A Multimedia 3D Game for Museums

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Abstract. Museums are very important in our society. They provide the public with access to collective heritage, culture, art and science, and somehow they help us remember who we are, and how we have lived. Nowadays museums come in all shapes and sizes, some let you see and some other let you touch. Science museums bring fun to parents and children, giving a positive view of science, properly mixing theory and practice.
Museums of Arts and Humanities are in some manner more serious for visitors and give less possibilities of interaction with. Can we let a child play with the prints and drawings? Objects made of precious materials such as gold and jewels, and fragile glass and porcelain are always shown behind a glass.
We present a Java3D game that let users play with historical pieces of art. The piece can be viewed in a 3D space with easy interaction and enlarged details. The game is basically a puzzle with many levels of difficulty that corresponds to subpieces of the original randomly broken. While user tries to recover the original counterpart, audio information and images could be offered in assistance. In this way, with a simple PC game people will experience with our past
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1. Introduction

The traditional role of the museum visitor consists of appreciating the exposed thing and acting with education (not to run, not to soil, not to speak aloud, etc.). In order to avoid a too singsong behaviour from the visitor, the museums try to contribute by showing the artefacts and data in a more dynamic way, offering visitors expert-guided visits, published guides where everything is explained in a comprehensible manner, or audiovisual devices where information is told in several languages, complementing then the informative panels.
Science Museums are achieving a remarkable success due to the new role of the visitor that they offer. No longer the visitor is a mere spectator, but becomes an active component of the experiment that is presented. Scientific areas like Chemistry (García-Ruiz et al., 1999), the Optics, the Physical Mechanics, etc. manage with hundreds and hundreds of theoretical and practical concepts that can be adapted to Science Museums as interactive experiments that do not involve any kind of risk. As much parents as children, enjoy Sciences in a similar manner as a game. Children can touch everything what they see, without fearing of being reproved by their parents.
In fact, this idea of playing with scientific concepts without any risk, leading us to feel like in home while being in fact in the museum, gave us the justification to initiate this project.
We have visited several History and Archaeology Museums, and all of them were boring, being merely shelves full of ceramics and bones, but without other information apart from a few informative panels. Thus, the basic idea came into our minds: why not develop an interactive game, to achieve an attractive feature to these museums? And, why not bringing students a new learning method?
Thus, as the Science Museums are so successful, we propose to place this kind of activities in arts and humanities museums. By adding this new look, Arts and History Museums will no more longer be seen as boring places from most of the population.

Fig. 1. Interactivity is one of the most attractive features of new Science Museums.

2. The Blueprint

Basically, the idea is to add new information sources, completely different from the existing ones. We should design something interactive and that were as exciting as a game (all of us know that games are very related with fun and diversion). At the moment we could wonder ourselves which kind of game is more suitable for art. What could we make that would be amuse, instructive and interactive for the visitor? Several proposals can be made depending on the related piece(s):

- Action adventures
- Quiz
- Painting
- Puzzles

One of the most traditional and instructive games are puzzles. Everybody has played it any time, and knows that it can get addictive. Usually, they reproduce figures from landscapes, historical monuments, famous paintings, maps, etc.

Puzzles are constructed on the basis of a bidimensional image and depending on their complexity, the time needed to complete it might vary. It is clear that once we get it without holes, we may identify in a much more detailed way the characteristics of the reproduction, i.e, we will have learned something new.
Nevertheless what we learn is static, an image from a point of view. We can miss interesting details that are perceived from other perspectives. If the puzzle is representing a picture, there are not many points of view (although some pictures were designed to be seen from just one point), but when we are visualizing a military weapon, a hunting of farming tool or an archaeological piece, there are some details that can only be seen from a very selected point of view, so it is necessary to manipulate the object in order to acquire the correct view, as if we had the object in our hands. Also, we might want to take a closer look, and recreate ourselves while observing all the small details.
Therefore the idea of a 3D puzzle, allows us to give to the museums what we wanted to offer.

3. "Magic Potter", the Game

We present here a multimedia game for museums, designed to allow the visitor to acquire the role of an archaeologist, by attempting to reconstruct an archaeological piece that has been extracted broken into small pieces.
The skill of the player and the observation of the exposed original piece in the museum will allow him to achieve its objective and to obtain a unique reconstruction.
This software allows visualizing a virtual object, complete and quite similar to the real one that existed centuries ago, although at the moment of its discovery, we had only a few fragments. Again, the user acquires knowledge and has the feeling of create a perfect archaeological piece. From this fact, we have named this game "Magic Potter".

3.1 Implementation

One very important detail to consider in implementing this project is its economic viability.
Nowadays, one of the cheapest and more powerful technologies for games programming is Java (Sun Microsystems, 2004), (Morgan M., 1999), and its graphics API Java3D (Java-3D Community, 2004),(Selman D., 2000).
The characteristics that Java3D offers us are especially interesting for the development of a multimedia application. To mention the most important Java3D features in this case:

- Collision detection.
- Integrated with other media type.
- Support for continuous action devices.
- Extensive viewing controls.
- Morphing / Character Animation.
- Variable appearance (Fig. 2)

By using Java and Java3D, our game is not restricted to a specific operating system, so it is very easy and cheap to run it over a wide variety of them.

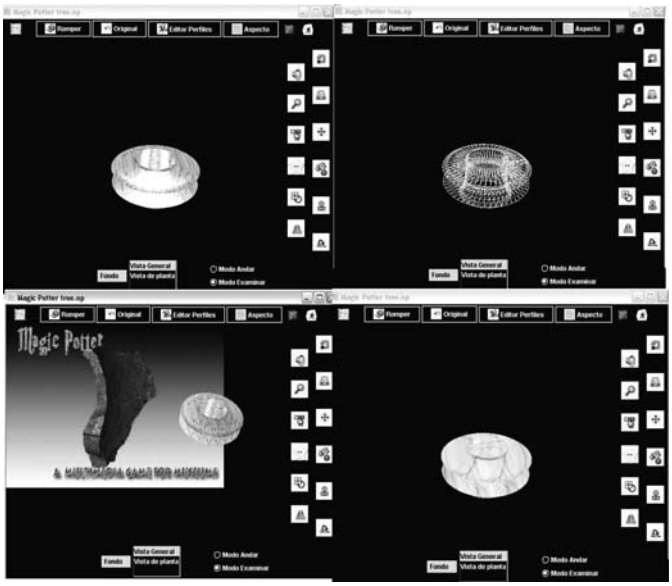

Fig. 2. Four different appearances of a reconstructed pot.

First thought is to use a Microsoft Windows© system, but it has an extra cost of licensing, and there are another alternatives much more attractive than this one, for example GNU/Linux (Linux Online, 2004). GNU/Linux is distributed under GPL licence, so it has no cost. Its kernel is free at the web, and hundreds of applications are daily released to offer more and more power to Linux-based systems.
But, anyway, the operating system used to support "Magic Potter" is up the Museum manager.

3.2 Hardware Requirements

We needed a single PC with multimedia characteristics, just like home-users PCs.

Fig. 3. Arcade machine running "Magic Potter".

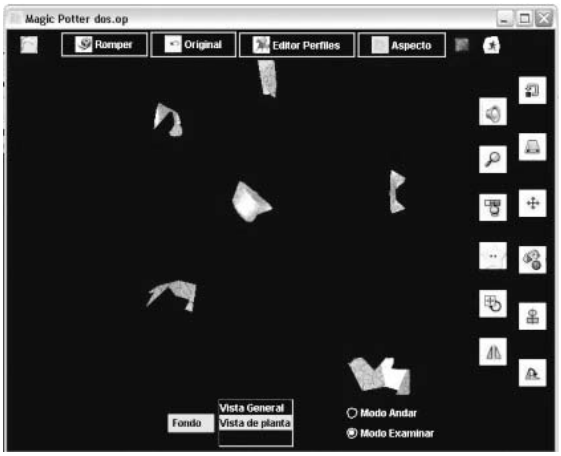

Fig. 4. Unordered fragments of a broken pot.

The more suitable form of presentation in a museum would be a computer with touch screen, assembled in a column or inside an arcade machine (Fig. 3), standing next to the original piece which the game is based on. Other possibilities somewhat more slight and portable would make use of PDAs, with no need of changes in the source code of the program.
The game also could be sold inside the souvenirs shop of the museum. So, people could use it at home in a standard Web browser no matter what operating system they use: Windows, Macintosh, UNIX, or Linux (Welsh MM. et al, 2003). No extra software needs to be pre-installed (drivers, libraries, etc…).
Although at this moment we are using a mouse or a touch screen to interact with the game, because they are more common devices, also we can use others devices of greater impact over the user, as virtual helmets, data gloves or haptic devices (Laycock S.D. and Day A.M 2003). Again, with no need to make changes in the source code of the program, since these features are supported by Java3D technology.

3.3 How to Play?

The game is so easy to play, and so easy to manipulate that a few lines will be enough to describe it.

Fig. 5. Reconstructed object.

At first screen, the user will select the skill level. At 0 level, the user will have to reconstruct a piece based in all its fragments, and these are large enough to be easily recognisable (Fig. 4).
While increasing the level of difficulty, the number of fragments will increase also, and randomly will disappear some fragments, getting closer and closer to the archaeologist task.
At highest levels, the user will have to classify first those fragments that belong to the same piece, which are mixed in the screen with other sherds with similar texture and shape.
The goal is to obtain the piece as it was designed by the potter (Fig 5), and compare it with the real one exposed next.

3.4 Extra Features

"Magic Potter" offers the user to design its own profile, in order to obtain a fictitious vessel, break it with a virtual hammer and play again.
This profile editor is integrated into the system, developed also with Java, and is as easy as drawing the profile over a canvas, selecting the desired resolution.

3.5 Algorithmic Implementation Details

In a two dimensional puzzle, it is necessary to take into account the position and shape of pieces in a XZ plane to make a successful match of two separate fragments.
Complexity of our puzzle comes obviously from the three dimensional world in which we are involved. It is not only difficult due to be working with three-dimensional coordinates, but also from the increasing of complexity of edges and handling possibilities.
At first sight it seems that the problem cannot be simplified, because we are working with intrinsically 3D objects, but take a look to this example: an atlas is drawn by projecting earth views onto a plane image, representing tuples of three dimensional values in Cartesian coordinates by a pair of numbers (latitude and length).
We took this example as starting point, and made an analogy between the atlas and our pot. If we try to project the external surface of out ceramic piece into a single image, the transformation is identical to that one shown above.

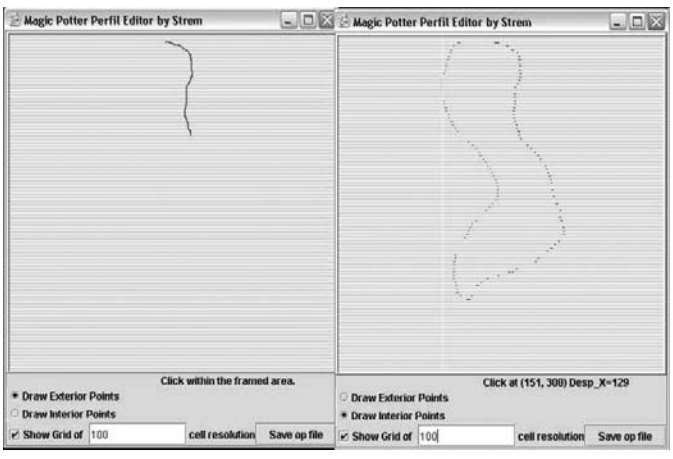

Fig. 6. "Magic Potter" Profile Editor for geometry generation.

The "Magic Potter" profile editor generates a data structure with two leading set of points: exterior points and interior points. Then we compute the distance between each two points at the same horizontal grid line, Y, and call it
This profile is extended horizontally, like an atlas, and the breaking process is made as in 2D images, but taking into account the normals of breaking edges, generated automatically by Java3D. After the breaking process, we obtain several sets of two dimensional data Y- which are visualized in 3D as fragments of the original pot.
The fragments are easily drawn using a Shape3D object from Java 3D library class, and it textures and appearances are easily selected from the graphical user interfaces.
In order to evaluate each matching, we test the dot product of the face normal that share breaking lines between adjacent fragments. If two adjacent fragments are close enough and the orientation test is passed, then geometries are merged in a unique Shape3D and new values of Y- data pairs are instantiated.
Game finishes when all fragments are matched properly.

4. Conclusions and Future Works

Therefore the characteristics to emphasize of Magic Potter are:

- It is an interactive game that comes with different levels of difficulty.
- Easy to use and intuitive interface.
- Extensive.
- Multimedia.
- Reduced costs.
- Multiple applications.

Our future work is mainly related with virtual reality extensions using haptic devices. We also consider that is important to enrich the gallery of art pieces representation.

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