The Globefish: A Novel Input Device for Desktop-based 3D Interaction

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Abstract

The Globefish is a novel desktop input device for efficient three-dimensional object manipulation and viewpoint navigation. The device was developed for the 3D graphics applications such as computer aided design (CAD), digital content creation (DCC) and 3D games. The Globefish consists of an elastically suspended 3D trackball, which provides a natural mapping for position-controlled 3D rotations. 3D translations are rate-controlled through small displacements of the trackball against the elastic counterforces of the elastic suspension. The device is operated by the fingertips allowing for precise interaction with virtual objects.

The Design and Implementation of the Globefish

Manipulating objects in 3D is a central task in most digital-content-creation systems. We observed users performing this task while using an integrated 6-DOF input device, the commercially available Spacemouse. They alternated between rotating and translating and rarely used both operations simultaneously. So, we decided to build an input device that uses separate sensors for these two interaction modes and allows rapid switching between them.

This is the central idea of our Globefish, a custom 3-DOF trackball embedded in a spring-loaded frame (figure 1). The trackball sensor measures the rotation of the ball, which is manipulated by the fingertips, and transforms the sensor reading into a corresponding rotation of a virtual object. Tightening the grip on the trackball and pushing or pulling it in any direction controls the virtual object's translation along all spatial dimensions. In a user study, we compared Globefish to the SpaceMouse for object positioning [1]. The Globefish clearly outperformed the SpaceMouse, and most users preferred the new device.

Motivated by these results, we have been studying Globefish's usability for viewpoint navigation [2]. In desktop applications 3D input devices are mostly operated by the non-dominant hand to control 3D viewpoint navigation, while selection and geometry manipulations are handled by the dominant hand using the regular 2D mouse. This asymmetric bi-manual interface is an alternative to commonly used keyboard and mouse input, where the non-dominant hand assists the dominant hand with keystroke input to toggle modes. In a user study we compared the keyboard and mouse interface to bi-manual interfaces using the 3D input devices SpaceTraveller and Globefish in a coarse spatial orientation task requiring egocentric and exocentric viewpoint navigation. The different interface configurations performed similarly with respect to task completion times, but the bi-manual techniques resulted in significantly less errors. This result is likely to be due to better workload balancing between the two hands allowing the user to focus on a single task for each hand. In a follow-up second study we focused on a bi-manual 3D point selection task, which required the selection of small targets and good depth perception. The Globefish interface employing position control for rotations performed significantly better than the SpaceTraveller interface for this task.

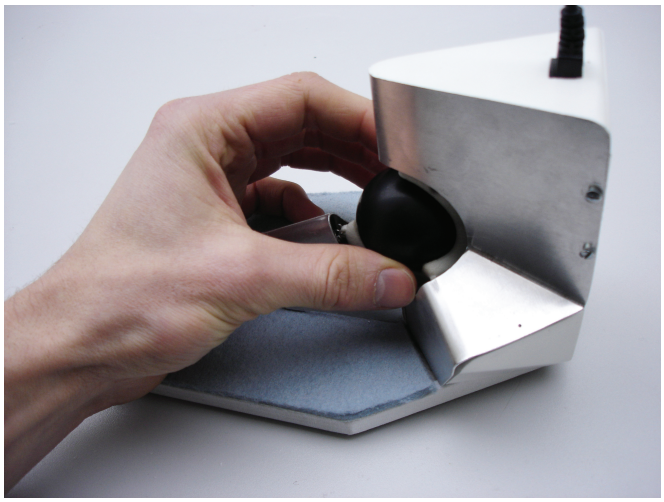

Figure 1: The most recent prototype of the Globefish 3D input device.

We are currently working on further variations of the Globefish idea. The Globewing is a two-handed input device – much like a game controller – consisting of two Globefish sensors, each providing six degrees of freedom. While the dominant hand manipulates virtual objects, the camera viewpoint may be simultaneously controlled by the non-dominant hand. Our Spheron supports collaborative group interaction taking place in front of large display walls. It is designed to facilitate 3D interaction tasks for presentations and for design reviews in mechanical engineering and architecture.

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References

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