

The I³Stick: An Inexpensive, Immersive, Interaction Device

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Abstract

Virtual environments require interaction devices that are intuitive and ergonomic, yet capable of many input parameters. Many devices satisfying these requirements can be expensive, difficult to manipulate, and often require the integration of large software libraries with existing applications. We present a device addressing these needs while avoiding the associated downfalls. The I³Stick is inexpensive to build from commodity components, has many user input parameters including 6DOF of orientation and position, and is easily integrated into applications via a simple public domain API. Our device readily implements a variety of standard and novel interaction techniques.

1 Introduction

While progress continues to be made in the applicable subfields of virtual reality, the *human-machine interface* still requires fundamental research to advance the state-of-the-art [2]. Interface devices for virtual environments require a sufficient number of control parameters for building useful interfaces, while not encumbering the user. Such devices incorporate position and orientation sensing to effect immersion, with additional input parameters provided for triggering events in the interface. Our design goal was to build an interface device that provides the features of typical devices at a reduced cost with improved ergonomics and a more general set of features.

2 Previous Work/Existing Devices

A variety of interface devices are commercially available for interacting with virtual environments. Notable examples include the Wand from Pyramid Technologies [12], the Logitech 3D Mouse [6], and the 3Ball[®] and Stylus from Polhemus [10]. While each of these devices provides varying levels of functionality and performance, none satisfies all of our design criteria.

All of these devices utilize tracking technology to provide orientation and position. The Wand uses an Ascension magnetic tracker, and offers a custom thumb joystick and three buttons. It is the most expensive of these devices, and can be difficult to use for manipulation, often resulting in “thumb-wrestling” maneuvers while trying to manipulate the joystick and buttons. The 3D Mouse can be awkward to use freely in space and suffers the occlusion problems of ultrasonic tracking. The Polhemus devices also use magnetic tracking and their physical shapes are geared toward specific interaction and digitizing tasks. Since they provide only one additional button, they are not general enough for complex interaction operations. All of these devices require custom programming or the purchase of an additional software package for interface implementation.

The I³Stick presented here is 1) inexpensive to build relative to the cost of comparable devices, 2) leverages proven magnetic tracking technology, 3) provides an additional hat switch (8-way directional) and 4 buttons, and 4) has a simple software API available for integrating the device into applications.

3 Components Of The I³Stick

The I³Stick consists of three components (see Figure1): an Ascension Flock of Birds[®] tracker [3] with a single receiver, a Microsoft Sidewinder[®] 3D Pro joystick [9], and a Technology Playgroup Unwinder [11]. The Flock provides the 6DOF of orientation and position, while the hat switch and buttons of the joystick provide an additional twelve discrete switch states. The Unwinder samples the output of the joystick and provides the serialized data to the host computer. The ergonomics of the joystick handle reflect consumer-driven refinement, so the feel and accessibility of the hat switch and buttons are comfortable for the user.

3.1 Assembling the Device

The basic construction of the device involves disassembling the joystick to mount the tracker receiver inside the base of the handle and to extend the ribbon connector relaying the switch

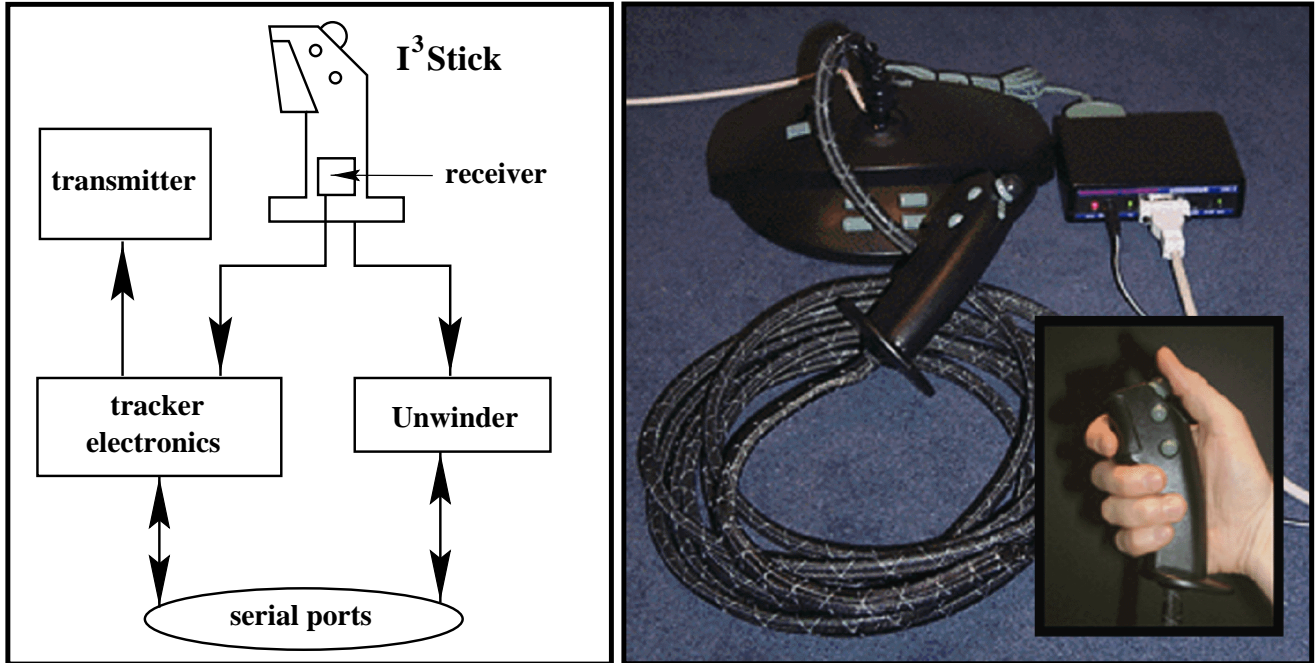


Figure 1. *The I³Stick. Left: a functional block diagram of the system components. Right: the complete system, (inset) the interface device in hand.*

signals from the handle to the base of the joystick. After reassembling the decoupled joystick, the PC gameport connector of the joystick is cabled to the Unwinder and serial cables from the tracker electronics unit and the Unwinder are connected to the host computer. With a bit of patience, the completed device appears as in Figure1. Construction details (complete with photos and diagrams), the API, and application code examples may be found at: <http://www.cs.utah.edu/~jdb/projects/I3Stick.html>.

3.2 Software Support

A simple software library, or API, has been developed for using the I³Stick. It is public domain and provides the following device functionality:

- initialization, configuration, and termination
- querying for position and orientation
- querying the hat switch and button states

Four functions implement these tasks, with all specifics of interfacing the components of the device encapsulated therein. The library was developed on SGI workstations running IRIX 6.5, but the available source can easily be ported to alternate systems; only simple serial port programming is necessary to port the code. Integration into applications is as easy as opening up the device,

binding interface parameters with data queried from the device, and then closing the device when finished. The open source nature of the API encourages integration and extension of the basic functionality provided.

4 Interface Techniques

A variety of useful interaction paradigms are easily realized with the I³Stick and its associated API. The website includes example code for several standard navigation techniques. One example technique is an inertial flying mode in which the device acts like a virtual flight yoke with momentum. Another example implements a “delta motion” mode whereby triggered “strokes” of the device in space correspond to camera transformations in the virtual environment. Our device is also suitable for a number of standard manipulation techniques such as touch/grabbing and “laser pointer” methods [1, 5].

The availability of the hat switch and buttons enable more novel interface methods to be realized with a single interface device (*eg.*, toolspace and glancing approaches [7]). With the addition of mono or stereo head tracking, it is also possible to implement image plane interaction techniques [4, 8]. The flexibility of our device permits a broad range of interface techniques to be implemented.

5 Conclusions

We have presented a device for interaction in virtual environments. The I³Stick is readily built from available components and is easy to use with its accompanying public domain API. A variety of common and novel interface techniques have been described which are well-suited for implementation with this device. Interested parties can find thorough documentation, source code, and video clips of the device in action on the aforementioned website.

6 Future Development

With the I³Stick prototype now complete, we are integrating various interface techniques with real applications at the Center for Scientific Computing and Imaging. It is our belief that the functionality and ease of use provided by this device will facilitate experimentation with useful interfaces. In particular, our computational steering and visualization environments should benefit from the I³Stick integrated with their user interfaces.

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References

- [1] D. A. Bowman and L. F. Hodges. An evaluation of techniques for grabbing and manipulating remote objects in immersive virtual environments. In *Symposium on Interactive 3D Graphics*, pages 35–38, Apr. 1997.
- [2] N. R. Council. *Virtual Reality: Scientific and Technological Challenges*, chapter I: Overview. National Academy Press, 1995.
- [3] Flock of Birds[®]. Ascension Technology Corporation. (<http://www.ascension-tech.com>).
- [4] A. Forsberg, K. Herndon, and R. Zeleznik. Aperture based selection for immersive virtual environments. In *Proceedings of UIST 1996*, pages 95–96, Nov. 1996.
- [5] K. Hinckley, R. Pausch, J. C. Goble, and N. F. Kassle. A survey of design issues in spatial input. In *Proceedings of UIST 1994*, pages 213–222, Nov. 1994.
- [6] Logitech 3D Mouse. Fakespace. (www.fakespace.com).
- [7] J. S. Pierce, M. J. Conway, M. van Dantzich, and G. Robertson. Toolspaces and glances: Storing, accessing, and retrieving objects in 3D desktop applications. In *Symposium on Interactive 3D Graphics*, pages 163–168, Apr. 1999.
- [8] J. S. Pierce, A. Forsberg, M. J. Conway, S. Hong, R. Zeleznik, and M. R. Mine. Image plane interaction techniques in 3D immersive environments. In *Symposium on Interactive 3D Graphics*, pages 39–43, Apr. 1997.
- [9] Sidewinder[®] 3D Pro. Microsoft Corporation. (www.microsoft.com).
- [10] Stylus, 3Ball[®]. Polhemus Incorporated. (www.polhemus.com).
- [11] Unwinder. Technology Playgroup, Inc. (and.this.is/tpg).
- [12] Wand. Pyramid Systems, Inc. (www.pyramidsystems.com).