SpaceCat – The Softly Elastic 6DoF Alternative for Computer Graphics Artists

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Why SpaceCat Outperforms Conventional 3D Mice

SpaceCat is a **softly elastic desktop 3D mouse** — unlike 3Dconnexion's stiffly elastic designs. Its advantages over traditional 3D mice and 2D mice are transformative:

1. **Position *and* Velocity Control**
   SpaceCat's stiffness is **10× lower** and its range of motion **10× larger** than conventional 3D mice. This enables **position control**: moving the handle translates one to one on-screen object movement. For rotations, the grip's motion can be amplified to cover ±180° in a single gesture. Research shows that **position control excels for positioning tasks** — something stiff 3D mice cannot provide.

2. **Dominant-Hand Finger Manipulation**
   Designed for **finger manipulation** with the the dominant hand, SpaceCat leverages the dexterity of human fingers for complex, precise manipulations. Traditional 3D mice relegate 3D navigation to the *non-dominant* hand, forcing users to switch between devices. SpaceCat **eliminates this inefficiency** by enabling dominant-hand control, aligning with natural human motor skills.

3. **6DoF Efficiency: No Tool Switching**
   Standard mice offer only 2DoF, forcing users to toggle between rotate/translate tools in 3D apps. SpaceCat's **6DoF position control** maps directly to user intent, allowing **simultaneous rotation and translation**—no switching required. This streamlines workflows like object positioning, where iterative adjustments become a single, fluid motion.

4. **Enhanced Viewport Navigation**
   The expanded range of motion enable **precise camera control**. With practice, users can **define camera paths on the fly** — ideal for film, virtual production, or architectural fly-throughs. This precision also reduces strain, as SpaceCat offers **ergonomic variety** beyond keyboard/mouse setups, helping prevent RSI.

Taken together, all these advantages bring **better ergonomics**, i.e. (1) user's choice between position and velocity control, (2) bigger range of motion for finger manipulation, (3) simplified and faster positioning of objects and (4) more precise control. Hence, **SpaceCat offers a much needed variation from the standard mouse and keyboard** which helps to avoid repetitive strain injuries (RSI).

Potential Use Cases

SpaceCat's applications span **digital content creation, CAD, gaming, and robotics**. Key tasks include:

- **Viewport and camera navigation** (e.g. for scene inspection or virtual production)
- **Camera path definition** (for animations or architectural fly-throughs)
- **Object and light positioning** (e.g. for environmental artists)
- **Modeling** (6DoF extrusion, editing)
- **Rigging/animation** (joint manipulation, virtual puppeteering)
- **Part assembly**
- **Desktop motion capture**

Some thoughts about added value with SpaceCat for computer graphics (CG) production

We're on a quest to find out how SpaceCat best can make 3D artists more productive. The humble mouse and keyboard offer (1) experienced users of 3D packages familiar work flows without much need to learn and handle new hardware, and (2) a standard human computer interface that provides software companies with a huge installed base. Hence, standard input devices have crucial benefits for both users and providers of software. Notwithstanding these obstacles, specialized hardware improving work flow has come forth in certain areas, because artists and producers are always looking for new methods to complete the same work in a shorter time frame. A further reason to use different input devices is to avoid repetitive strain injuries or any upper limb disorders in general. Examples of used specialized hardware include cameras for motion capture, 3D scanners supporting indirect modeling, tablets for sculpting and 3D mice for navigation. Anyone who has attempted to use a CG package knows that 3D is difficult. There is always a need to make these systems easier to use. In 3D CG for film and video, things are often done in the way that we do them today because of the engineering background instead of a more intuitive way. 6DoF navigation and positioning give reasons to consider other ways of CG software interaction.

- In computer graphics software different coordinate systems are used, such as global, local and view coordinates. With SpaceCat you have all 6DoF accessible so you don't need to bother which coordinate system to work in or switching between separate tools for rotations and translations, thereby saving time.

- One can regard a CG as a camera that can shoot images of digital assets. The fundamental questions associated with CG are the same as with any camera:
  - What are you going to shoot?
  - When are you going to shoot it?
  - From where?

  SpaceCat intuitively helps finding still camera positions because of the one to one correspondence between the 6DoF of the camera and SpaceCat. With SpaceCat you can move Blender's camera as you would have it in your hand. But maybe even more useful is to use SpaceCat controlling a cinema camera path on the fly in 6DoF. SpaceCat gives you WYSIWYG (what-you-see-is-what-you-get) visual effects on set, in the viewfinder, during principal photography in virtual production. Think what that means in terms of creative control to the director, environmental artist, or director of photography.

- The HMI guru Bill Buxton once said that the conceptual difference between manipulation and animation is "Do you have the record pedal down?" For SpaceCat this means that any manipulation or navigation can also be used for desktop motion capture with six degrees of freedom.

- With SpaceCat the modeler or animator can manipulate the view port with the same device as joints and bones by just pressing a keyboard shortcut and without going through menus for camera manipulation. This enhances posing or modeling work, as you can check very quickly your objects from any angle. Further, using SpaceCat may reduce cognitive load because the animator can more easily keep a reference in his memory of the previous positions, therefore producing smoother, more organic animations with less time wasted for clean-up and correction.

- Combination of view port manipulation and light manipulation is helpful for both cleaning up your model shape as well as setting best light in the scene. It is fast and intuitive and allows you to prevent problems in the light set-up.

6DoF interaction with SpaceCat gives depth to a flat screen

Moving virtual objects and navigating in the virtual space help users to form mental representations of 3D graphics. This is because the movement induces so called **kinetic depth cues**:

1. Viewpoint Parallax (relative motion gradient) occurs from moving the viewpoint. When we move relative to a 3D scene, objects that are closer to us show greater relative motion than those that are more distant.
2. Shadow Parallax occurs from movements of a light source, an object casting shadows or the viewpoint.
3. Shifting contours of moving objects give users important cues of 3D space.

Hence, using SpaceCat with its 6DoF interaction is an efficient way to cognitively grasp 3D space from a flat screen.

Another class of depth cues are the **observer centered depth cues:** (1) stereoscopic vision, (2) eye accommodation, and (3) eye convergence (*i.e. the "cross-eyed" pattern of the eyes is necessary to bring the image onto the detail-sensitive retina of both eyes, whereby the degree of convergence informs about the distance*). Research has shown that the kinetic depth cues are more important for computer 3D interaction than observer centered depth cues. Further, supporting the observer centered depth cues is difficult with hardware means. Shutter glasses, for instance, only support the stereoscopic vision depth cue, whereas both eye accommodation and convergence give the impression of a flat screen at a fixed distance. This contradiction is perceived to be bewildering for some users. Therefore, we don't recommend primarily to invest in supporting observer centered depth cues.

Finally, there is a third class of depth cues called **pictorial depth cues**. These include (1) linear perspective and (2) interposition (*i.e. when the contours of one object obscures the contours of another, we assume that the obscured object is more distant*) that together with flat shading have been available for large polygon scenes for a long time. With photo realistic lighting, further depth cues are made available to the user including: (3) When objects are lighted from one direction they have shadows that offer cues about the object's orientation relative to us as well as its three dimensional shape. (4) The grain of the texture will grow finer at greater distance. (5) Continuous reductions in illumination and intensity are assumed to signal increasing distance. (6) More distant objects tend to be hazier and less clearly defined. Nowadays these photo realistic depth cues can be supported even for billion polygon motion picture interaction.

In our research we have seen that users in a docking task needed more than double the time to adjust the right depth compared to the other five degrees of freedom. Photo realistic lighting supporting pictorial depth cues is crucial to mitigate the difficulty of perceiving depth. Also, enabling kinetic depth cues with 6DoF input is essential for scene navigation and object positioning.

Hence, our conclusion is that a combination of photo realistic pictorial depth cues from powerful computer graphics combined with kinetic depth cues supported with 6DoF softly elastic input (i.e. SpaceCat) is a key for more efficient 3D interaction.

SpaceCat Test Pilot wanted

The unfortunate reality for SpaceCat is that it needs time to learn and that when given a chance to try a new device an artist may not have enough time to truly test it. When asked to evaluate it during work time the artist is forced to complete their daily work while at the same time learn a new device. This means that we cannot ask an artist for a thorough evaluation of all potential use cases of SpaceCat, but that we need to find at least one use case for which an artist gets enough advantages in a short time that motivates learning the new device.

Therefore, we're looking for one test pilot making a thorough evaluation with the currently only available SpaceCat prototype. The goal is to find at least one use case where SpaceCat can clearly help streamlining production work flow. Supposedly this work would lead to at least one step in SpaceCat's iterative development cycle. The next step could for instance be a crowd funding project financing an initial batch of SpaceCat.

If you feel that you're the right person to contribute to a step forwards for 6DoF desktop input devices after a number of relatively tranquil years, please feel free to contact me. Preferably, I'm primarily looking for someone in Switzerland, in the south of Germany or eastern Austria because discussions on human computer interaction with a new kind of input device is best done in person and we're situated in Arbon in Switzerland.

Further reading

Martin Sundin & Morten Fjeld (2009) Softly Elastic 6 DOF Input, International Journal of Human–Computer Interaction, 25:7, 647-691, DOI: 10.1080/10447310902964124

Martin Sundin (2001) Elastic computer input control in six degrees of freedom, Unpublished doctoral dissertation, ETH, Switzerland. Available from http://e-collection.ethbib.ethz.ch/show?type=diss&nr=14134