

Real Walking in Virtual Environments

A new Experimental Device.

Michael M. Popp¹, Emmanuel Gouy¹ & Jens Holtmannspötter¹

Human Factors Institute
Faculty of Aerospace Technologies
University of the Armed Forces Munich
Werner-Heisenberg-Weg 39
85579 Neubiberg
michael.popp@unibw-muenchen.de

1 Introduction

Experiments in VR are increasingly useful for research of human navigation and orientation. But they suffer from different problems. One of these problems is the incompatibility between field of view and real movableness. Wearing a head mounted display (HUD) gives the possibility to walk around like a pedestrian in reality. But visual field of view and resolution of the image of the VR are poor. Standing in the middle of the projection sphere of a high-resolution projection system, the optical image fills the whole field of view and the scene could look very realistic. But is not possible to move physically more than one step away from the focal point without loosing the realistic visual impression. An immersiv optical flow field is necessary for the impression of presence in a VR but isn't sufficient. Our own research showed significant differences in distance perception between walking in the reality and moving through an optically corresponding VR (Popp et al., 2004).

To solve this problem, different approaches have been made. Some labs use fixed based wheelchairs or bicycles to supply the experimental subject with some of the nonvisual stimuli of moving without leaving the focal point.

2 Spheres and Treadmills

A lot of ideas have been patented concerning the solution of real walking around without leaving the focal point of VR projection systems. Some of them look strange and only a few have reached the stage of prototypes. An interesting approach is the omni-directional-treadmill (ODT). Two perpendicular tread-mills, one inside the other, enable bipedal locomotion in any direction of travel (Darken et al., 1997). But the construction produces more than 80 dB noise in action. Another approach tried to solve the problem in using a transparent sphere (torus treadmill) in which the experimental subject should be able to walk in every desired direction. The VR

projection uses the semi transparent material of the sphere as its projection surface (Iwata et al, 1999).

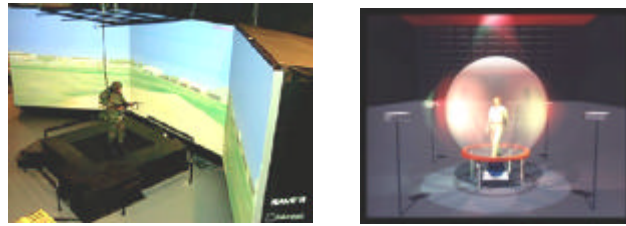


Fig. 1: left) omnidirectional treadmill, right) torus treadmill

3 Think simple!

Using only a simple unidirectional (forward/ backward) treadmill we look for a method to sense position and direction of a walking person using only two infrared point light sources on both shoulders and two infrared video cameras positioned on both sides of the treadmill.

3.1 Walking straight ahead

The video streams of both cameras were converted and processed using two video capture cards in a standard PC (Linux). The program computes the position of each light point relative to the borders of the whole image in the X direction for each frame. The contra rotating oscillations of the shoulders are symmetrically if a walking person moves straight ahead. In this case the mean value of the position of both shoulders is the position of the body center of the moving person.

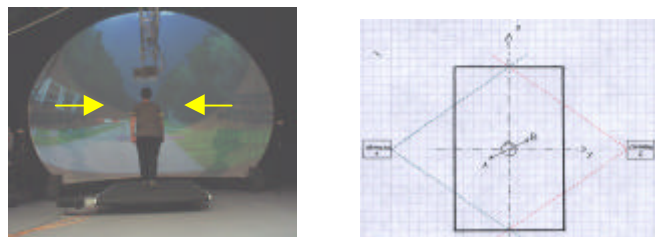


Fig. 2: left) infrared emitters, right) principle of position calculation

From the position differences in time, speed and longitudinal direction (forward/backward) of the target is calculated. The speed value is used to control direction and speed of the tread-mill. Some extra calculations are necessary to fit onto the inertia of the moving parts of the treadmill.

3.2 Walking curves

Whenever a person changes the direction of walking, the first body action is a turning of the shoulder belt into the new direction. Our shoulder position detecting device is able to detect these turnings of the shoulder belt too. The solution of this task uses the fact, that people guide their walking movements and body orientation towards the goal they want to walk to. If their goal moves in the visible image, they change their direction of movement accordingly.

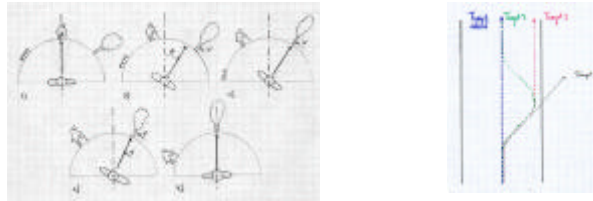


Fig.3: left) principle of rotation calculation, right) walking trajectory on the treadmill in walking a curve

Whenever the computer program detects a significant change of body orientation, the projected visual world is rotated against that deviation. The result is a tracking back of the movement to the center line of the treadmill towards the goal which now moves step by step towards the center of the projection. Some effort is necessary to low pass filter unintended body rotations and too 'nervous' visual system reactions.

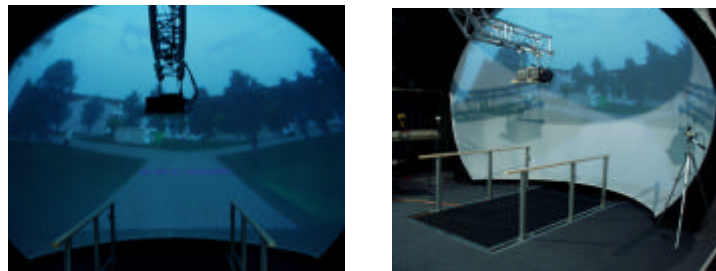


Fig. 4: VisionDome V5 at the University of the Armed Forces Munich with the new walking device

The mechanical components of the system are set up und we now are concerned to do the necessary calibrations to make the system usefull for our experimental purposes in the field of human navigational behavior in large scale urban areas.

References

- Darken R.P. & Carmein D. (1997). "The Omnidirectional Treadmill: A Locomotion Device for Virtual Worlds." Proceedings of UIST '97, pp. 213-221.
- Iwata H. & Yoshida Y. (1999). "The Torus Treadmill solved the Problems in the Darken's ODT: Path Reproduction Tests Using a Torus Treadmill". PRESENCE, Vol. 8, No. 6, pp 587-597.
- Popp M. M., Platzer E., Eichner M. & Schade M. (2004). "Experiments in Virtual Reality and the Reality: Perception of Distance and Time in Large Scale Urban Areas." PRESENCE, MIT Press, 2004 (in press).