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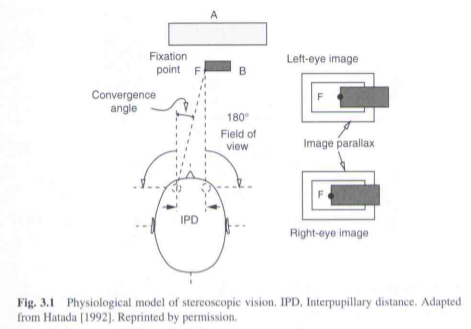
Mechanics Of VR

This section of the essay relates to the technology and architecture behind Virtual Reality, the systems the user interacts with and how they all work together to maintain a sense of immersion for the user.

Graphics Displays

The primary means of human-computer interaction in VR is the Head Mounted Display (HMD) which provides a graphics display using LCD or CRT-based technology although nearly all modern VR systems use LCD and even OLED displays. An effective graphics display needs to match its image characteristics to those of the user’s ability to view the synthetic scene. Essentially this means that each display, (one for each eye) must be similar in shape and render the synthetic scene in a similar manner to the human eye. (pg. 58 Virtual Reality Technology 2003) The human eye has an uneven distribution over the retina. The central area of the retina is called the fovea. It is a high-resolution, colour perception area. This area is surrounded by low-resolution, motion perception photoreceptors covering the rest of the eye. With this in mind the HMD must display a focused image over the fovea. Many systems include eye-tracking to dynamically update this area, tracking the fovea. Early models, such as the first oculus rift did not have eye tracking.

Another aspect to consider in relation to the HMD is the human field of view. It is 180 degrees horizontally and 120 degrees vertically using both eyes. There is a central area called the stereopsis where both eyes register the same image. This overlap is 120 degrees horizontally and the brain uses it to measure depth. This is important when helping the brain measure depth in VR to keep the sense of immersion.



The point F in the diagram above will appear shifted horizontally between the eyes due to its position being different in relation to each eye. This image shift is called parallax and needs to be replicated by the HMD to help the brain interpret depth in the synthetic world. To do this each display outputs two slightly shifted images. If the HMD uses one single display instead of one for each eye the two images are either time-sequenced or spatially sequenced. Depth perception, high-resolution images and depth perception are important factors to sustain a feeling of immersion and also important for preventing the user from feeling nauseous or getting motion sickness. Depth perception is simulated using shadows, occlusions, surface texture and object detail. On single display systems depth perception is made using motion parallax, where closer objects seem to move further than distant ones when the user moves their head. (pg. 59 Virtual Reality Technology 2003)

User Tracking- Hybrid Inertial Trackers

Hybrid Inertial trackers are used in more modern VR systems and use microelectromechanical systems technology. These trackers are used to track an object, primarily the user to simulate their position and limb movement in the simulation. Using gyroscopes, the angular velocity of an object if measured. Three of these are machined on mutually orthogonal axes, measuring yaw, pitch and roll angular velocities. The trackers also measure acceleration using solid-state accelerometers, three are machined coaxially with the three gyroscopes to measure body-referenced accelerations. Such as using user movement to move in the simulation and to track arm movement for manipulation with the simulation. (pg. 38 Virtual Reality Technology 2003)

The advantages of using hybrid inertial tracking is the unlimited range, no line-of-sight constraints like with optical tracking and very low sensor noise. Although this can be filtered out through integration. All of this adds to reducing the latency of the tracking operation. Although there are significant drawbacks to inertial trackers, they have rapidly accumulating errors or drift and can lose synchronisation with the user. Once drift starts to occur the error in calculating the user’s position or the percentage error increases with time, such as accelerometer bias that increases by the time squared. To solve the drift problem data is used from other trackers to reset the output of the inertial trackers. (pg. 39 Virtual Reality Technology 2003)

Manipulation Interfaces

A manipulation interface is a device that allows the interactive change of the view of the virtual environment through selection and manipulation of a virtual object of interest. The manipulation can be through either absolute coordinates or relative coordinates. Trackers like the hybrid inertial trackers are absolute as they use the position and orientation of a moving object with respect to a fixed system of coordinates. Then the objects in VR are directly mapped to the absolute position of the user in the world. Relative sensors is an alternate tracking option which returns zeros when the user is at rest whereas absolute positioning data is a never zero set. (pg. 41/42 Virtual Reality Technology 2003)

One example of a manipulation interface which uses relative sensors is the Didjiglove, which even tracks the use’rs fingers with the hand. To do this it users 10 capacitive bend sensors. A conductive layer of sensors is arranged in a comb like fashion, such that the overlapping surface is proportional to the amount of sensor bending. (pg. 51 Virtual Reality Technology 2003) The Didjigolve uses an A/D converter, a multiplexer, a processor, and an RS232 line for communication with the host computer. The 10-bit A/D converter resolution is 1024 positions for the proximal joint, which is the joint closest to the palm. The glove calibrates the finger position by reading the sensor values when the user keeps the finger extended, with the value of 0 and when the fingers are bent which the value is set to 1023 and any values in between relative to the fingers position. The Didjiglove was designed as an advanced programming interface from computer animation, for the 3D Studio Max toolkit but due to the gloves low latency of 10 milliseconds, the glove was highly suitable for VR interactions as well. (pg. 52 Virtual Reality Technology 2003) The 5DT Data Golve measured each finger separately and also featured a title sensor to measure wrist orientation. Each finger has a fiber loop routed through attachments which allow for small translations due to finger bending with additional sensors for minor joints. These fiber-optic sensors are compact and light which grants greater comfort to the user. The 5DT communicates with the host computer similarly to the Didjiglove using multiplexers and RS232communcation ports. (pg. 49 Virtual Reality Technology 2003)

Reference: Grigor C. Burdea, Phillippe Coiffet (2003) Virtual Reality Technology, 2nd ed., John Wiley & Sons