AR Tracking Demo

Eric Foxlin & Leonid Naimark
InterSense Inc.
{ericf/leonidn}@isense.com

Abstract

As Augmented Reality becomes more developed, there are different concepts and solutions for tracking presented. It has become standard to use hybrid approaches for AR in order to achieve better registration and avoid latency. The most attractive approach is probably optical-inertial tracking. To our knowledge all existing trackers do not have good scalability, which means that one tracker could not be used for small (table-size) and large (room-size) tracking volume applications. Typically table-size applications would require much higher accuracy, while wide-area application would require tracker to be wearable. In this demo we are trying to incorporate these two problems together, proposing a "Scalable Tracker", which could be successfully used in applications of different scale.

It has been pointed out in the last several AR/MR/VR conferences that there are two main difficulties preventing AR to become a custom applications: lack of good tracking and lack of good HMD. We are pretending to solve the first problem, however the second one is still remaining a big issue. In this demo we propose surprisingly and novel approach, where instead of tracking a person's head with HMD we are using standard LCD Projector. This allows us to demonstrate a registration of "Scalable Tracker" for different scenarios (scales). This is not an only a qualitative impression of tracking registration, that one can experience from HMD, but also a quantitative measure of registration as a difference between real object on a wall and projected wire-frame overlay, which normally one can get only from pan-tilt unit or robotic arm.

Keywords: Scalable Tracking, Hybrid Optical-Inertial Trackers, "Inside-out" and "Outside-in" Cameras", Auto-mapping, LCD Projector tracking.

1. Hall-size tracking system and Auto-mapping

A basic tracking system consists of one IMU and one camera. This tracking head could be mounted on HMD handheld display panel (for video AR). A sensor fusion core is running in the wearable computer. A user can comfortably wear this system on the belt (this system is described in [1] in full details). A tracking constellation consists of uniquely designed fiducials (described in [2]). These fiducials could be mounted on the ceiling or/and on the walls. This tracker is usable for tracking in practically unlimited areas. A particular goal of the demonstration is to present an auto-mapping function of the tracker. A large amount of fiducials (~50) is installed, while originally tracker knows a 3D position of only 4 of them (a Seed). The system acquires and starts tracking itself from the Seed while it simultaneously auto-maps new fiducials. As a result all fiducials are added to the map. The auto-mapping can be switched-off and just tracking is running over entire area.

2. From Hall to Table

The tracking quality of basic tracking system is very reasonable, however it is unacceptable for table-size applications. There are 3 reasons, why tracking is not very precise: large-scale of operation, some inaccuracies related to auto-map construction, limited hardware (1 camera and 1 IMU).

In order to receive considerably higher accuracy for table-size applications, we would combine our basic tracking system with two outside-in (stationary) cameras. This is possible due to unique architecture described in [3]. These cameras would track a small number of 0.5 cm size retro-reflective targets attached to the tracked object (shown as an LCD projector in figure 1).

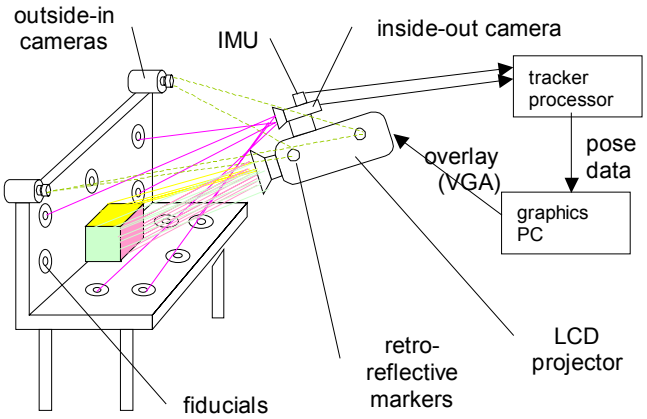

Figure 1. Demonstration setup

Two stationary cameras are mounted on the distance of approximately 1 meter from the tracked device, while one

IMU and one inside-out camera are mounted on the tracked device. The inside-out camera is once again tracking artificial fiducial markers mounted on the vertical and horizontal surfaces of the demonstration table.

This configuration would allow an extremely high tracking accuracy in 1 m^3 volume. In order to demonstrate accuracy of tracker in different scales we would attach it to an LCD projector. The LCD projector would project an overlay onto a physical object provided for testing. We would plan to use a cube with faces colored by the projector in different colors (shown in yellow, green and red on the Figure 1). This would allow demonstrating the tracker to multiple observers. Also attendees are welcome to hold the LCD projector in their hands and test the dynamic registration of the system. In order to demonstrate a static registration of a system we would place the projector on a table and measure the difference between actual and overlaid objects on a wall.

In addition to its use here as a device for evaluating the accuracy of a tracking system, this type of AR implemented with a tracked projector (worn on a helmet or held in the hand) could perhaps be useful as an alternative to HMD-based AR for a applications like plumbing maintenance. Given a CAD model of a building with pipes map hidden inside the walls, an operator could shine the projector on the wall and see a projection of the wire-frame pipe onto the place where real pipes are located.

2. Bibliography

[1] Foxlin, E. and Naimark, L. (2002). Wearable Vision-Inertial Self-Tracker. In preparation.

[2] Naimark, L and Foxlin, E. (2002). Circular Data Matrix Fiducial System and Robust Image Processing for a Wearable Vision-Inertial Self-Tracker. IEEE ISMAR 2002, Dormshtadt, Germany.

[3] Foxlin, E. (2002). Generalized Architecture for Simultaneous Localization, Auto-Calibration, and Map-building. IEEE/RSJ Intelligent Robotic Systems Conference (IROS 2002), Lausanne, Switzerland.

3. Equipment and space requirements

For our table-top demo, we will be bringing the following equipment:

1. The horizontal and vertical fiducial boards to be set up on a table top, and the white test cube
2. A bar with the two outside-in cameras which we will mount on top of the vertical fiducial board
3. A PC (possibly a laptop) for generating the graphics overlays, and an LCD projector for projecting them onto the real physical objects (i.e. the test cube)
4. The tracking sensor assembly to mount on the tracked object (LCD projector) and a tracking processor unit which receives and fuses data from both the sensors on the tracked object and the outside-in cameras mounted on the vertical fiducial board.

We will need:

1. A sturdy desk or table to place the fiducial boards on with space in front of it where several people can stand to watch the demo.
2. Another small table next to it to place the laptop, the tracker processor and the projector when nobody is trying it out.
3. An AC power plug (please tell us what voltage and prong style are used in Germany)

For our wide area automapping demo we will also need:

1. Additional space around our demo table where we can walk around with a wearable computer and handheld display, and several people observing. The space can be an aisle or an open area which is the central part of the room in which all the other demo tables are arranged around the outside. 16-25 square meters of space would be ideal.
2. Permission to mount about 50 8.5 X 11” sheets of paper on the ceiling with masking tape. Note that masking tape does not peel paint. The ceiling height needs to be low enough that we can easily reach it with a small ladder to attach and remove the fiducials.
3. A small ladder to access the ceiling before and after the demo session.