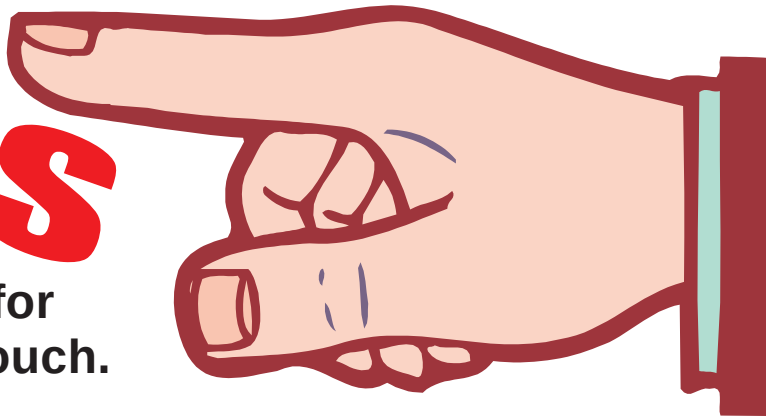
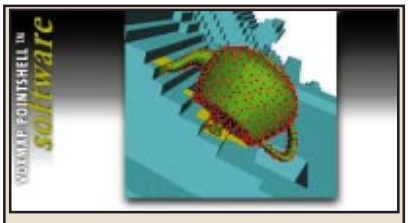
HAPTICS



Virtual reality for the sense of touch.



Voxmap PointShell™ Collision-Detection Software

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Voxmap PointShell (VPS™) is a new advanced software technology from Boeing that will help you solve certain difficult geometry-related computing problems much faster and more efficiently than comparable technologies. Examples include detecting when two moving objects collide in a computer simulation, or even when they come within a certain distance of each other.

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In a virtual reality environment, the VPS physically based modeling capability will help you ensure that colliding objects react realistically to contact instead of uselessly passing through each other. This problem is so difficult that the capability is either missing or very limited in today's VR systems. But VPS solves this problem at a speed that satisfies even the extremely demanding requirements of force-feedback devices, which in turn enables the VR user to touch, feel, and manipulate virtual objects.

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VPS source code is now available for licensing to qualified software and hardware developers.

VPS
Voxmap PointShell™

Have you ever wondered what it feels like to touch the virtual world? A collaboration currently underway between The Boeing Company and SensAble Technologies, Inc. will allow you to do just that. Based upon unique software developed at Boeing, the project enables a user to manipulate a modestly complex rigid object within an arbitrarily complex environment of static rigid objects, while at the same time yielding stable and convincing force feedback through a full 6 degrees of freedom (6-DOF—3 translational and 3 rotational). With this capability, it will be possible to test assemblability in a CAD model, for example, feeling the clearances between a fuel pump and the engine housing in the digital mockup of an automobile.

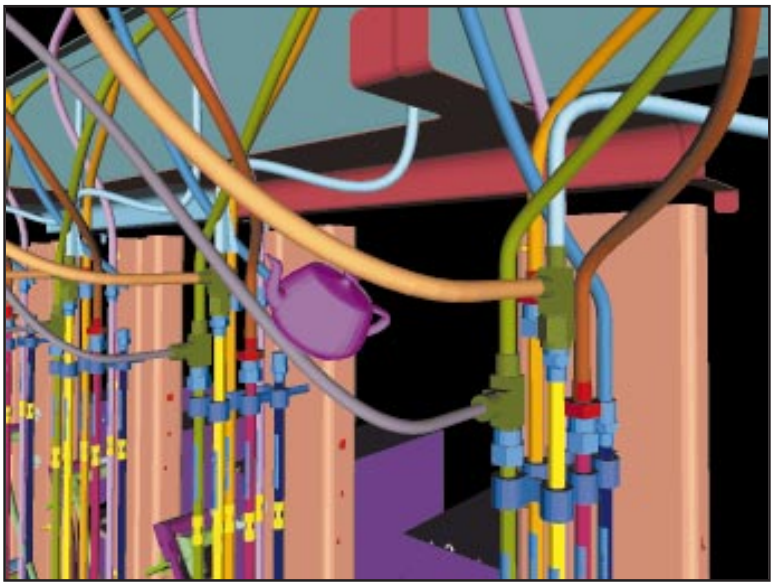
Current graphical applications allow users to navigate within a 3D virtual reality scene. However a typical 3D scene graph does not allow the user to sense physical properties, such as collisions and reaction forces, which are critical to realistic and efficient real-time simulations. Voxmap PointShell (VPS) enhanced with Physically Based Modelling changes all that. VPS monitors the movements of a virtual object within a complex scene, calculating and simulating the physical properties of its motion at a rate of 1000 Hz. VPS is sufficiently accurate for a wide range of simulations. It is naturally CPU intensive, but it is easily parallelizable and surprisingly efficient in its use of memory and disk space.

Boeing 6-DOF demo based on VPS software.

BOEING®

Using VPS paradigms, haptic interfaces can deliver much more realistic feedback, including:

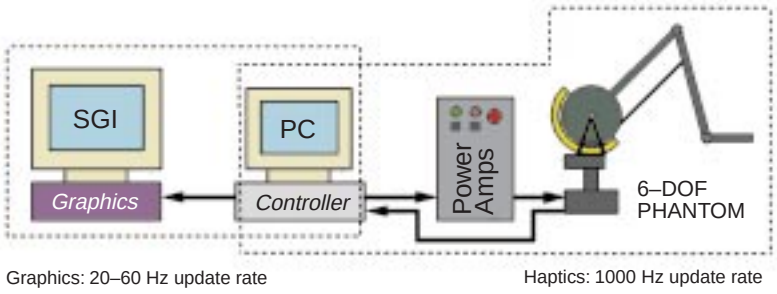
- Detecting all surface contact instead of stopping at the first evidence of it.
- Calculating a reaction force and torque at every point or extended region of contact or proximity.
- Maintaining a 1000 Hz haptic refresh rate without resorting to asynchronous physics and haptic rendering loops.



These new capabilities make haptic devices more useful than ever. Physically based modelling and feedback control techniques can be used to create realistic forces for several types of such devices. When used with physically based modeling software (kinematics, dynamics, and collision detection), haptic devices allow intuitive interaction with mechanically functional virtual mockups. Possible applications for these types of haptic based systems include: generation of realistic forces for computer simulations and as an analysis tool for mechanism design, manufacturing, and product support.

Now that the technology exists to simulate the haptic sense through devices that provide force feedback, we are investigating the feasibility and benefits of applying this technology to Boeing applications such as design for maintainability and training.

We have built example haptics applications for maintenance access and maintenance training that use a 6-DOF PHANTOM™. Even though the VPS force model is very efficient, the applications have very complex virtual environments and require a substantial amount of computing power in order maintain the 1000Hz haptic update rates needed for system stability. We solve this need by running our haptics applications on a two processor SGI Octane. We have also run the VPS applications on a multiple computer configuration using PCs, and we are investigating cluster computing systems.



Multiple computer configuration.

Technical details of the VPS based haptics method can be found in "Six Degree-of-Freedom Haptic Rendering Using Voxel Sampling" (in the *SIGGRAPH 99* conference proceedings).

For more information visit the Boeing or SensAble Web Pages, or contact us in person:

www.boeing.com/assocproducts/vps • www.sensable.com

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