserted into the interface to minimize negative emotions and reinforce positive emotions.

3 Immersion in HCI

Immersion is a term used widely to describe the user experience, in particular in an entertainment context. The following definition is quoted widely and has been described as the most accepted one [23]:

> "The experience of being transported to an elaborately simulated place is pleasurable in itself, regardless of the fantasy content. We refer to this experience as immersion. Immersion is a metaphorical term derived from the physical experience of being submerged in water. We seek the same feeling from a psychologically immersive experience that we do from a plunge in the ocean or swimming pool: the sensation of being surrounded by a completely other reality, as different as water is from air, that takes over all of our attention, our whole perceptual apparatus..." ([25], p. 98).

Before further investigating the nature of immersion we delineate similar concepts that are all too often used synonymously with immersion. Several authors adapted Csikszentmihalyi's [9] theory of flow to an HCI context: The GameFlow model [30] maps components of flow theory to elements from game design literature. The authors report that the model in its current state is useful for evaluation of games but needs further development to inform the design of games. An important item of flow theory is the flow zone: A person is in the flow zone when the person's abilities are matched by a challenge. Too much challenge leads to frustration, too little challenge to boredom. In [6], the author recommends games to adapt to the users' skills in order to keep them in the flow zone.

Presence is another term that appears in the literature to describe the gaming experience. The term originates from studies into virtual reality and is often defined as "the feeling of being there" [19]. In [5] it is argued that presence in a virtual reality context corresponds to immersion in a gaming context. Similarly, Ermi and Mäyrä prefer the term immersion as "it more clearly connotes the mental processes involved in gameplay" ([11], p. 19). We follow this line of argumentation and see immersion as the appropriate term when speaking of user experience in an entertainment context.

In the existing literature on immersion, two models have been proposed that focus on different aspects of immersion. The first model we discuss in the following focuses on the intensity of immersion into a virtual environment, while the second distinguishes different types of immersion.

3.1 Levels of Immersion

In the study presented in [4], Brown and Cairns investigate the intensity of immersion in video games. From interview data with gamers regarding their experiences during gameplay the authors identify three distinct levels of immersion, labeled engagement, engrossment, and total immersion. For each level barriers exist that have to be overcome to reach the level. Figure 1 shows the three levels and their respective barriers.

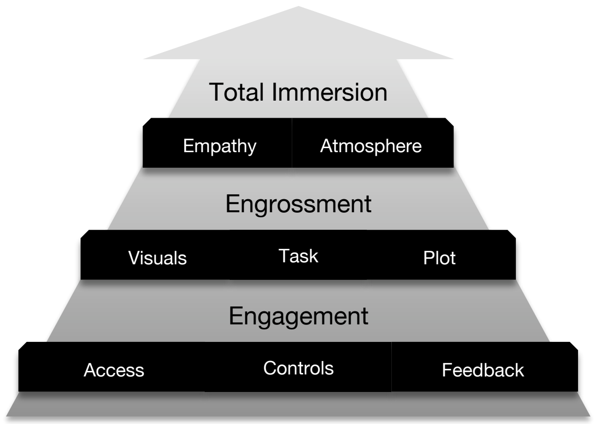

Fig. 1. Immersion Model of Brown and Cairns [4], own depiction. Barriers (shown in black) hinder the user from reaching (deeper) immersion.

Engagement is the first level of immersion. To reach it, gamers must first have access to a game. If gamers do not like a certain type or style of games, they will not even try to engage with it. So they must be willing to invest time, effort, and attention. In addition, controls and feedback must be provided: “Controls and feedback need to correspond in an appropriate manner so that the user can become an expert, at least at the main controls“ ([4], p. 1298).

The barrier that has to be overcome to reach the second level, engrossment, is bad game construction, by which the authors refer to visuals, tasks, and plot. They point out that at this stage the gamers have already invested emotionally into the game and this makes them continue gaming.

Total immersion is the final level and it is described as being cut off from the world to an extent where the game is all that matters. Barriers to total immersion are a lack of empathy with game characters or a lack of feeling the atmosphere of the game. In a follow-up study [7], the stability of immersion is investigated. Here, the authors attempt to deliberately break the immersion of their test subjects and find that already low levels of immersion make subjects ignore drastic changes in the games behavior.

3.2 Types of Immersion

The second model is presented in [11] where the authors describe their investigation into different types of immersion, by interviewing gaming children and their parents. This way the authors identify three different types of immersion:

sensory, challenge-based, and imaginative (SCI), from which they built the SCI-model of immersion, as shown in Figure 2. Sensory immersion refers to sensory information during gaming. Large screens and powerful sound are given as examples where sensory information of the real world is overpowered and the gamer entirely focuses on the game. Challenge-based immersion is described as most powerful when a balance between the abilities of the player and the challenge of the game is achieved and as such seems to correspond to the flow concept mentioned earlier. Finally, imaginative immersion happens when the player gets absorbed with the story line and identifies with the game characters.

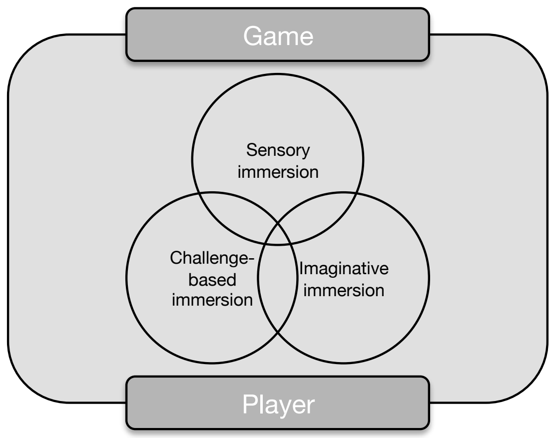

Fig. 2. Immersion Model of Ermi and Mäyrä [11], simplified. Three types of immersion are distinguished that can lead the user to immersive states: sensory, challenge-based, and imaginative immersion.

Neither of the models contain movement-specific items. Yet we speculate that movement has an influence on immersion for several reasons: First, movement-based interfaces offer a more natural interaction as pointed out in the previous section. This should facilitate the experience of immersion, since users do not have to relay their commands via mouse or keyboard. In [2] it has been shown that body movements as an input device do not only increase video gamers“ levels of engagement, but also have an influence on the way a gamer becomes engaged. Also, there is growing evidence that physical exercise increases mental well-being [13].

4 Movement-based Interaction and Immersion

To investigate how users experience and interpret their interaction with movement-based systems we conduct an interview study. In the following we first present the setup of the study and then the movement-specific features that we can identify with the outcomes of the interviews.

4.1 Interview Study

To be able to compare the interview results we choose for one common interaction scenario as focus of our investigation. We choose the video game console Nintendo Wii as interaction platform, because it enjoys great commercial success and by this allows us to find interview subjects with sufficient familiarity to be able to reflect on their experiences. Four regular users of the Wii take part in this study.

A 20 minutes session of playing the Nintendo Wii Sports games primes the interviewees before the interview. The subjects are asked to play two different games on the Nintendo Wii, each for about 10 minutes. The particular games are changed for the different participants to avoid possible biases due to characteristics of a certain game. Still, in all sessions it is ensured that participants play one fast-paced game (boxing or tennis) and one slow-paced game (bowling, golf or baseball). We do this with the intention of asking about differences between the games later in the interview session, i.e., how the amount of physical activity and the type of movement may affect their gaming experience. The interview sessions take between 20 - 30 minutes and are held in a semi-structured style. Initial outcomes are used to update the interview guide for the following interviews.

The interviews are transcribed and analyzed using Grounded Theory [14, 15] to identify relations between statements and establish concepts. In the following we present the outcomes of the interviews. To give the reader a better impression of general trends in the interview data, we show representative statements where they can help understanding.

4.2 Movement-specific Features

Control appears to be a major factor in the gaming experience that includes body movements and is the first movement feature. How easy the game controls can be understood is an important point for the interviewees. The learning of the controls can be facilitated by appealing to the gamer‘s experience with similar activities in real life. It is seen as positive when gamers can transfer real world knowledge to learn the necessary movements for the game.

> “It is like tennis, I really like playing tennis in real life. And with the Wii I really like playing tennis, but you don‘t have as much as control, you can‘t move the players yourself. So I don‘t really see it as playing in real life. But then again bowling, it sort of involves the same movements [...] With the bowling you are doing the same as you would be doing in a bowling alley, except for the running. You know, the whole arm chucking movement. Whereas tennis, you‘re hitting a ball but you don‘t get that sort of feeling as you would have in real life.“ (i1)

> “The games I liked most so far are the sports games. I don‘t know why, but the principles are very simple, the controls are very easy and intuitive and its big fun to play with friends.“ (i2)

Interviewee 1 describes playing Wii tennis as an incomplete experience. It does not feel like playing real tennis, whereas she gets that feeling from Wii bowling. From the comments of interviewee 2 it seems that games that mimic real life activities should replicate the movements in those activities quite accurately. They should be "intuitive". For scenarios that mimic real life this is quite straight forward, but it also leads to the question of what determines the movements in a fantasy game with no reference to a real world scenario.

Another important concept can be described as *mapping of movements*. This refers to how well the gamers movements are replicated on screen and how the game reduces the high degrees of freedom of possible movements that a gamer can make.

> "... But I think with the technology that we have so far it might be limited how it can be really reflected. In boxing for example, what I said earlier, the type of punches that I can do are not really reflecting the diversity that I can have in real life." (i2)

The comment of interviewee 2 exemplifies this. He states that he is unsatisfied with the fact that the system does not replicate the movements exactly as he executes them. Still, he acknowledges that there are technical limitations involved. Interestingly, when it comes to the Wii Tennis game, interviewees are positive about the fact, that they cannot steer the movements of the avatar itself, but only execute the swings, stating that this is already difficult enough.

> "My movements were a bit larger and faster than the ones that the avatar was making. And sometimes the avatar was loosing its balance or something. It was leaning in one direction and I was in another and it was taking a while to catch up with me."(i4)

Feedback is another concept recurring in the data, though the term feedback itself is not mentioned explicitely by the interviewees. We interpret the statements in a way that the body itself is a source of feedback for the user. In the example above, interviewee 4 describes that he is physically leaning in one direction, whereas the avatar is still leaning in another direction. This discrepancy is of course also related to the feature "mapping of movements" that is described above. But it also shows that the positioning of the body is a source of feedback that at this moment is not in agreement with the visual feedback coming from the screen. Through the movements, the user receives additional feedback in form of proprioceptive feedback. In traditional video games sensory immersion is limited to sight, hearing and touch. These senses belong to the so-called exteroceptive senses (i.e. hearing, sight, smell, taste, and touch). The proprioceptive sense provides information about the relative position of neighboring parts of the body. It is for instance indispensable for moving without looking at where you go, e.g. walking in the dark (e.g., Sacks [29] reports of a patient that lost her proprioceptive sense and can only walk when she looks at her feet).

Challenge in movement-based interaction appears not only to have a mental, but also a physical component. The fourth feature that we can identify from the interview data is physical challenge. Frequently the interviewees state feeling physically challenged by the game and being exhausted afterwards.

5 Discussion

We discuss the results of our interview study by applying the four identified movement features to the two aforementioned models of immersion. The features and the respective model constituents are shown in Figure 3 and we discuss each relation and how the respective feature can potentially influence immersion in the following.

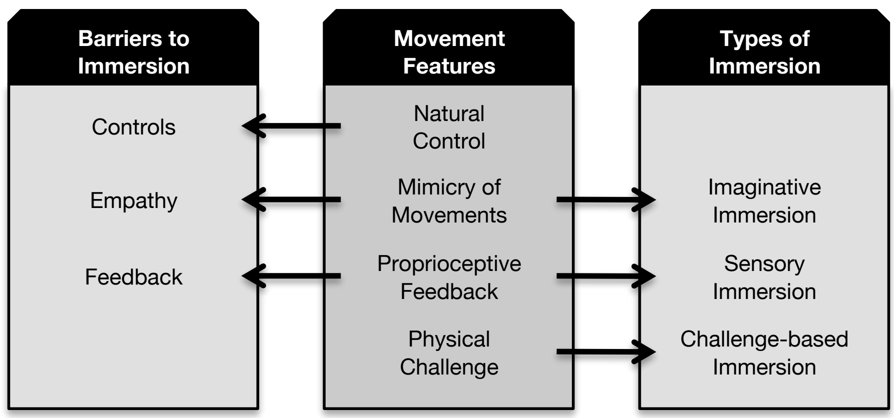

Fig. 3. Identified movement features and their potential influence on barriers to immersion [4] and types of immersion [11]

Movement-based interfaces offer a more natural control than mouse, keyboard or joystick. Using body movements is often described as intuitive by the interviewees and also critized when it is not resembling movements in real life, as they expect. In Brown and Cairns‘ [4] model of immersion, control is a barrier to the first level of immersion. A more natural mode of control can lower this barrier and facilitate immersion, given that the interaction resembles movements in real life.

Mimicry of movements is the second movement feature identified from interview data. When the avatar copies the movements of the gamer, this appears to raise the level of empathy that is felt with an avatar. The following quotes exemplify this:

> “The boxing also felt more personal, because it feels like someone is hitting back at you, although that‘s not the case. So it‘s more emotionally engaging.“ (i3)

> "Keeping your arms up all the time and trying eagerly to punch and being in a situation where you can virtually be punched as well is maybe more stress than bowling." (i2)

Interviewee 3 reports about the Wii Boxing game that it "feels like someone is hitting back at you." Though he is immediately reflecting that this is not possible, there seems to be a strong emotional connection to the avatar. The same is true for interviewee 2 who finds a situation where he can be hit, though it is only virtual, as stressful. As shown in [1], mimicry can lead to increased empathy with a virtual character. In the case of movement-based video games like Wii Boxing, the avatar copies the movements of a gamer. It is conceivable that this mimicry of the gamer's movements leads to a stronger identification with the avatar, than in non movement-based games. Empathy is also a barrier to immersion and mimicry of movements appears to have the potential to lower this barrier. In terms of the different types of immersion it also seems to facilitate imaginative immersion.

Proprioceptive feedback is the third movement feature. With regards to the barriers to immersion this additional channel of immersion offers the potential of lowering the barrier feedback. When we look to the other model of immersion it appears to facilitate sensory immersion.

Physical challenge is our final movement feature. In sedentary games, challenge is usually put on mental capabilies of a gamer (Racing games and first-person shooter games form of course an exception here as they challenge the gamer's reflexes, but one might also categorize them as movement-based games). In movement-based interaction the physical challenge offers an additional channel of feeling challenged. Regarding the types of immersion model, it can open a new channel of challenge-based immersion.

6 Conclusions

We discussed the phenomenon of immersion in HCI and two models that focus on different types of immersion, respectively different levels of immersion and barriers to reach these. We also discussed movement-based interfaces, differentiated by the intensity of movement they require (or enable) and mentioned the potential of 'intelligent' movement-based interfaces that sense the movements of the user and adapt accordingly. With the results of an interview study on how users experience movements in their interaction with interactive systems we identified four features of movement-based interaction that potentially influence the constituents of the two immersion models: Natural control, mimicry of movements, proprioceptive feedback, and physical challenge.

For the moment, ensuring that the four mentioned movement features are considered, should help interaction designers to develop engaging movement-based user interfaces. Yet, still little is known on the relation between body movements as mode of interaction and immersion. The approach taken in this study is an exploratory one and the results are derived from a qualitative study.

They represent trends that should be further investigated in quantitative studies. The current results hold a lot of potential for immersive, movement-based interfaces, but we need much more research on their validity and correct implementation. More knowledge on what makes an interface really engaging and fun to use, together with the potential of applications that can sense and interpret the state of the user (physical, affective, context, etc.) should result in a new generation of health promoting, challenging, supportive, and enjoyable interfaces.

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References

1. Bailenson, J.N., Yee, N.: Digital Chameleons. Automatic Assimilation of Nonverbal Gestures in Immersive Virtual Environments. Psychological Science, 16, 10, pp. 814–819 (2005)
2. Bianchi-Berthouze, N., Kim, W.W., Darshak, P.: Does Body Movement Engage You More in Digital Game Play? and Why? Aective Computing and Intelligent Interaction, Springer, LNCS 4738, pp. 102-113 (2007)
3. Bonis, J.: Acute wiitis. New England Journal of Medicine, 356, 23, pp. 2431-2432 (2007)
4. Brown, E., Cairns, P.: A grounded investigation of game immersion. Proceedings CHI 2004, pp. 1297-1300 (2004)
5. Cairns, P., Cox, A., Berthouze, N., Dhoparee, S., Jennett, C.: Quantifying the experience of immersion in games. Cognitive Science, Vancouver (2006)
6. Chen, J.: Flow in games (and everything else). Communications of the ACM, 50(4), pp. 31-34 (2007)
7. Cheng, K., Cairns, P. A.: Behaviour, realism and immersion in games. Proceedings CHI 2005, pp. 1272-1275 (2005)
8. Cowley, A.D., Minnaar, G.: Watch out for wii shoulder. British Medical Journal, 336, p. 110 (2008)
9. Csikszentmihalyi, M.: Flow: the psychology of optimal experience. Harper and Row, New York (1990)
10. Epstein, L.H., Roemmich, J.N., Robinson, J.L., Paluch, R.A., Winiewicz, D.D., Fuerch, J.H., et al.: A Randomized Trial of the Effects of Reducing Television Viewing and Computer Use on Body Mass Index in Young Children. Archives of Pediatrics and Adolescent Medicine, 162(3), pp. 239-245 (2008)

11. Ermi, L., Mäyrä, F.: Fundamental components of the gameplay experience: analysing immersion. In: de Castell, S., Jenson, J. (eds.) Changing views: worlds in play, Selected Papers DiGRA conference, pp. 15-27 (2005)
12. Fairclough, S.H.: Fundamentals of physiological computing. Interacting with Computers, (pre-print online version) doi:10.1016/j.intcom.2008.10.011 (2008)
13. Fox, K.R.: The influence of physical activity on mental well-being. Public Health Nutrition, 2(3a), pp. 411-418 (1999)
14. Glaser, B., Strauss, A.: The discovery of grounded theory: Strategies for qualitative research. Aldine, New York (1967)
15. Goulding, C.: Grounded Theory: A Practical Guide for Management, Business and Market Researchers. London, SAGE (2002)
16. Graves, L.E., Ridgers, N.D., Stratton, G.: The contribution of upper limb and total body movement to adolescents' energy expenditure whilst playing Nintendo Wii. Eur. J. Appl. Physiol., (online version without issue and page number) (2008)
17. Hillier, A.: Childhood overweight and the built environment: making technology part of the solution rather than part of the problem. The ANNALS of the American Academy of Political and Social Science, 615(1), pp. 56-82 (2008)
18. Höysniemi, J., Aula, A., Auvinen, P., Hännikäinen, J., Hämäläinen, P.: Shadow boxer: a physically interactive fitness game. Third Nordic Conference on Human-Computer Interaction (NordiCHI 2004), vol. 82, pp. 389-392. ACM Press, New York (2004)
19. Ijsselsteijn, W., Riva, G.: Being there: the experience of presence in mediated environments. In: Riva, G., Davide, F., Ijsselsteijn, W. (eds.) Being There: Concepts, Effects and Measurements of User Presence in Synthetic Environments, pp. 3-16, IOS Press, Amsterdam (2003)
20. Jacob, R.K.J.: What you look at is what you get: Eye movement-based interaction techniques. Proceedings CHI'90, pp. 11-18 (1990)
21. Lanningham-Foster, L., Jensen, T.B., Foster, R.C., Redmond, A.B., Walker, B.A., Heinz, D., et al.: Energy expenditure of sedentary screen time compared with active screen time for children. Pediatrics, 118(6), pp. 1831–1835 (2006)
22. Loke, L., Larssen, A.T., Robertson, T., Edwards, J.: Understanding movement for interaction design: frameworks and approaches. Personal and Ubiquitous Computing, 11, 8, pp. 691–701, Springer, London, (2007)
23. McMahan, A.: Immersion, engagement and presence. The Video Game Theory Reader, pp. 67-86 (2003)
24. Mueller, F., Agamanolis, S., Picard, R.: Exertion Interfaces: Sports over a Distance for Social Bonding and Fun. Proceedings CHI 2003, pp. 561-568 (2003)
25. Murray, J.: Hamlet on the Holodeck: The Future of Narrative in Cyberspace. MIT Press, Cambridge (1997)
26. Nijholt, A., van Dijk, B., Reidsma. D.: Design of Experience and Flow in Movement-based Interaction. Proceedings Motion in Games, LNCS 5277, pp. 166-175, Springer, Berlin (2008)
27. Park, J.Y., Yi, J.H.: Gesture Recognition Based Interactive Boxing Game. International Journal of Information Technology, 12(7), pp. 36–44 (2006)
28. Pasch, M.: Bye-bye Couch Potato: Body Movement in the Gaming Experience. MSc Thesis, University of Twente, the Netherlands (2008)
29. Sacks, O.: The Man Who Mistook His Wife for a Hat, and Other Clinical Tales. Touchstone, New York (1998)
30. Sweetser, P., Wyeth, P.: Gameflow: a model for evaluating player enjoyment in games, Computers in Entertainment, 3(3), pp. 1-24 (2005)