Virtual Wiiality Redux

Background Research

Joel Clemens

Multimedia 4B03

For Prof. Rockwell

Virtual Wiiality Redux was created to increase accessibility of the type of technology required to experience artificial reality. The idea of virtual reality has been around for a while, but yet it seems to be limited to high end commercial applications and academics. There are many people who want access to this for the main motivation of enhanced media immersion. Through research, trial and error, and tactical compromising, a home accessible and reproducible product has been achieved.

Firstly, what this project is trying to accomplish is not only technology accessibility, but also true Six Degrees Of Freedom (6DOF); vertical, horizontal straight, horizontal sideways, pitch, yaw, and roll movements. The ultimate goal is to be released from the constraints of cables, tracking transducers, and or wall projections. Ultimately, with further development, any empty room could theoretically become similar to Star Trek's 'Holodeck'. Naturally, it is expected that others have attempted this too, by reviewing existing research on the subject, verification and or problem solutions can be obtained to aid this project.

Since Myron Krueger's time, there have been many variations of responsive artificial environments. Krueger (1977) built a room with floor sensors, allowing the environment to respond to the user's location. VR has evolved based on that, and still keeps the same constraints that were necessary at the time. The user is bound to a small enclosed area, regardless of having 6DOF enabled or not. Also, having 6DOF in the first place is essential for a proper immersive experience.

Some people admit the convenience of limited space because of existing hardware and software allows easy interaction while sitting down at a computer. Yet enhanced immersion is still desired. This is evident in Steffi Beckhaus' et al. (2005) project dubbed

‘ChairIO’. They modified a stool so that it acts as a joystick to control movements in a 3D shooter type environment, while the user holds a motion tracked gun to point at a projection. Rotation of the stool rotates the view, bouncing the stool causes a jump, and leaning in a direction will cause motion in the virtual environment. It should be noted that the user must still face one direction as the projection is not mobile. A slight rotation of the chair will cause the camera’s yaw to start moving. While the ChairIO system may lack in practicality, it is an excellent example of ongoing experimentation and expansion with tools to increase accessibility and quality of artificial environments. User test results also reported that it can be fun to use. It also inspires the idea for a portal cave-type simulator by mounting a pocket sized projector onto a pointing device, such as a gun, along with pitch, yaw, and roll tracking hardware. An appropriate projector could be the solid state laser projector by Microvision available next year.

There is a head tracking method developed by Jurriaan D. Mulder et al. (2003) that is meant to be affordable and therefore accessible. Yet, like most VR systems, the user is still forced to the confinement of a desk and chair. They explain:

> Many types of 3D applications do not require CAVE-like, fully immersive environments. Often, fish tank, desktop, or dexterous types of environments are sufficient.

Using 2 fire-wire cameras, a pattern of 3 high contrast dots, and some special software, they have been able to replace an expensive acoustic head tracking system. In this particular project, the user is intentionally constricted to a desk because the desk itself is part of the experience. The Personal Space station allows the user’s hands to directly (physically and virtually) manipulate objects for an augmented reality experience. Like the ChairIO, this is technically doing 6DOF, and is an excellent step in the research of VR/AR methods.

The immersive method of using a cave-type simulator for artificial reality has not been left out. Vorozcovs et al. (2005) presented a new type of head tracking meant for cave systems. ‘The Hedgehog’ uses computer controlled laser diodes to project unique dots onto the cave walls that can be then tracked by cameras. It seems that the more immersion that is sought, the more complicated, the more complicated the systems become. This project isn’t something that can be easily reproduced by those who are on limited time and or budget. The cave system alone requires special software and projection hardware. If lasers can track position of a person in a confined area, and a laser mouse and track absolute position on any mouse pad, then could this technology be developed further to be free of the cave? Though this technology is not immediately accessible to everyone, this could become so with time.

Breaking free of confined areas is also not left un-researched. If the head motion can’t be tracked outside a confined space, then a compromise would be to track the motion from footsteps, or the motion of the floor below the user. Leaving the confined space would also mean leaving behind Krueger’s floor panel sensors. This would then require the user to have receiving sensors on the body that could tell the computer direction and speed. Shun-yuan Yeh et al. (2007) developed a system to track foot motion on geta sandals. A Geta is a type of wooden sandal that originates from Japan. It is a flat wooden block which is traditionally supported with 2 blocks on the bottom that are perpendicular to the foot. They augmented the sandals with; ultrasonic-infrared transceivers, pressure sensors, RFID tags, and again with accelerometers. Human walking patterns are non-uniform and require complex algorithms to be expressed mathematically. With some limited success, they were able to track footsteps walking, going up stairs, and jumping, however, the methods had accuracy issues and error was introduced in all attempted methods.

Expanding on the geta tracking's accelerometer method is Michael Dippold's (2006) Dead Reckoning step tracking. This project is part of a development process of an actual commercial product now available from Xsens Motion Technologies. Building on the same complex algorithms, and adding noise filters, Dippold successfully built a positional tracking device using accelerometers in the foot. He used a not only accelerometers, but a digital compass, and gyroscopes in the device as well. This device is intended for long distance walking as a supplement to GPS tracking. Similarly, and more appropriate to artificial reality is a project by CarloAlberto Avizzano et al. (2004) who attempted the same thing using accelerometers mounted on a pair of glasses. Much like the Geta sandals, this group had problems with accuracy. They concluded that the system had to rely on user feedback to correct for accumulated error.

With the dropping price, size and power consumption of accelerometers, they are becoming more and more popular among researchers and developers as the motion tracking transducer of choice. "By monitoring a combination of angle of tilt, direction and velocity of motion, relative change in position, amount of shock, frequency, vibration, and freefall we can transform a game controller into a motion recognition system." (Kelsey, 2007). Accelerometers alone won't be able to properly track a full range of motion, as Dippold's project proved, additional components were required.

Also returning to the point of accessibility, using hardware that people already have or is readily cheaply available is paramount to increased spread of this technology. With increased spread, comes increased development, and therefore increased quality. Using latest generation console controllers is hardware that meets this ideal. When the Virtual Wiiality Redux project started, it was determined that using only accelerometers available in the Nintendo Wiimote would not be enough. Since the Sony Playstation Sixaxis controller also includes a gyroscope, it seemed much more plausible for a working motion tracker.

For absolute position tracking, while it is proven to be technically possible for the sixaxis' accelerometers to track direction and speed, there is a lack of resources to complete this development in an inexpensive and timely manner. It seems reasonable to conclude that step/walk tracking is not a reliable method of absolute position tracking at this time. A technique that is seems previously unattempted would be to use a trackball type peripheral that would augment the joystick of the sixaxis. Similar to a ball mouse, the speed and direction of the user moving along the floor will be detected by a ball and axels. This would be wired into the joystick which would in turn, directly control the direction and speed of motion in the virtual environment. This is indeed a compromise as the user would need to push/drag this "mouse" around the floor via broomstick or something to that effect.

Absolute position tracking technology certainly does already exist, and has been used before, but has been limited to those with access and can often have space limitations. Expanding our capabilities in using technology to better ourselves and our environment is highly dependant on accessibility. Putting a limitation on cost, who, and how long it can be used for, inherently limits how fast it can be developed and implemented. By opening up new ideas for executing the concept of artificial reality, we can readily create new, useful and fun applications. UCSB's Christine Ma's psychology experiment is an excellent example on how this can be applied. "Christine and her advisor conducted an experiment in which subjects were instructed to walk across a narrow plank in a room while wearing VR goggles which streamed a video of them walking above a vast abyss." (Saeang, 2008) The psychology aside, this concept is a novel idea to demonstrate the potential of this open source VR project. Christine's project had much more than merely crossing an abyss, this basic concept should prove an adequate and fun application example for Virtual Wiiality Redux.

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Appendix

Microvision's Show (pocket laser projector)

http://www.microvision.com/

Xsens Motion Technologies.

http://www.xsens.com