Ludic and Didactic Paths in a Cultural Heritage Building

Prototype of a Learning System

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Abstract: *This article proposes a conception method of ludic and didactic paths improving the acquisition of knowledge of archaeological and architectural heritage. In order to have an idea of a monument, the learner is guided and motivated following strategic paths during the 3D exploration and developing a memory map during the creation of knowledge. A prototype is realized and presented in order to see how this learning system guides the reasoning of the learner and can improve the acquisition of knowledge. We chose the Cheops Pyramid to Gizeh to illustrate our work.*

Keywords: *Learning system; archaeology and architecture; 3D navigation; strategic path; memory map.*

Introduction

Experiments in communication of archaeological and architectural heritage are increasing. Thanks to the attractions of multimedia, namely interactivity and multimodality, it seems that web sites and CD-ROMs have the capacity to transmit heritage information to the public. But ultimately they miss real cognitive or educational purposes.

This research work consists of proposing a new 3D navigation mode based on strategic paths as an aid in the understanding of cultural heritage. To use this work in a very instructive way, we intend to increase the cognitive efficiency that develops between this system and a non-expert learner.

During the real time movement in a monument, the learner performs two activities in parallel:
- the exploration of the 3D model,
- the creation of the memory map.

The exploration and creation activities allow us to elaborate a learning system supervising the navigation of the learner: by managing his movements and by taking into account his cognitive capacities. The creation of the memory map is based on the structure of the topographic and cognitive paths.

The realization of the prototype puts in relation the theoretical model with the technical feasibility.

First, we study the difference and correspondence of these two paths mentioned above. Then, we describe the memory map accompanying the learner's exploration. Finally, the prototype will correlate the creation of the memory map with the kind of narrative proposed during the exploration. In our study, we will choose the Great Pyramid of Giza in Egypt.

Figure 1
Successive sequences of the
path defining a quest
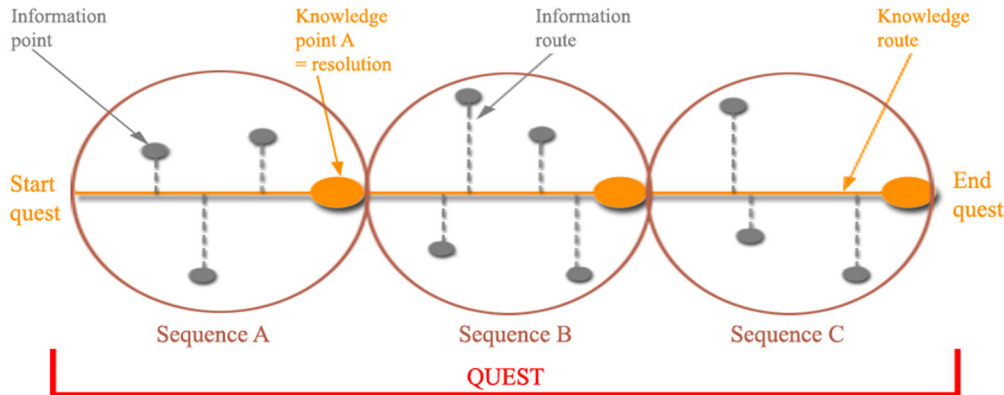
The strategic paths helping the exploration of a 3D model

The topographical path

To be able to structure the movements, we introduce the notion of the topographical path by identifying critical points and secondary points in the path and by putting them in concordance. It is necessary to choose in the studied building the interesting critical points according to the message that we want to communicate to the learner.

Each crossing point suggests specific actions that we wish to represent in the topographical path. The crossing points of the path consist of two types of points:
- the information points, defining the information route,
- the knowledge points, defining the knowledge route.

The data on the information route are reinvested in the knowledge points where the learner transforms the information into knowledge. The knowledge point is a critical point structuring the path in sequences.

The successive sequences define a quest. The number of information points in each sequence is defined in relation to the riddle proposed and the number of knowledge points in a quest is defined by the message (religious, structural aspect, etc.) to be taught (Figure 1).
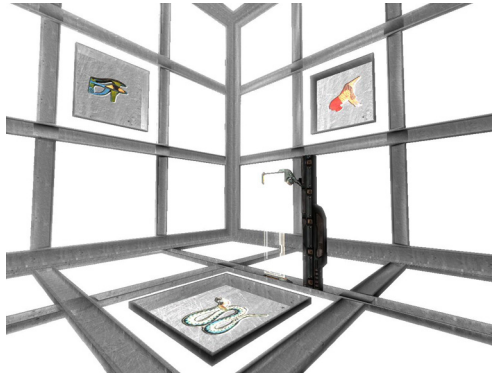
The cognitive path

Research and cognitive experiments have shown that the learner must be constantly alerted and motivated to be interested in the studied topic. The acquisition of new knowledge depends on his willingness to achieve the objectives.

To motivate the learner by avoiding a "cognitive overload" (Jacquinot, 1996), we define a ludic aspect of the path in relation to the diversity of spaces that can be visited and in relation to the possible interactions in these spaces by manipulating multimodal information.

We decide to create some extensions of the path in the 3D base model. These spaces voluntarily added, fictitious or depending on the historical context of the building, belong to the information route and hold the clues for solving the riddle at the knowledge point and for moving to the next sequence. The knowledge points would thus be existing spaces in a building to be communicated. The transition between the existing spaces and added spaces is possible by crossing portals.

Imagine a path in the Cheops Pyramid in Egypt. The learner moves in real time in the existing spaces in the monument. By leaving the "Queen's Chamber" for example, he could go to an invented virtual space allowing an interaction between the learner and his

environment:

- logic and mechanism space in reference to the film "Cube" (figure 2),
- reading space: the papyrus of Ani,
- immersion space: the solar bark of Cheops.

The transitions between the existing spaces and added spaces are possible through "temporal corridors" by passing portals located in the pyramid (figure 3).

The memory map helping the construction and memorization of knowledge

A multimedia notebook

The memory map is a support crossing various graphic and sound representations: it allows the

learner to store images, take notes, sketch drawings and play audio or video: multimodal information found during the 3D exploration or created by the learner. Information contained on the map is manipulated. Actions such as moving, connecting, correcting, removing, etc, maintain an interaction between information and the user.

A memory tool

The memory map transmits messages. Its capacity to produce meanings allows the learner to build his own reasoning. According to Jean Piaget (1970), knowledge results from the interaction between the person and the environment, compared to the constructivist hypothesis: we appropriate knowledge that we build ourselves.

The possible links between the information allow the learner to create associations between elements. This process is similar to the mnemonic method. This activity is a learning process by organizing information and by encouraging memorization.

Description of the prototype

Choice of tools

Our learning system proposes two different and inseparable activities. How to maintain a link between the exploration and creation while these two activities have a different mode of use and programming language?

The possible interface between the exploration of the Cheops Pyramid and the creation of the memory map will determine the choice of tools.
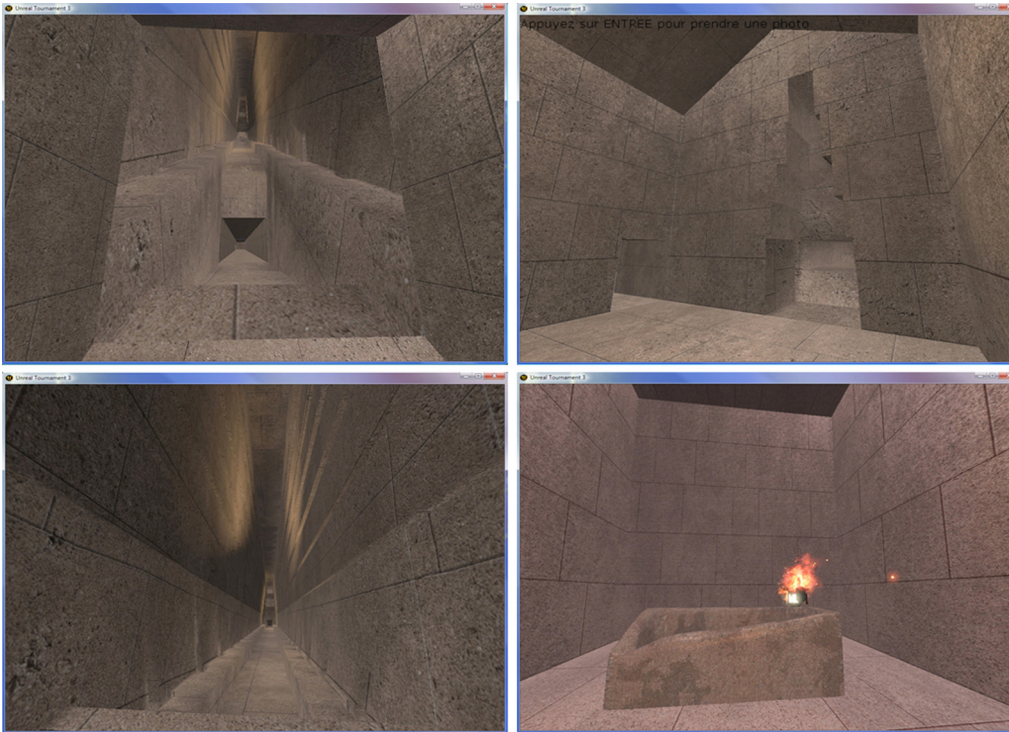
Thanks to the features integrated into the video game *Unreal Tournament 3* to communicate online, it is possible to put in relation its programming language (*Unreal Script*) with another ordinary language: the *Java*. The method consists in using the Internet protocols: *TCP* and *HTTP*.

Functioning of the system

The application is divided into three distinct parts:

1. The 3D model of the Cheops Pyramid explored

with Unreal Engine 3
2. The memory map programmed in Java
3. The database programmed in Xml

With the level editor *Unreal Ed 4.0*, the 3D model of the pyramid is added as a supplementary level in the video game *Unreal Tournament 3*. In the manner of *FPS* (*First Person Shooter*), the learner can then visit the pyramid with a subjective point of view (figure 4).

Events are added in the new level allowing the learner to interact with his environment. Each event (Trigger_0, Trigger_1, etc.) is controlled by a graphic script composed of a trigger button (Trigger_0 Used, Trigger_1 Used, etc.) and block scripts (Message_Out) with an "id". The id 00_00_0000 refers to the sequence 00, the information point 00 and the event 0000 (figure 5).
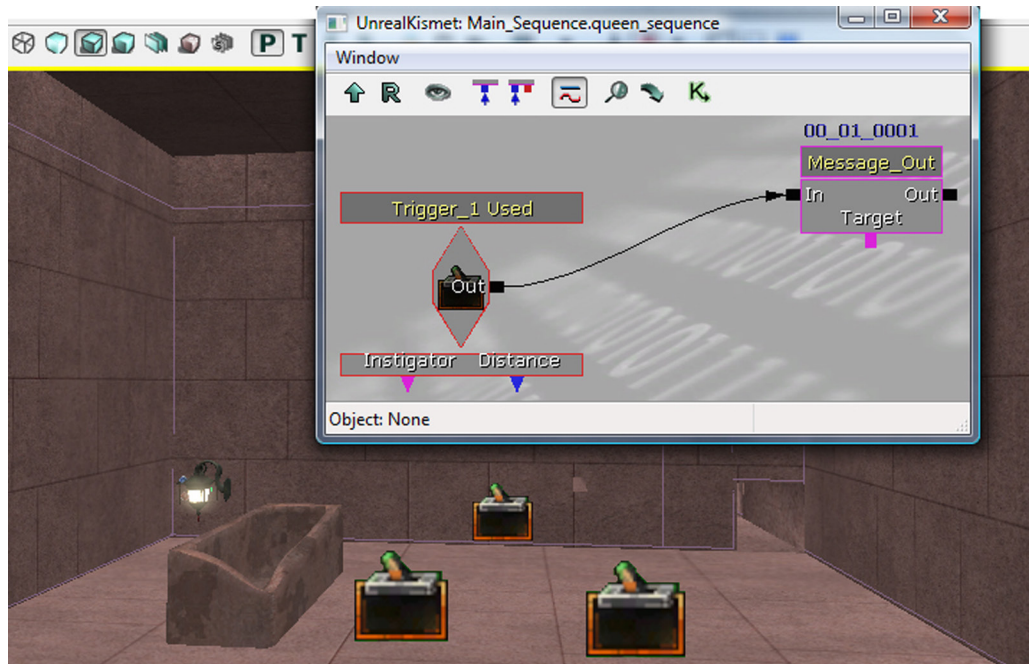
When the learner activates the button, the "Message_Out" block sends a message with the *TCP* protocol to the program *Java* updating the memory map.

The *Java* program retrieves all the actions of the learner as an event to view and treat on each page of the memory map. The memory map is displayed in another window on the screen.

Drawing and text tools allow the learner to personalize his map. A particular tool allows the learner to organize and link information resulting from the real time exploration. He can build data required to solve the riddle because each link (between a word and an image for example) has a meaning.

The *Java* program communicates with a database in *Xml*. It contains all information on the events and references all multimedia files (image, video, sound).

Use of the system

The screenshot realized by the learner is the first action of the sequence displaying a page of the memory map as a support for future actions. The learner goes in the knowledge space; he takes a photo (a first trigger event). The photo is a new page of the memory map (figure 7).

This page gives indispensable indications to solve the sequence:

- The photo is a background image showing the name and riddle of the sequence
- A square orange button allows a rapid movement towards the knowledge space

- Information bubbles with connectors indicate the name and number of information spaces to visit in the sequence

The number of connectors indicates the number of multimedia information to be found in the information space. Each connector possesses a name; the connection between the connector and the information is possible with the mouse (figure 8).

Thus, a new data appears on the curve. When all the connectors are plugged, a message related to the information space can be read by the learner.

The resolution process

Solving riddles

At the stage of knowledge, where the information is converted into data on the memory map, the information bubbles are automatically connected if their connectors are plugged. The knowledge specifies the action to be realized in the knowledge space.
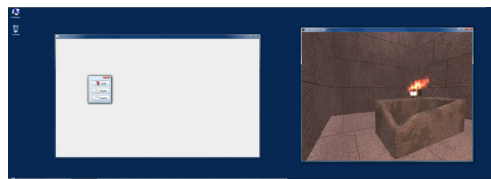
When the riddle is solved a canopic jar appears on the page and the sequence is finished (figure 9).

Solving quests

The resolution of the quest involves the resolution of all the sequences. The pages are added until the end of the quest. The multiplication of the pages requires the consideration of new types of 3D links. If the 2D links on pages help to resolve the riddle, the 3D links help to resolve the quest (Figure 10).

Conclusion

The topographical and cognitive paths allow the learner to find his bearings during navigation, from a spatial and cognitive point of view; they also maintain motivation encouraging the learner to participate.

By combining these paths with the memory map, we conceive a real learning structure guiding the reasoning of the learner: the 3D navigation is in an organized system allowing the constant reinvestment of the information into data and then knowledge. Every action has consequences. The memory map helps and validates step by step, the knowledge construction to solve the riddles in the knowledge spaces and finish the quest.

The realization of the prototype shows some technical or screenplay problems. This prototype will allow us to validate or revise our work. An experiment

Figure 7
A new page at the beginning of the sequence B "The Queen's Chamber"

Figure 8
A connection between the connector and the information

Figure 9
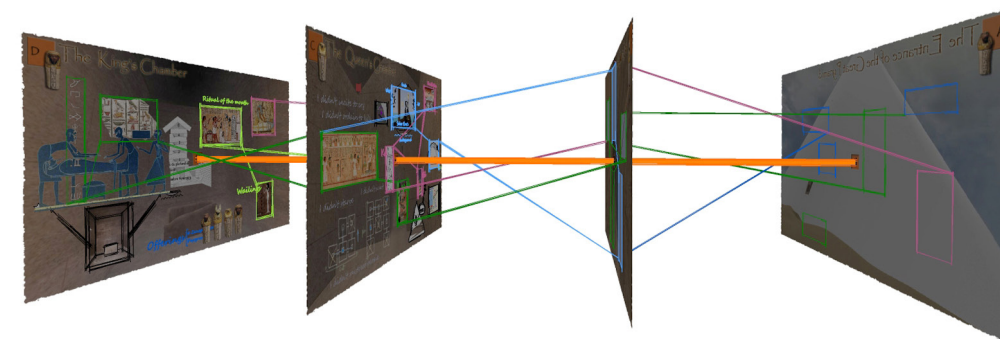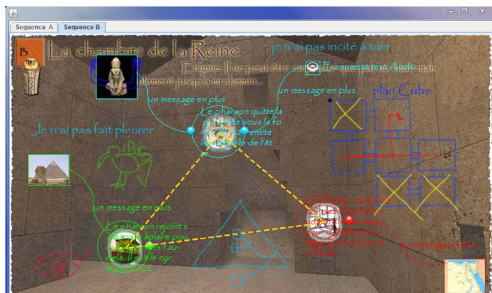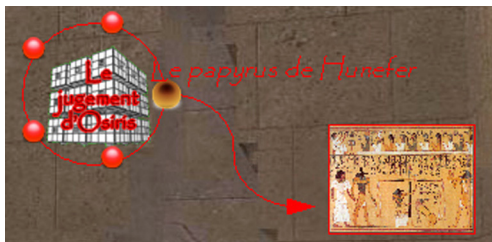*When the sequence is resolved, the page displays a canopic jar*

Figure 10
Simulation of the memory map at the end of the quest

is planned with students in order to know if this system really improves learning.

References

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