## The *kata* of Web3D (online id web-028)

Chris Thorne*
Ping Interactive Broadband
University of Western Australia

## 1. Introduction

In karate one does *kata* or prescribed movements. Throughout the kata you must maintain your mental and physical balance or *center*. This paper proposes centered motion for computer graphics where, as a viewpoint is moved the viewer's position within the viewing coordinate space stays at (0,0,0) and instead other objects are moved in reverse around the origin. The benefit of this approach is that one can navigate virtually unlimited spaces without motion instability resulting from coordinate precision limitations

## 2. Understanding the motion instability problem

Without smooth motion in VR it is hard to navigate, there is loss of realism and it may be uncomfortable to the eyes. Most 3D graphics hardware and software is limited to no more than single precision floating point, and often a lot less. In geographic terms, single precision floating point allows smooth motion over an entire 2km radius volume. In larger environments motion starts to become perceptibly unstable towards its boundary. At about 100,000 radius there is very bad *jitter.*

In our centered motion or *zero centered* (ZC) system the world model is maintained on a distributed server network. Users have an independent client localized view. In the ZC model avatar viewpoint selection and avatar motion actuators leave the avatar viewpoint at the coordinate origin and move other world objects around avatar position instead (figure 1).

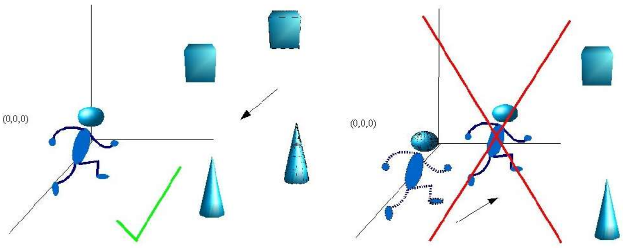


*Figure 1 Zero centered motion*

This approach keeps high fidelity motion within the vicinity of the observer no matter what his corresponding real world position. Unstable motion may still occur for objects at great distances from the observer but such instability will not be discernible - due to perspective foreshortening – even if it is visible. Instability is effectively pushed far away from the viewpoint.

Figure 2 shows the relationship between clients with their localized views and the server network. Server(s) maintain the real world model in a ZC client's universe using high precision coordinates. When a client requests information its coordinates are transformed to be relative to the client local origin before displaying. This can be done either by pre-transforming the coordinates before sending to the client or by adding a reverse transformation around the client's scenegraph.

The closest approach to ZC was that taken by GeoVRML [Reddy et al 2001] and TerraVision [Leclerc et al 2002] which used GeoVRML. In GeoVRML the client specified an origin in real world coordinates. The client scenegraph was then transformed to be relative to this origin, which becomes (0,0,0) in local viewing coordinates. Both systems allow avatar motion relative to the local origin. Terravision partly makes up for this: whenever the user viewpoint became far enough from the viewing origin as to cause instability the origin was reset to the viewpoint position. ZC motion goes one step further and keeps the viewpoint at (0,0,0).

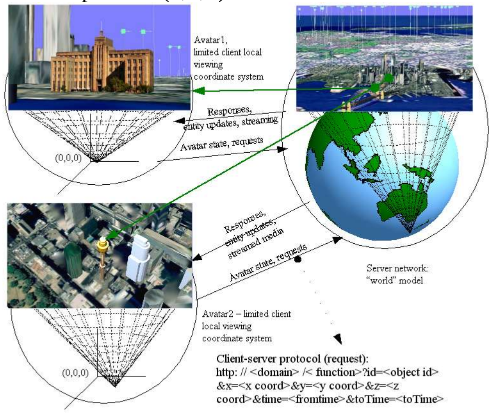


*Figure 2 ZC Client views into distributed server world model*

GeoVRML both maintained the real-world coordinate model and transformed the scenegraph all on the client. Terravision used the same GeoVRML system. Therefore, both were limited to client capabilities (GeoVRML became limited by a now defunct VRML web browser plugin). ZC performs these operations on the servers, liberating the application from client limitations. The main constraint is that real-world avatar position needs to be transmitted back to the server(s) so that correct real-world positioning can be maintained.

## 3. Conclusion

The common approach to motion in 3D graphics moves the avatar viewpoint relative to the viewing coordinate system origin. ZC motion maintains the viewpoint at the local view system origin and instead moves the rest of the scengraph in reverse. The ZC approach maintains smooth navigability and object motion within the viewer's vicinity no matter where the viewer's real-world position is in a highly scalable virtual space. If 3D graphics engines support this motion rule it will be possible to consistently visualize large distributed VR spaces on challenged devices.

## References

1. Leclerc, Y., Reddy, M., Eriksen, M., Brecht, J. and Colleen, D. 2002, *SRI's Digital Earth Project,* Technical Note No. 560, Artificial Intelligence Center, SRI International, Menlo Park, CA.
2. M. Reddy, L. Iverson, Y. Leclerc, and A. Heller (2001). *GeoVRML: Open Web-based 3D Cartography.* In Proceedings of the International Cartographic Conference (ICC2001), Beijing, 6-10 August 2001.

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*e-mail: chris@ping.com.au