Study of geometric dispatching of four-kinect tracking module inside a Cave

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ABSTRACT

In a virtual reality application that requires the user to interact with his environment and in the context of an application inside a virtual reality room (CAVE) there is an ever increasing need to optimize the interaction cycle in all its steps, especially in the tracking step. Many existent tracking systems are used inside CAVEs, in this paper we propose a study of geometric dispatching of four-kinects inside a CAVE to be used as a tracking module for virtual reality applications.

1. INTRODUCTION

Over the past few years, Virtual Reality (VR) has become a rapidly growing domain and a promising platform (Tanriverdi et al, 2001, Allison et al, 1997). Virtual reality enhances and increases interactivity and immersiveness for many applications and domains (Richard, 2000, State et al, 1996, Manseur 2005, Hodges et al, 1995, Wyk 2009).

Users in Virtual reality can make powerful actions such as exploring, modifying, navigating, training, feeling, moving and playing as in the real world (Oliveira et al, 2006, Qureshi et al, 2007). Those user actions are monitored frame-by-frame through interaction cycles (see Figure 1 (left)) which are directly linked to the Virtual Reality context and environment, especially on the tracking step. In our case we are building virtual reality applications inside a CAVE (named the “SAS”) (see. Figure 1) (right). The tracking step, inside the “SAS” is based on an ART-Tracking[1] module. One can refer to TerraDynamica[2] project for some results of our applications.

In our current work described in this paper we present our design of a new tracking system for a Virtual Reality room (the “SAS”) based on a multi-kinects module. The next section briefly presents existent multi-kinects module. Section 3 deals with the proposed multi-kinect module for the “SAS”. Finally we will conclude with a short outlook in section 4.

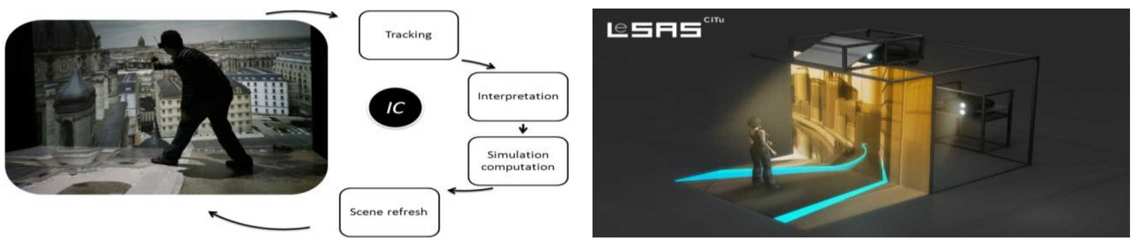

Figure 1. *(Right) Interaction Cycle – (3D Virtual City Visit – project TerraDynamica). (Left) “Le SAS”: an immersive room with a wall screen and a floor screen.*

2. MULTI-KINECTS STATE OF THE ART

Many approaches use multi-kinects as a solution in their applications. Here are various examples. Kainz *et al* (2012) Use the data provided by multi-kinects to recreate a 3D representation of an object or a person for various purposes such as augmented reality or full-body scanning. Satta *et al* (2012) Use multi-kinects as an identification tool to recognize persons within kinects' range. Sumar (2011) Collect data from multi-kinects for the creation of a real-time image processing application. Faion *et al* (2012) Develop an application to scan objects or persons based on multi-kinects and to apply this, they develop an algorithm that determines what Kinects are the closest to them and deactivate the others'IR streams to reduce interferences in a multi-kinects configuration. Correia (2013) uses multi-kinects to tracks users as part of a musical application that produces music according to the users' movements and the movements of modded smartphones. Tong *et al* (2012) Built a system to scan 3D full human bodies using multi-kinects, in this system each kinect sees a specific part of the human body; three kinects can cover the entire human body with minimum overlapping between kinects. Ruhl *et al* (2011) Use RGB and IR kinect cameras to capture gas flows around objects in the flow using three kinects inside a lab room. As we can observe, in existent literature, the multi-kinects module was never proposed in case of the "SAS", in virtual reality context (see. Figure 2).

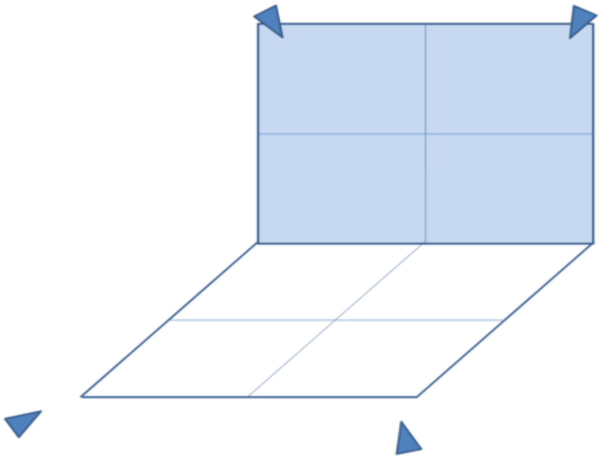

Figure 2. *This is a representation of the "SAS" with the location of the four Kinects.*

3. PROPOSED APPROACH

3.1 Global Idea

In our case we propose to build a four-kinects module for tracking inside a CAVE (see. Figure 2). Using multi-kinects has more than one advantage: relatively high coverage space, low cost compared to ART-Tracking (multi-Kinect module has 10% of the cost of ART-Tracking module) and feasible. Taking into account the horizontal and vertical FOV of a single kinect (see. Figure 3), we dispatch the kinects inside the "SAS" with the maximum of coverage. The orientation of the kinect sensor should be taken into account with high accuracy. But we have to deal with some usual problems such as interferences between kinects, for example by adding a motor that cause vibrations Maimone *et al* (2012).

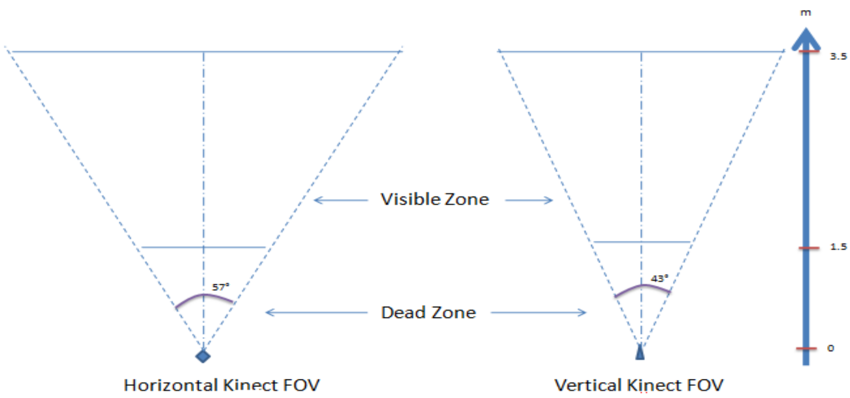

Figure 3. *FOV Kinect horizontal, vertical, visible zone and dead zone. Horizontal FOV: 57 degrees, Vertical FOV: 43 degrees, Tilt angle: from -27 degrees to 27 degrees, Range: from 1.2 to 3.5 meters.*

3.2 Geometric dispatching

Kinect has certain horizontal and vertical FOV as in **Error! Reference source not found.**. The way the multiple kinects have been dispatched implies overlapping areas; Figure 4 represents an example of overlapping between two kinects inside the "SAS".

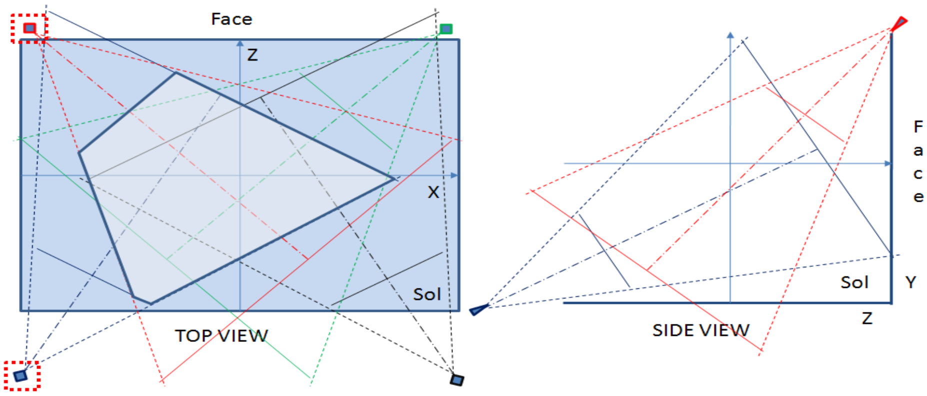

***Figure 4**. Overlapping area between upper-left and lower-left Kinect.*

Parts of the "SAS" will be covered by several kinects at the same time (see Figure 5), and combining the kinects' FOV allows us to determine how the server will manage the tracking of the users (some kinects can be temporarily disabled if there is no one in their FOV for instance) and how the fusion algorithm will proceed. Figure 6 explains a tracking example inside the "SAS". For reasons of efficiency, processing speed and reduction of IR interference, it may be necessary not to let all kinects function simultaneously at all times. This is why we have to define the overlapping areas between the kinects. Our objective with the analysis of the overlapping areas of the "SAS" is to provide data to determine the coverage of the kinects, and therefore, the effectiveness of the dispatching we proposed.

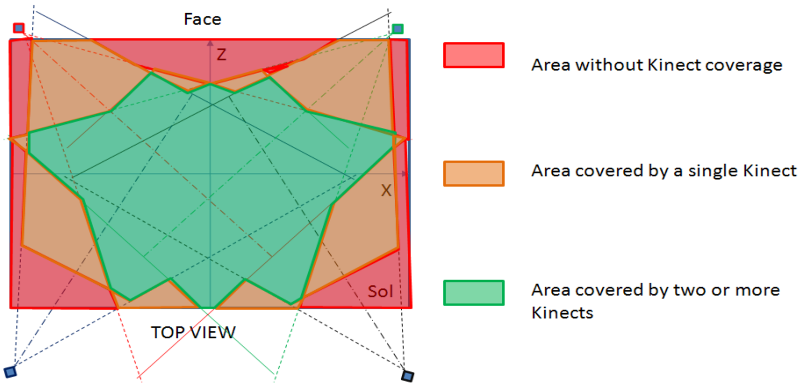

Figure 5. *Classification of the overlapping areas according to their level of reliability. Red spots are unreliable because no Kinect covers them; Orange zones have an average level of reliability as only a single Kinect has access to those; Green areas are the most reliable given that they are in two or more Kinects' FOV.*

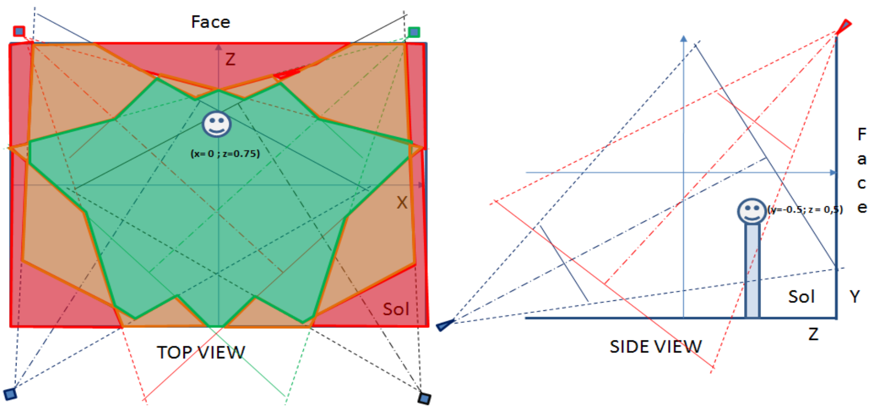

Figure 6. *Example of a successful attempt at tracking a user in the "SAS"*

4. CONCLUSION

In this paper we presented a study of an optimized geometric dispatching of a four-kinects module. This module is used as a tracking module in an interaction cycles for virtual reality context, in our case inside a CAVE "the SAS".

Our system is still in its beta version, and we need to build the fusion roles and to make a test of this module in real application. We also need to perform a quantitative study of comparison with our existent ART-Tracking system.

Acknowledgement. The works reported in this paper were in part conducted and sponsored as part of the *CapDigital* Business Cluster *TerraDynamica* project.

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[1]www.ar-tracking.com
[2]www.terradynamica.com