Mixed reality empowerment for enhancing physical exercise

Perttu Hämäläinen

Aalto University

Department of Media Technology

P.O. Box 15500

FI00076 Aalto

Finland

perttu.hamalainen@aalto.fi

Raine Kajastila

Aalto University

Department of Media Technology

P.O. Box 15500

FI00076 Aalto

Finland

raine.kajastila@aalto.fi

Abstract

In this paper we explore the ways to motivate and enhance physical exercise by boosting users' abilities in both physical and in virtual worlds. Moreover, we discuss how skill exaggeration and ability boosting in an exergame could affect the players' and audience's perception of skill and fitness. Finally, we discuss research questions and hypotheses for studying these concepts.

Author Keywords

Exergames; exertion interfaces; augmented feedback; computer vision

ACM Classification Keywords

H.5.2. User Interfaces

Introduction

The last decade has brought about interesting developments in combining video games, sports, and exercise. So called motion games or exergames, also known as active video games (AVGs) have become mainstream thanks to technologies like Microsoft Kinect, PlayStation Move and Nintendo Wii. The games require the players to move their bodies instead of only fingers, thus providing a more physically active alternative to gaming. The Kinect depth camera and real-time computer vision
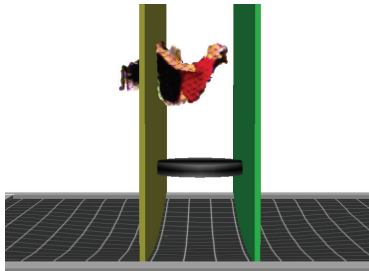
technology in particular have transformed the field, enabling unencumbered tracking of the bodies of multiple players. However, while some motion games have been shown to provide moderate or even vigorous exercise [6], the health benefits of commercial motion games in general are debatable [1, 15]. More research is needed on how to design and implement motion games that are both fun and effective as exercise and motor learning environments.

In this paper we describe new ways to motivate exercising and enhance exercise experience by utilizing **Mixed reality empowerment** and **Expressive amplification of interaction**. These concepts are discussed next and the suggested research for validating the concepts is described in the end.

Mixed Reality Empowerment

Video games can empower their players beyond reality, giving them superhuman abilities and letting them use the abilities for exploring fantasy worlds. Curiosity, challenge and fantasy have been identified among the intrinsic motivations of computer games [14]. Similarly, boosting of abilities can also make real-life exercising fun. Indoor activity parks and fitness centers appear to utilize more and more motion-enhancing equipment such as trampolines, inflatable bouncy surfaces, and crash mats. This prompts the question of whether a combination of physical and digital empowerment could further boost exercise and game motivation. Recently, our group has begun exploring this novel concept, denoted here as *mixed reality empowerment*.

As a practical example, using a Kinect depth camera, computer vision software, a screen, and a trampoline, one can create mixed reality trampoline games that

Figure 1 Top: screenshot of a platform jumping exergame on a trampoline where the avatar's jump height is exaggerated. Middle: screenshot of a virtual training space game where virtual walls give augmented feedback. Bottom: Player on a trampoline.

give the players superpowers both on the screen and in the real world, and provide quantitative feedback about jump height, tightness of tucking in somersaults etc. We have created the trampoline game prototypes shown in Figure 1 and which are described in more detail in [9] and [12]. Our study suggest that a trampoline exergame is more engaging than self-training. In addition, extra empowerment, such as jump height exaggeration further enhances the experience without adversely affecting jumping performance and half of the participants did not even consciously notice it [12]. Jump height exaggeration is explained in Figure 2.

Expressive Amplification of Interaction

The notion of mixed reality empowerment is related to what film scholar David Bordwell calls *expressive amplification of action* in his study of Hong Kong action movies [5]. According to Bordwell, *"After you walk out of the best Hong Kong action movies you are charged up, you feel that you can do anything. How can mere movies create such feelings?"* He argues that Hong Kong action movies select and exaggerate the emotion-arousing features of pursuit or combat. This is implemented using 1) style of acting, such as exaggerated contrast between movement and rest, 2) camera angles and shooting speeds, 3) physical equipment like trampolines when filming, and 4) cutting and post-production effects.

One can argue that many action video games also employ the principles of expressive amplification. There's also relevant computer graphics research such as the style translation system by Hsu et al. [11], which can generate, e.g., an aggressive and powerful versions of weak movements, although not for real-
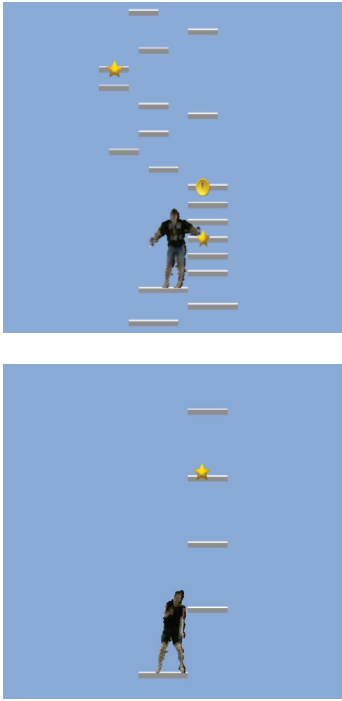
Figure 2 An example of jump height exaggeration in a trampoline exergame. Avatars of two participants are on the same platform. The level design is otherwise the same, but the spacing between the platforms was adjusted to the jump height in the game. In both cases the next platforms can be reached with same physical effort, but in the exaggerated game (bottom) the players can jump many times their height.

time tracking data. However, the concept is almost unexplored in the context of physically interactive games. In addition to our previous studies [8, 9, 12], Bleiweiss et al. [4] recently noted that the player's movements may not be as expressive as what is expected from the player's avatar. They presented a system where tracked movement and animation are blended to yield exaggerated, beautified motions.

In our research, we are interested in extending Bordwell's ideas to mixed reality HCI applied both social and user experience design. For example, the way our trampoline games empower the user in both real and virtual world is similar to how the movement of action movie actors is manipulated during both shooting and post-processing.

Suggested Future Research

One particularly interesting topic of research is how the brain integrates real and virtual information into the percepts of the self and the world, and how the visual, aural and bodily sensations affect each other. The design of a digital self-representation (an avatar) affects action, known as the Proteus effect [16]. Apparently, perception is also affected, as there's evidence that a virtual backpack changes the perceived height of virtual hills similar to an actual backpack [17]. Also in our work, players expressed surprise when seeing how low they really jump when the boosted jump ability is turned off [8, 12]. It has also been shown that if the body is made to express, e.g., happiness or depression, the process reciprocally primes one to feel and act accordingly [3, 13]. Furthermore, children express joy and arousal by spontaneous running and jumping, and there's reciprocal evidence that increased exertion leads to

more engagement, positive affect and arousal in digital games [2, 3].

In light of the discussed research, we propose the following research questions related to expressive amplification and mixed reality empowerment:

- *What abilities of the user can be exaggerated in addition to the jump height and running speed reported earlier?* For example, we hypothesize that one can plausibly exaggerate the flexibility of an avatar and affect the feeling of control and self-efficacy.

- *Can one use mixed reality empowerment and expressive amplification to motivate exercise without adversely affecting learning?* We hypothesize that virtual motion and skill manipulation may motivate exercise, e.g., by increasing the feeling of thrill and masking the fact that learning usually slows down over time.

- *How does expressive amplification affect how an audience perceives the player?* Impressing and audience has been reported as one of the motivations of dance gamers [10]. We hypothesize that the audience's perception of skill can be affected by the virtually exaggerated abilities.

- *Does expressive amplification positively affect perceived competence and self-efficacy?* Perceived competence and self-efficacy are related psychological constructs that measure how one perceives one's abilities and the belief one has in being able to reach goals and execute tasks. We hypothesize that expressive amplification may work similarly to self-modeling, i.e., repeatedly observing the correct or best parts of one's past performance, which has been suggested to affect self-efficacy in sports [7].

References

[1]   Baranowski, T. et al. 2012. Impact of an Active Video Game on Healthy Children's Physical Activity. *Pediatrics*. 129, 3 (Mar. 2012), e636–e642.

[2]   Bianchi-Berthouze, N. et al. 2007. Does Body Movement Engage You More in Digital Game Play? and Why? *Affective Computing and Intelligent Interaction*. A.C.R. Paiva et al., eds. Springer Berlin Heidelberg. 102–113.

[3]   Bianchi-Berthouze, N. 2013. Understanding the Role of Body Movement in Player Engagement. *Human–Computer Interaction*. 28, 1 (2013), 40–75.

[4]   Bleiweiss, A. et al. 2010. Enhanced interactive gaming by blending full-body tracking and gesture animation. *ACM SIGGRAPH ASIA 2010 Sketches* (New York, NY, USA, 2010), 34:1–34:2.

[5]   Bordwell, D. 2001. Aesthetics in Action: Kungfu, Gunplay, and Cinematic Expressivity in Esther Yau. *At full speed: Hong Kong cinema in a borderless world*. (2001), 73–93.

[6]   Bronner, S. et al. 2013. Energy Cost and Game Flow of 5 Exergames in Trained Players. *American Journal of Health Behavior*. 37, 3 (May 2013), 369–380.

[7]   Feltz, D.L. and Lirgg, C.D. 2001. Self-efficacy beliefs of athletes, teams, and coaches. *Handbook of sport psychology*. 2, (2001), 340–361.

[8]   Hämäläinen, P. et al. 2005. Martial arts in artificial reality. *Proceedings of the SIGCHI conference on Human factors in computing systems* (2005), 781–790.

[9]   Holsti, L. et al. 2013. Body-controlled trampoline training games based on computer vision. *CHI '13 Extended Abstracts on Human Factors in Computing Systems* (New York, NY, USA, 2013), 1143–1148.

[10] Hoysniemi, J. 2006. International survey on the Dance Dance Revolution game. *Comput. Entertain.* 4, 2 (Apr. 2006).

[11] Hsu, E. et al. 2005. Style translation for human motion. *ACM Trans. Graph.* 24, 3 (Jul. 2005), 1082–1089.

[12] Kajastila, R. et al. 2014. Empowering the Exercise: a Body-Controlled Trampoline Training Game. *International Journal of Computer Science in Sport*. Accepted for publication, (2014).

[13] Laird, J.D. 1974. Self-attribution of emotion: The effects of expressive behavior on the quality of emotional experience. *Journal of Personality and Social Psychology*. 29, 4 (1974), 475–486.

[14] Malone, T.W. 1981. Toward a theory of intrinsically motivating instruction. *Cognitive Science*. 5, 4 (Oct. 1981), 333–369.

[15] Owens, S.G. et al. 2011. Changes in Physical Activity and Fitness After 3 Months of Home Wii Fit™ Use. *Journal of Strength and Conditioning Research*. 25, 11 (Nov. 2011), 3191–3197.

[16] Yee, N. and Bailenson, J. 2007. The Proteus Effect: The Effect of Transformed Self-Representation on Behavior. *Human Communication Research*. 33, 3 (2007), 271–290.

[17] You, S. and Sundar, S.S. 2013. I feel for my avatar: embodied perception in VEs. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2013), 3135–3138.