HARDWARE DESIGN OPTIMIZATION FOR HUMAN MOTION TRACKING SYSTEMS

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AIM

A key component of any interactive computer graphics application is the system for tracking user or input device motion. An accurate estimate of the position and/or orientation of the virtual world tracking targets is critical to effectively creating a convincing virtual experience. Tracking is one of the pillars upon which a virtual reality environment is built and it imposes a fundamental limit on how real the “reality” of Virtual Reality can be. Whether working on a new or modified tracking system, designers typically begin the design process with requirements for the working volume, the expected user motion, and the infrastructure.

BACKGROUND

Considering these requirements they develop a candidate design that includes one or more tracking mediums (optical, acoustic, etc.), associated source/sensor devices (hardware), and an algorithm (software) for combining the information from the devices. They then simulate the candidate system to estimate the performance for some specific motion paths. Thus the predictions of such traditional simulations typically include the combined effect of hardware and algorithm choices, but only for the chosen motion paths. Before tracker algorithm selection, and irrespective of the motion paths, it is the choice and configuration of the source/sensor devices that are critical to performance. The global limitations imposed by these hardware design choices set a limit on the quantity and quality of the available information (signal) for a given system configuration, and they do so in complex and sometimes unexpected ways. This complexity often makes it difficult for designers to predict or develop intuition about the expected performance impact of adding, removing, or moving source/sensor devices, changing the device parameters.

RESULT

This research introduces a stochastic framework for evaluating and comparing the expected performance of sensing systems for interactive computer graphics. Incorporating models of the sensor devices and expected user motion dynamics; this framework enables complimentary system- and measurement-level hardware information optimization, independent of algorithm and motion paths. The approach for system-level optimization is to estimate the asymptotic position and/or orientation uncertainty at many points throughout a desired working volume or surface, and to visualize the results graphically. This global performance estimation can provide both a quantitative assessment of the expected performance and intuition about how to improve the type and arrangement of sources and sensors, in the context of the desired working volume and expected scene dynamics. Using the same model components required for this system-level optimization, the optimal sensor sampling time can be

determined with respect to the expected scene dynamics for measurement-level optimization. Also presented is an experimental evaluation to support the verification of asymptotic analysis of tracking system hardware design along with theoretical analysis aimed at supporting the validity of both the system- and measurement-level optimization methods. In addition, a case study in which both the system- and measurement-level optimization methods to a working tracking system is presented.

CONCLUSSION

Artemis, a software tool for amplifying human intuition and experience in tracking hardware design is introduced. Artemis implements the system-level optimization framework with a visualization component for insight into hardware design choices. Like fluid flow dynamics, Artemis examines and visualizes the “information flow” of the source and sensor devices in a tracking system, affording interaction with the modeled devices and the resulting performance uncertainty estimate.