Future entertainment technologies

Report

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Abstract
Today's computer games provide a realistic visual output, combined with a convincing sound sensation. However, another important perception channel – the proprioceptive sensation – is only 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 thus describes an approach that might lead to a new quality of future computer games by integrating a new spatial awareness through the sensation of real walking.

Motivation
Many computer games lack in addressing all human perception channels. While games are realistically perceptualized in terms of 3D graphics and immersive sound, the haptic channel is not addressed very well. This holds in particular true for the walking sensation, which is the most intuitive ability to navigate through large-scale environments. As stated by [Usch99], 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 much higher sensation as it could be achieved when 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 this.

Walking in Virtual Environments
Previous work for realizing unlimited walking in a virtual environment started with locomotion interfaces, while recently the concept of redirection is favored.
Locomotion interfaces
Locomotion interfaces [Bong02], [Iwata05], [Iwata06], [Schwai07] allow walking over large distances in a virtual world, but keep the user in a small space in the real word. However, all of these solutions are very costly and only support the walking experience 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.
Redirected walking
Psychologists have known for years that if the visual and the proprioceptive channels disagree, the visual one dominates [Gib93]. 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 at least the two perception entities [Burns05].

Advances in Redirected Walking
In previous work, various concepts were elaborated how such a redirection can be achieved, reaching from scaling of linear movement [Inter07], via continuous redirection, up to placing obstacles into the user's way [Peck08]. 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 [Razzaq01]. Their method called "Redirected Walking" (RW) is based on the idea to imperceptibly rotate the virtual environment around the user causing him to reorient and to 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 that the user does not notice this injected rotation and to make him think that the external motion is in fact self-motion [Razzaq02].
Meanwhile, several reorientation techniques (ROT) were proposed. Nitzsche et al. [Nitzsche04] 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 into 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. [Williams06] 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 when 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" [Williams07]. Peck et al. 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.

Application to Entertainment

Today, redirection technologies are researched concerning the human perceptual threshold, to which any redirection remains unnoticed to the user [Zuberbuehler03]. While such technologies only can be used to a certain extend 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 to be used in various applications: entertainment, serious games, but also in medicine or education.

In such a real-walking virtual environment, the user will wear a head-mounted display and is tracked in position and orientation. In order to reach the illusion of an unconstraint and unlimited walking in a virtual environment, the real world must not be visible anymore and thus only a non-seethrough head-mounted display will be used. The tracking system and the employed algorithms will 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 for each others as avatars. If the users are collocated, the reorientation algorithms also have to prevent multiple users to bump into each other, while the tracking systems must be capable of tracking multiple users. However, also 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.

Conclusion

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

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