Future Entertainment Technologies

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Today's computer games provide a realistic visual output combined with a convincing sound sensation. However, another important perception channel, the proprioceptive sensation, is insufficiently addressed. In particular the perception of spatial distances, which is typically supported by a real walking experience, is not yet integrated into existing games. However, walking is sensed by our limbs both in a proprioceptive way (joints, muscles etc.) and through skin surface sensors. This article describes an approach that could lead to a new quality of future computer games by integrating spatial awareness through the sensation of real walking.

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1. MOTIVATION

Many computer games do not address all human perception channels. While games are realistically presented in terms of 3D graphics and immersive sound, the haptic channel is not well addressed. This holds true in particular for the walking sensation, which is the most intuitive ability to navigate through large-scale environments. As stated by Usch et al. [1999], real walking is better than flying (driving) or walking in place in terms of presence, ease of use, and naturalness. The proprioceptive sensation of real walking in a virtual environment would create a heightened sensation as it could be achieved while just using joysticks or other manual input devices. However, this implies the challenge that a virtually unlimited environment needs to be "compressed" into a physically limited space without the user noticing it.

2. WALKING IN VIRTUAL ENVIRONMENTS

Realizing unlimited walking in a virtual environment started with locomotion interfaces, but now the concept of redirection is favored.

2.1. Locomotion Interfaces

Locomotion interfaces [Bonguila and Sato 2002; Iwata et al. 2005, 2006] allow walking over large distances in a virtual world, but keep the user in a small space in the real word. However, these solutions are very costly and only support the walking experience

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of a single user. In order to achieve a realistic walking sensation, a very complex control algorithm for the walking device is required. However, such devices still cannot provide a fully realistic sensation.

2.2. Redirected Walking

Psychologists have known for years that if the visual and the proprioceptive channels disagree, the visual one dominates [Gibson 1993]. Therefore, it is possible to redirect a user's real walking in such a way that a virtually unlimited space can be compressed into a real limited space since the user unconsciously compensates for small differences between the two perception entities [Burns et al. 2005].

3. ADVANCES IN REDIRECTED WALKING

In previous work, various concepts were explored to determine how such a redirection could be achieved, ranging from scaling of linear movement [Interrante et al. 2007] via continuous redirection, to placing obstacles in the user's way [Peck et al. 2008]. In 2001, Razzaque et al. proposed a novel locomotion technique for virtual environments that captures the benefits of real walking while extending the physically limited size of the virtual environment [Razzaque et al. 2001]. Their method called Redirected Walking (RW) is based on the idea of imperceptibly rotating the virtual environment around the user causing him to reorient and walk continually towards a certain fixed point. Hence, RW allows increasing the felt size of the virtual environment beyond the size of the physical room. RW adds a rotational distortion to redirect a user in a virtual environment. Depending on whether the user is walking, standing, or turning, the injected rotational distortion differs. The goal is to prevent the user from noticing this injected rotation and to make him think that the external motion is in fact self-motion [Razzaque et al. 2002].

Meanwhile, several Reorientation Techniques (ROT) were proposed. Nitzsche et al. [2004] introduced a method called Motion Compression (MC), which bends the user's predicted path in the virtual environment so that it always fits into the physical space. In contrast to RW, MC does not have the goal of an imperceptible VE's rotation. Instead, it guarantees that whenever a user approaches an edge of the tracked area, the VE rotates so that the predicted user path points back to the tracked area. Hence, the user gets the impression of a spinning virtual environment. Similar to Razzaque's idea of adding rotational distortion, Williams et al. [2006] suggested a ROT that scales the translational step-size of a user in a virtual environment. Scaling the translational step-size allows visiting virtual environments which are larger than the physical space, but it does not address the problem of reaching the physical limits of the tracking area. Williams proposed several ROTs to reset the users' location in physical space to move them out of the path of the physical obstruction maintaining their spatial awareness of the virtual space" [Williams et al. 2007]. Peck et al. [2008] proposed a new approach for ROTs called *distractors*. These are virtual objects for the user to focus on while additional scene motion is inserted into the virtual environment.

4. APPLICATION TO ENTERTAINMENT

Today, research is focused on redirection technologies concerning the human perceptual threshold where any redirection remains unnoticed to the user [Zuberbuehler 2003]. While such technologies can only be used to a certain extent for the visualization of realistic environments, they are very suitable for experiencing new haptic sensations in an artificial environment, which does not claim to be a realistic and geometrically correct. Within a fictive world, new reorientation techniques could even increase the possible "compression", making them suitable for use in various applications: entertainment, serious games, as well as in medicine or education.

In such a real-walking virtual environment, the user would wear a head-mounted display and be tracked in position and orientation. In order to experience the illusion of unconstrained and unlimited walking in a virtual environment, the real world must not be visible and thus only a non-seethrough head-mounted display could be used. The tracking system and the employed algorithms must guarantee that the user will not bump into the room's real wall. It also will be possible to have multiple users in the same virtual environment, who will be visible to each other as avatars. If the users are collocated, the reorientation algorithms also have to prevent multiple users from bumping into each other, while the tracking systems must be capable of tracking multiple users. Net-based systems will be possible. Having multiple users in such a virtual environment could not only increase the possibilities in entertainment applications, but also in other fields. A user could be an opponent, but also a trainer, a member of a team, a teacher, etc.

5. CONCLUSION

Based on ongoing intensive research in reorientation techniques and on upcoming cheap tracking technologies, a user will not be passive in the future when navigating through virtual environments in computer games. The sensation of real walking instead of using a pseudo-sensation by controlling for instance, an avatar with a joystick will open many scenarios not only for entertainment, but also for education or medicine.

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