3D Annotations in Immersive Environments

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Brief

The requirement of a 3D Annotation System for Immersive Environments with telecooperation capabilities was a basic and unfulfilled need present at the Institute Image when I arrived. For this reason I was given the task of developing such system as my undergrad thesis. The use of the immersive facilities present at the Institute in the provided solution was a requirement, as well as keeping the compatibility with standard computers. The provided application succeed in the fulfillment of the original requirement. The following document describes this solution as well as the considerations taken in account for developing it.

Smoke whirls
After the passage of a train.
Young foliage.
Shiki Masaoka (1867-1902)

1 Introduction

For a long time now I've wanted to visit France. Actually, thinking about it, I had that desire before I started to study Systems and Computer Engineering at Universidad de los Andes. Someday I just asked Tiberio about the possibilities of making my thesis abroad. He gave me certain options and one of them was the Institut Image at Chalon-sur-Saône (in which I am writing this Introduction). Since then a few months passed before the bureaucratic nightmare started.

From the university demanding information they already had, and for which I had to pay a considerable amount of money; to the French Embassy and their Kafkesque process to give me a 5 minutes appointment after weeks of collecting innumerable documents, without taking in account my travel to Brazil to participate in Interactivos? 2010 BH, Christmas and New Year's eve, I thought I wouldn't be able to fly to France in time. After all it actually happened.

The subject of this work was given to me by Frédéric two weeks after my arrival at Chalon. In standard circumstances I prefer my projects to be product of my ideas and not someone else's, but the opportunity to come here for a whole semester easily took over that. Looking backwards, this project has been a great learning opportunity, both personal and professionally.

The instructions for developing my project were simple and precise: A system for making annotations on 3D models using the cave facilities present at the institute, however usable in a standard computer. The idea is to be able to comment collaboratively and in distant locations a 3D model. The annotations would be simply a plain text comment, with an author and a priority attached.

So, as you can see, rather than the traditional way to choosing a thesis I was given a determinate topic and a narrow and precise expected solution. For this reason, in this project, I will work on the possibilities, contexts in which it might be used, constraints and potential scopes of the given solution.

Some of the basic design choices of the solution were given by the facilities present at the Institute. Windows XP running in the cave computers, infrared tracking cameras, passive stereo projections and the Android powered tablet are some examples of these design choices. The software was developed using Microsoft Visual C++ for the software running in the servers and the Eclipse IDE for the tablet application; thus C++ and Java were used to build the solution. OpenSceneGraph and VRPN were also used.

Aca falta **Diseño e implementación, Resultados obtenidos. Estructura del documento (cómo leerlo y seguirlo)**

First of all I thank my mother and my sister for supporting me, I know it have been tough. I also thank Tiberio and Frédéric for supervising this work, and giving me this opportunity. Luisa for her friendship and love; David for his friendship and ¿?, and both for their support and our shared memories. Sadly I can't thank God because I don't believe in him, nevertheless I can thank Alan Turing for making this work possible.

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General Description

2.1 Goals

The objective of the project is to create a 3D Annotation System for Immersive Environments with not concurrent tele-cooperation capabilities and which might be used in a standard computer. The projected is developed for fulfill the need of such system at the facilities of the Institut Image and at the COLIVRI Laboratory at the Universidad de los Andes; without being restricted to these two contexts.

The final solution must be capable of performing this task in models of a variety of 3D formats, associating with each annotation its type and urgency to be managed. On the other hand the system meet the ever-present needs of scalability, flexibility, performance and specially usability. The project must be developed using C++ and OpenSceneGraph and must run in Windows XP.

2.2 Prior Work

The most similar prior work I found while making the research for this work is the one presented by Kadobayaby et al. in [6]. It's similarity consists in the use of annotations in 3D immersive environments to deal with the inherent complexity of 3D models. The work is nevertheless, restricted by it's use of Croquet. The Croquet Project was a very promising project, now fallen into disregard and oblivion because of the sudden drop of its development. It also provides interesting ideas behind user defined paths inside the VR space that will be addressed later.

This work makes a good case behind the reasons of using a 3D annotation system to move beyond the "eye-candy" environment. It also provides a nice definition of annotation, as follows "Annotations may be thought of as author- attributable content placed within a Croquet scene in association with (or reference to) a particular element of that scene.". On the other hand it also provides a rather bizarre visualization of these annotations, "...we have developed basic conventions by which annotations can be created independent of the form of media. We allow objects to become annotation even if the object was not originally designed to be an annotation,"

The work by *Sonnet et al.* [7] integrates a 3d probe with annotations, giving meaningful information and an exploded view of the 3D model depending of the position of the 3D probe. It uses an automated algorithm to select the best position to display the annotations given both the position of the probe and the centroid of the objet of interest. It also uses handy techniques to navigate the 3D space and isolate important parts of the 3D model. On the other hand it uses complex ways of annotating objects and rare shapes to work as containers of the annotations.

The work by *Duval et al.* [3] works the possibilities around collaborative explorations of 3D scientific data. The most remarkable parts of it concern the definition of annotations as 3D viewpoints rather than textual information freely located in the space as shown in [6] and [7]. This idea will be used later in the development of this project. It also uses a minimap to locate the users in the scene similar to the ones featured in the game industry.

The work on annotating and sketching on 3D models via a web interface developed by *Jung et al.* [5] draws interesting lines between the needs behind a post-it metaphor driven annotation system and a more free 3D sketching system. It also raises interesting points around the possible advantages of an asynchronous collaborative system and it's support for a more semantic history of the evolution of the model, versus a real-time voice based discussion system.

Other sources consulted did not work as prior work but as excellent references for a more specific part of the project. The work by *Gonçalves et al.* in their software Tag Around [4], concerned with correct tagging and meta-data enriching of photos, proposes an interesting approach to usability tests focused in non conventional interaction. The work by *Burton et al.*[2] and by *Bernheim et al.*[1] presents a really insightful conclusion around collaborative annotation systems, which as summarized in [5] should "be unobtrusive but accessible, inform without overwhelming, separate higher and lower priority information for different actors at different times", even when their work concerns the annotation of ext documents the principles are extrapolable.

2.3 The Problem

The root of the problem to resolve is the inherent complexity of 3D models. The need to reduce these inherent complexity and expand the models through the use of textual information is the primary concern that gave light to this project. Textual information of a general kind would serve to cast clarity and allow a deeper understanding of the modeled scene. As said in [6] 'To be generally useful for collaborative research and learning, immersive virtual 3D spaces must include intuitive content creation and annotation tools'.

The uses of such technology are rather diverse. From enabling educational experiences not possible before, to reducing the time to market via reducing the time to design in a diverse range of manufacturing companies; passing through semantically augmenting architectonic heritage, the potential uses are innumerable.

These potential uses and its associated potential shareholders are still restricted to the access of a cave-like facility given it's high costs. On the other hand, the personal computer version could be used by anyone with access to a standard computer. However, this scenario provides a rather poor experience and similar solutions are already available in the market.

The context of the problem is nevertheless a rather specific one, the facilities of the Institut Image, which devotes most of its attention to educational and research ends. These facilities count with two immersive systems relevant to this work. The first one is the MoVe, a cave-like system with three faces and the floor projecting passive-stereo images and a IR tracking system with two cameras. The second immersive system is the Spidar, a single screen projected as well with passive-stereo images and 4 IR cameras.

As part of the problem definition the requirements of using the C++ programming language, along with OpenSceneGraph, running in various Windows XP machines, were given.

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Design and Specifications

3.1 The Problem's Definition

3.2 Specifications

3.3 Restrictions

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Design Process

4.1 Information Gathering

4.2 Design Alternatives

5 Implementation

5.1 Implementation Review

5.2 Expected Results

6 Validation

6.1 Methods

6.2 Validation of Results

6.3 Discussion

6.4 Future Work

Bibliography

[1] Bernheim Brush A.J., Bargeron D., G. A. C. J. Robust annotation positioning in digital documents. In *Proceedings of the SIG-CHI Conference on Human Factors in Computing Systems* (2001), pp. 285–292.

[2] Burton N, Kilgour A C, T. H. A case study in the use of vrml 2.0 for marketing a product. In *Proceedings of From Desk-Top to Web-Top: Virtual Environments on the Internet, World Wide Web and Networks* (1997), pp. 1–24.

[3] Duval, T., Fleury, C., Nouailhas, B., and Aguerreche, L. Collaborative exploration of 3d scientific data. In *Proceedings of the 2008 ACM symposium on Virtual reality software and technology* (New York, NY, USA, 2008), VRST '08, ACM, pp. 303–304.

[4] Gonçalves, D., Jesus, R., Grangeiro, F., Romão, T., and Correia, N. Tag around: a 3d gesture game for image annotation. In *Proceedings of the 2008 International Conference on Advances in Computer Entertainment Technology* (New York, NY, USA, 2008), ACE '08, ACM, pp. 259–262.

[5] Jung, T., Gross, M. D., and Do, E. Y.-L. Annotating and sketching on 3d web models. In *Proceedings of the 7th international conference on Intelligent user interfaces* (New York, NY, USA, 2002), IUI '02, ACM, pp. 95–102.

[6] Kadobayashi, R., Lombardi, J., McCahill, M. P., Stearns, H., Tanaka, K., and Kay, A. Annotation authoring in collaborative 3d virtual environments. In *Proceedings of the 2005 international conference*

on Augmented tele-existence (New York, NY, USA, 2005), ICAT '05, ACM, pp. 255–256.

[7] Sonnet, H., Carpendale, S., and Strothotte, T. Integrating expanding annotations with a 3d explosion probe. In *Proceedings of the working conference on Advanced visual interfaces* (New York, NY, USA, 2004), AVI '04, ACM, pp. 63–70.