IM3D: Magnetic Motion Tracking System for Dexterous 3D Interactions

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(a)   (b)   (c)

Figure 1: *IM3D. (a) 3D interaction with markers fixed on user's fingers, (b) tracking motion of insects, (c) real-time 3D modeling*

1 Introduction

3D motion tracking is one key technology in computer animation, virtual reality, natural user interface, and so on. Over the last thirty years numerous projects with various approaches have developed motion tracking systems, including mechanical, ultrasonic, magnetic, and optical schemes. Recently, interest has also been growing in the motion tracking of small targets in complex environments and tracking subtle movements. For example, the behavior analysis of insects or other small creatures in the earth will contribute to the growth of biology or related sciences, and the precise analysis of dexterous finger motions will be useful for professional techniques or the skills required for traditional handcrafts or medical procedures. Unfortunately, common existing tracking systems cannot satisfy the requirements of these tasks because the targets are too small and their motions are complex and easily occluded.

Thus, we propose IM3D, a novel magnetic motion tracking system with multiple tiny, identifiable, wireless, occlusion-free markers that provides reasonable accuracy, a reasonable update rate, and an appropriate working space for exterous 3D interaction. Though the principle IM3D is based, which is proposed by [Yabukami et al. 2004], has a ten-year history, IM3D is the first system to make it suitable for interactive applications, as we managed to find out an appropriate layout, and calculate the inverse problem through parallel programming to boost its speed, and so on.

2 Design of IM3D

The workflow of IM3D is described in Figure 2. It uses LC resonating magnetic markers, an exciting coil, an amplifier for excitation signal generation, a 32-pick-up-coil array, a measurement platform for data acquisition, and a PC for calculation. Once a varying current passes through the exciting coil and electromagnetic field is generated, the LC marker inside the field space is excited and generates a resonant magnetic flux. The pick-up coil array takes the magnetic field from the excited marker, and the system measures that data from the measurement platform and uses them to calculate the position and posture of the markers by solving an inverse problem. Multiple LC markers can be designed with different resonant frequencies to achieve identification. The system is scalable as the tracking space and number of markers can be changed. The current implementation of IM3D supports up to 10 markers, providing a semi-sphere tracking space with radius of 150mm, and high position accuracy with average error smaller than 1.5mm. The tracking speed is 100 fps with one marker and 22 fps with 10 markers.

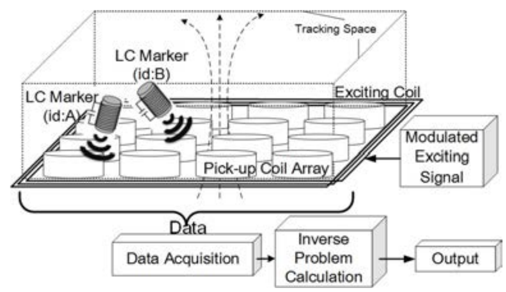

Figure 2: *Principle work flow*

3 Application Examples

IM3D's features contribute to motion capture and interaction. Three novel applications that effectively utilize the features are built to demonstrate these possibilities. Figure 1(a) shows a multi-finger application in which markers are fixed on users finger tips to enable finger-based manipulation with virtual objects. Figure 1(b) shows the scene of tracking beetles in natural complex environment by fastening the markers on beetles horns. This can be applied in biology research because IM3D's battery-less markers make it possible to continuously track small creatures in natural environment for long time. Figure 1(c) shows a method of interactive 3D clay modeling. Each of the ten markers is put into a small sphere case, which is covered with clay. The application allows users to create more flexible virtual 3D objects by manipulating the actual clay using our tiny and occlusion-free markers.

References

YABUKAMI, S., HASHI, S., TOKUNAGA, Y., ARAI, K., AND OKAZAKI, Y. 2004. Development of a position-sensing system for a wireless magnetic marker. *Journal of the Magnetics Society of Japan 28*, 877–885 (in Japanese).

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