IPT-EGVE Symposium (2007)
B. Fröhlich, R. Blach, and R. van Liere (Editors)

Improved 3D Interactive Devices for Passive and Active Stereo Virtual Environments

D. Wormell (deanw@intersense.com), E. Foxlin (ericf@intersense.com), and P. Katzman (pkatzman@intersense.com)

InterSense, Inc., 36 Crosby Drive, Suite 150, Bedford, MA, USA

Abstract

This paper introduces a new set of tracking devices for 3D virtual environment interaction and reviews enhancements including device miniaturization, power reduction, and ruggedization. The goal of these improvements was to reduce size and weight of head-worn tracking devices for use with passive-stereo immersive display systems, whose polarized glasses are much smaller than LCD shutter glasses and therefore require smaller tracking sensors. The major changes include a 2-fold reduction in the size and weight of the wearable sensor devices and improvement of wireless tracking capability and battery life.

Keywords:

Motion Tracking, Wireless Tracking, I^2C Bus, Tracking in Virtual Environments, Inertial Tracking

Categories and Subject Descriptors: H.5.2 [User Interfaces]: Input devices and strategies; I.3.6 [Methodology and Techniques]: Interaction techniques; I.3.7 [Computer Graphics]: Virtual Reality

1. Introduction

InterSense introduced the IS-900 inside-out ultrasonic/inertial hybrid system designed to provide robust and fast tracking in projection VR environments in 1999 [1]. The original IS-900 was completely revamped in 2003 to produce the Gen2 system [2]. This year, the product line is again being refreshed to produce smaller, more rugged and more ergonomic tracking devices. This paper will describe the goals and plans for the IS-900 Gen3 system being introduced at the time of this paper's publication.

Gen3 takes advantage of new MEMS inertial components and new wireless technology to further reduce the size and power of the head tracker. In addition to the core technology improvements, a stylish and rugged industrial design was chosen for comfort, durability, and improved acoustic line-of-sight capabilities leading to better tracking performance.

2. IS-900 Gen1 to Gen2 Enhancements

The Gen1 IS-900 was designed to provide uniform motion tracking of both head and handheld devices in immersive displays and simulators. The Gen2 version added wireless capabilities, provided miniaturization and additional OEM capabilities such as an I^2C bus with documented API to allow for easy integration into flight simulators and other custom simulation systems. Many system integrators have taken advantage of the I^2C bus to add custom input and output devices to their tracked objects while piggy-backing this extra I/O data on our wireless links.

3. IS-900 Gen3 System Design Goals

Based on years of customer experience, we developed a focused set of requirements for the Gen3 improvement: (1) Improve the ergonomics and ruggedness of the wand; (2) Reduce the size of head-tracker and its radio/battery to fit on a pair of passive stereo glasses; (3) Maintain or improve the system performance; (4) Increase the number of wireless devices available to a system; and (5) Preserve all OEM integration features including the I^2C interface.

3.1. New Wireless Technology

The main technology changes required to achieve the desired miniaturization and power reduction are based on the radio and an update of the MEMS sensors and electronics. The spread spectrum frequency-hopping technology of Gen2 is replaced with a 2.4 GHz non-frequency-hopping

spread spectrum radio module that allows up to 16 different channel selections. The new radio allows additional wireless devices to be added. Key improvements between the Gen2 and Gen3 designs include: (1) increased number of simultaneous tracking devices per system from 4 to 7; (2) radio power reduction from 728 mW to 60 mW; (3) battery size reduction from 35x50x15mm to 25x30x7mm; and, (4) four-fold radio transmitter package reduction (see Fig 3).

3.2. Improved Wand Ergonomics and Ruggedness

The major focus for the wand redesign was to improve the ruggedness and ergonomics, and at the same time take advantage of the smaller electronics to trim the front section for better acoustic tracking performance.

Fig. 1: Gen2 vs. Gen3 Wand Design

Fig. 1 shows the wand designs from Gen2 to Gen3. The increased angle between the handle and the front section allows the hand to be held in the most comfortable rest position while still pointing the front section straight into the virtual world, with the center of gravity balanced for maximum comfort during prolonged use. Front microphones are positioned at acute-angle vertices, giving them a more omni-directional field-of-view for receiving range measurements from different directions. The increased angle between handle and head section also allowed the trigger to be recessed in the bend, resulting in a flat bottom so the wand can rest on a table when not in use.

3.3. Head-Tracker for Passive Stereo Glasses

The main requirement for the new head-tracker design is to seamlessly mount onto passive stereo glasses. In order to achieve this, the head-tracker needed to be much slimmer and lighter than the Gen2 design. Using new MEMS components, the circuit-board width was reduced from 19 mm to 9.5 mm, while the height was reduced from 19.8 mm to 8.5 mm. Fig. 2 shows the circuit board and Head Tracker size reduction from Gen2 to Gen3 .

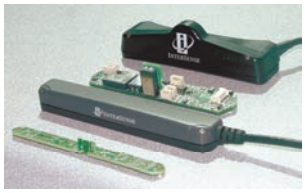

Fig. 2: Gen2 vs. Gen3 Head Tracker Circuits

In addition to a smaller head tracker, a lighter and smaller wireless transmitter/battery module is also implemented (Fig 3). This transmitter is designed to clip to a user's lapel or shirt-pocket, or even the back of a headband.

Fig. 3: Gen2 vs. Gen3 Wireless Transmitter

3.4. Charging and Docking Station

For increased convenience, practicality and overall presentation of the Gen3 product offering, a combined charging and docking station provides a place to store and recharge the wireless devices. As shown in Fig. 4, the charging station can simultaneously recharge the wand, the transmitter pack of the head-tracker, and two spare batteries. Although normally the user will not need to replace batteries if he remembers to place the devices in the charging cradle each night, both the wand and the head-tracker transmitter have easy-access battery compartments so that batteries may be replaced by the user if they do run low during a working session.

Fig. 4: Gen2 vs. Gen3 Charging Station

4. Summary

We have briefly summarized recent improvements to the IS-900 inertial/acoustic hybrid tracking system. These improvements address the requests from our customers, providing a more rugged, reliable and convenient tracking system for immersive display environments.

References

1. E. Foxlin, M. Harrington, and G. Pfeiffer. (1998). "Constellation™: A Wide-Range Wireless Motion Tracking System for Augmented Reality and Virtual Set Applications", SIGGRAPH 98 Conference Proceedings, ACM Annual Conference Series, Orlando.
2. E. Foxlin and D. Wormell (2003). "Advancements in 3D Interactive Devices for Virtual Environments", 7th International Immersive Projection Technology Workshop and 9th Eurographics Workshop on Virtual Environments.