The Pelvis as Physical Centre in Virtual Environments

Josef Widesström, M.Arch
Chalmers Medialab
Chalmers University of Technology
SE-412 96 Göteborg, Sweden
josef@medialab.chalmers.se

Pia Muchin, MFA
School of Theatre and Opera
Göteborg University
SE-405 30 Göteborg, Sweden
pia.muchin@scen.gu.se

ABSTRACT
The increasing uses of virtual environments (VE's) stress the importance on how the human body relates to the concepts of *motion* and *space*. Normally, the visual sense is used as the centre of VE's, with the eyes as physical control point. However, our study shows that the pelvis should be used as physical center to create the necessary connection between humans and virtual space in order to minimize distress.

Keywords
Human motion, space, Virtual Environments, 3D-Cube, gravity, pelvis, dimensions, icosahedron, agreement, connection, concept, balance, human-computer interface.

1. INTRODUCTION

Virtual Reality (VR) has a strong tradition of visual simulation, focused on rendering the camera view in real-time [1]. Since the development from head mounted displays to immersive 3D-Cube VR, humans can actually be present in the virtual environments (VE) with their own bodies. Still, the VR technology is focused on tracking the user's head so that the computer can render the correct perspective. Her hands might be used to interact with the environment, but her body works only as a tripod for the camera. This evidently causes discomfort in an immersive environment.

In the relationship between humans and space Laban [2] formed in the 1950's a number of definitions that can be used as tools to identify existing problems and to improve the interface between humans and VR.

The purpose of this study is to develop new technical and interaction models and concepts to improve the Human-Computer Interface and the symbiotic relation between man and machine.

2. HUMANS AND SPACE

Space is the place that humans take possession of through physical, emotional and intellectual motion. The size and shape of the space is determined by outer limitations. The void between the limitations defines the possibilities for the individual to expand its own space relative to the outer limitations. When *humans* enter a space, the connection between humans, space and objects creates an expectation of muscular, intellectual and emotional preparation. This constitutes to the foundation of the *agreement* between humans and space called the *extrovert space*. Into this space humans carry their own physical space called the *introvert space*. Laban is using the geometrical concept *icosahedron* to capture the individual's total *kinesphere*, defined by the maximum stretch of the body without stepping out of the center of gravity. Bartenieff [3] shows the three dimensions of physical space where every change in movement originates from a centre in the pelvis, Fig 1.

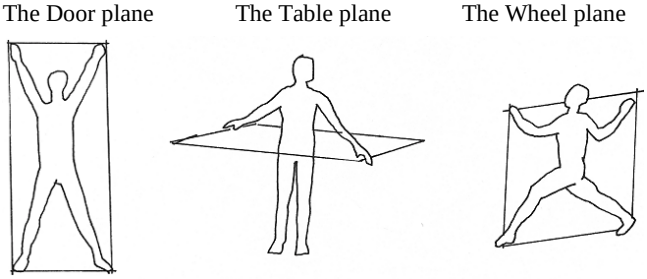

Figure 1. The three dimensions of physical space.

3. VIRTUAL ENVIRONMENTS

The VE's are run on Chalmers Medialab's five-wall, cave-type immersive 3D-Cube system connected to a 14-processor SGI Onyx2 computer. For motion tracking in the 3D-Cube a Polhemus electromagnetic tracking system with four sensors for placement on the body and other items for 6DOF (degree of freedom) movement is used. One sensor is mounted on a pair of CrystalEyes LCD shutter glasses providing input to the computer so that the viewer perspective is projected correctly on the walls.

4. EXPERIMENTS

Fifteen different immersive VE applications are explored ranging from architectural environments to games and scientific visualizations. To illustrate the problem we focus on the "The Cave Labyrinth" developed in the VR toolkit Avocado.

4.1 The head as the physical center

Standing in the VE the navigator can move rapidly through deep caves, over high bridges and along steep edges by pressing a button and steering with a wand in her hand. The application presents a powerful, infernal underground filled with gravity and flow. As soon as the user starts to move it becomes clear that the agreements are made on the conditions of the application, and that you just have to adjust to the upcoming concepts. The user doesn't move but *travels* in the three dimensions of:

Space: direct - flexible motion

Time: sudden - extended

Force: light - strong gravity

You steer with your hand, defining a spatial orientation from the relation between the hand and the eyes. However, the only control point the user has is the maneuver device in her hand for navigation through the caves corresponding to the perspective of time and space. When the tempo is changed the application interacts with the user who gets a physical experience of increased muscle tonus and stronger emotions when the sense of balance is affected, just as in a roller coaster. The physical experience will however confuse the agreement founded in the user's physical centre and therefore, there is a conflict between the method of navigation using the hand and the strong feeling of gravity. The sense of balance is lost and the user gets nauseous.

4.2 The pelvis as the physical centre

The spatial orientation is now moved from the head or the hand to the pelvis, where a tracked sensor is attached defining the directions, Fig. 2. Now the physical directions in the *extrovert* space are established and the three dimensions of the *introvert* space are centred. Gravity can now be experienced from this centre.

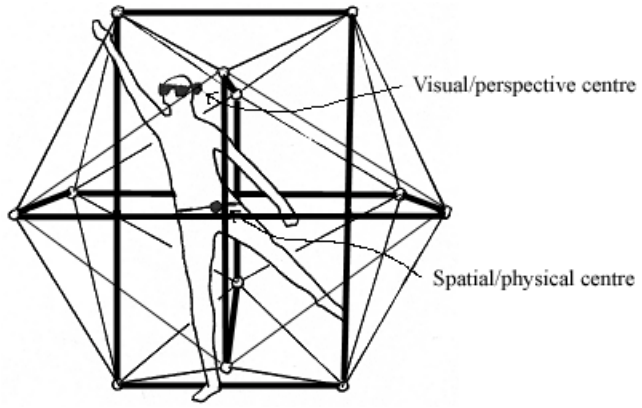

Figure 2. The virtual icosahedron.

5. RESULTS AND CONCLUSIONS

The examination of the VE's indicates two important problems to solve:

- **Orientation**: there is no connection between the user's physical centre and the concepts of *navigation/ orientation*. Therefore, the experience from the application is like driving an invisible vehicle simulator.
- **Gravity**: realistic or concrete VE's give the user an expectation of gravity. When the experience of gravity is missing, the *agreement* between human and space doesn't work, and the user gets confused about the concepts.

It is clear that connecting the physical centre to the concepts of *navigation/orientation* is the most important issue. It is also necessary to separate the *visual/perspective centre* from the *spatial/physical centre*. It is quite natural that the eyes should work as a visual centre, since you see with your eyes. It should be just as natural to use the pelvis as physical centre, since that is where the direction of the human body in relation to space is centred.

Our initial trials show a major difference in the experience of being present in the environment when your own body is more involved. The improved sense of balance is also a major factor to lessen VR nausea.

6. FUTURE WORK

We have developed a virtual *icosahedron* with a tracked pelvis. We are continuing our experiments in order to evaluate these tools. The virtual icosahedron will also be developed to involve both auditive and haptic feedback.

ACKNOWLEDGMENTS

We thank the staff at Chalmers Medialab for guidance and inspiration, especially Sven Andersson and Henrik Ahlberg.

REFERENCES

1. Ellis, Stephen R. *Origins and Elements of Virtual Environments*. Barfield, W. and Furness, T. A. Virtual Environments and Advanced Interface Design. Oxford University Press, 1995.
2. Laban, Rudolf, revised by Ullman, Lisa. *The Master of Movement*, Billing & Sons Ltd, Worcester, 1988
3. Bartenieff, Irmgard. *Body Movement*. Gordon and Breach Science, 1980.