3D Visualisation and Interaction with a Paleolithic Database

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Prehistory is a science at the crossroad of many disciplines and requires to compile data from three main sources : the geology of the site, the environment of the fossils and the fossils. Then, researchers must handle an enormous quantity of information.

In particular, during the excavation on the prehistoric site of Tautavel (Cave of Arago, Tautavel, France, 450,000 years B.C.), archaeologists have found more than 500 000 objects. The processing of these data is till now performed in 2 dimensions only and their compilation remains difficult. There is then a large requirement of 3D digital modelling.

The purpose of our study was to conceive a virtual environment of excavation, allowing a three-dimensional interaction with the archaeological data. The 3D environment is composed of the digital copy of the cave in which the objects of the archaeological database are integrated using the mapping method of Benedikt space. We have developed tools to ease the handling of data, the visualisation and the navigation in the virtual environment as filtering (focus + context), management of the level of details for the objects.

The 3D visualisation and interaction with data should support the work of archaeologists. The prospects are multiple as to allow a virtual excavation considering the time variable, to think about an innovative interface mode using haptic feedback and to develop a distributed platform of virtual reality.

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General presentation

The *FOVEA* Project (*http://foveaproject.free.fr*) (Guipert et al., 2003) gathers 2 research teams in Paleontology - the Department of Prehistory of the French Museum on Natural History and the European Center of Paleontological Research of Tautavel - and 2 research teams in Computer Science - the Department Virtual Reality of the Research Institute in Computer Science of Toulouse (IRIT) and the EPIDAURE Project of the French National Institute of Research in Computer Science and Automatics (INRIA Sophia Antipolis) in an ambitious 2-year research program, supported by CNRS, that aims (see Fig. 1):

• to build a 3D digital model of a paleo-anthropological excavation site,
• to archive exhaustively the discoveries,
• to assist the paleo-anthropologists in their research,

• to favor scientific collaborations,

• to broadcast the results over Internet.

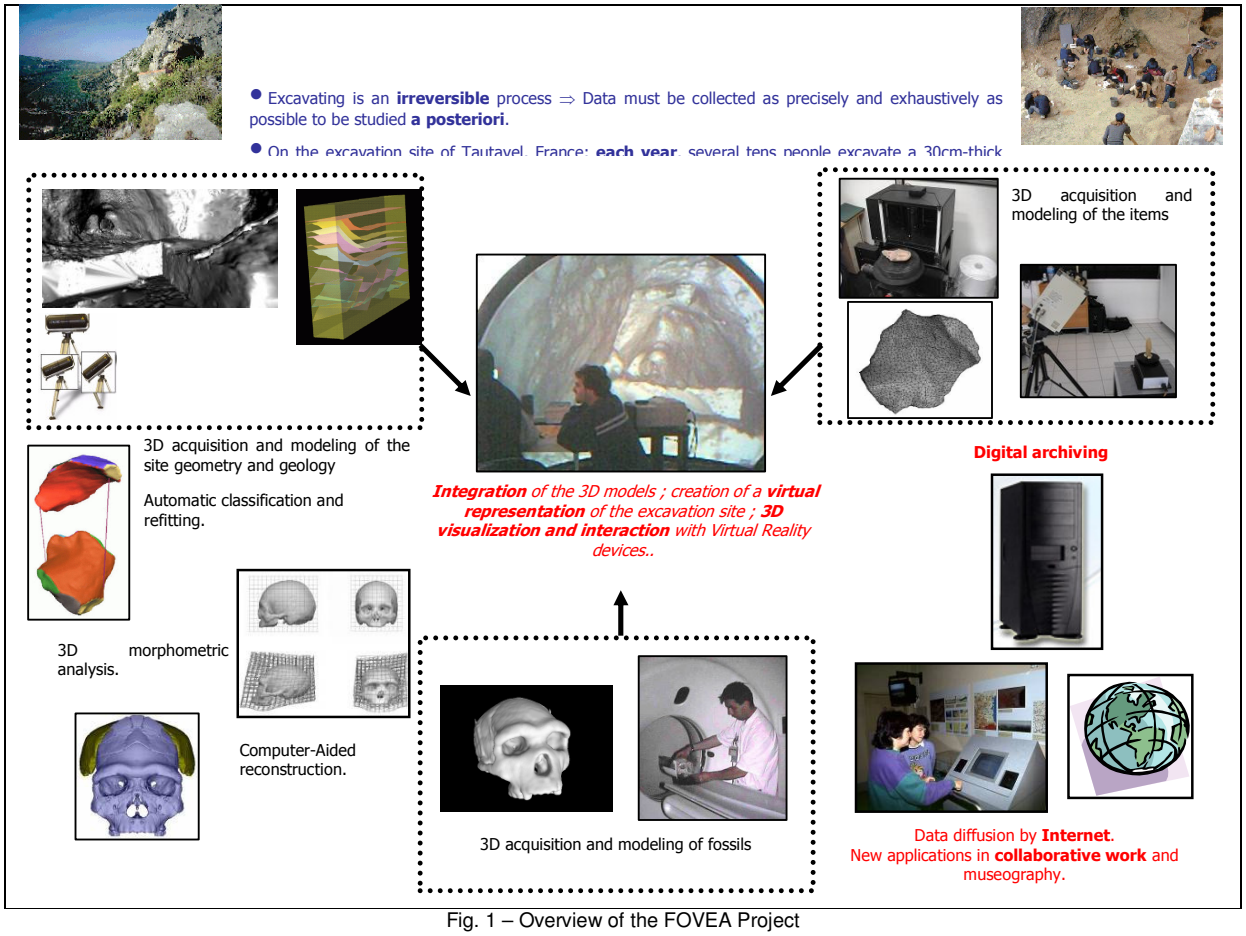

Fig. 1 – Overview of the FOVEA Project

3D modeling the database information

The database *Paleontological Material* includes information about the items (fossils, tools, etc.) that have been found on the Caune de l'Arago since more than 30 years of excavation (de Lumley, 1998) (Pois, 1999). It includes around 250,000 items with their 3D coordinates and between 30 to 300 descriptive attributes that are stored as text files in a SQL-based system.

We have developed a software framework for:

3D Visualization (see Fig. 2)

- Integration with a detailed 3D geometrical model.
- Visualization of the item properties by clicking on it.
- Immersive visualization by using Virtual Reality device.

Fig 2 – 3D Visualization.

3D Navigation (see Fig. 3)

- 3D navigation by using the mouse or/and keyboard
- Focusing on an item: when it is pointed, it is possible to move **around it** to explore its environment.

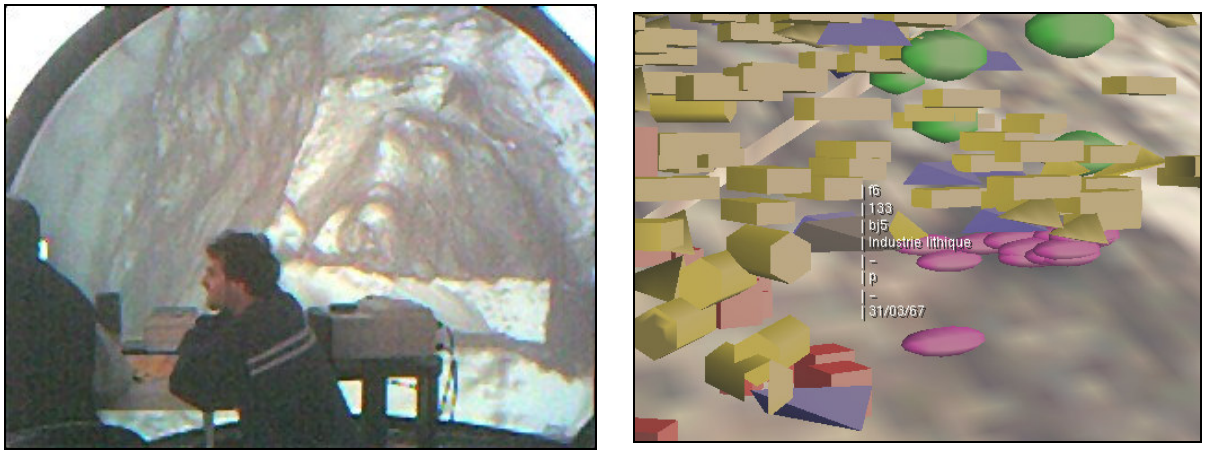

Fig. 3 – 3D Navigation.

3D Interaction (see Fig. 4)

- Filtering the items according to their properties (excavation period, type, orientation, etc.)

- Detailed visualization of the item if a 3D model is available (Delingette, 2002). For example, we have scan in 3D some fossils (Mafart et al., 2004) and tools (Borderie et al., 2004).

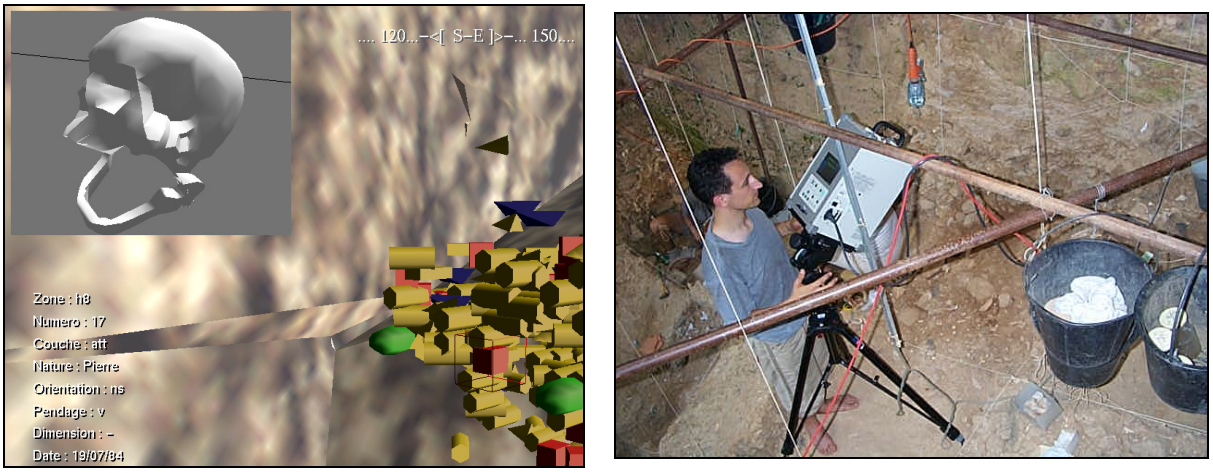

Fig. 4 – 3D Interaction.

More details on the features and implementation are given in (Thomas, 2004).

Future work

- *A new approach: the 4D excavation*. If we are able to model the physical properties of the geological layers, it will become possible to deform them to recover the subsoil of a given period. We will see then the modification on the localization of the artifacts and on the shape of the items or fossils. The 3D model of the excavation site will then become a 4D model (i.e., *3D + time*).
- *An innovative interface mode, the haptic feedback*. We plan to study the utility of the haptic feedback for virtual excavation. For example, the paleo-anthropologist could probe the site by feeling a force proportional to the density or to the properties of some objects.
- *Towards a distributed paleo-anthropological research*. 3D visualization and interaction tools allow specialists of different disciplines to work at distance on the same data via Internet as it is already done in industrial Computer Aided Design (Torguet et al., 1999).

Acknowledgment

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References

Electronic versions of some references are available on the Web site: http://foveaproject.free.fr

Borderie, Q., Torguet, P., Subsol, G., de Lumley, G., Mafart, M., Vigouroux, A., Jessel, J.P., 2004. "3D Modeling of Paleolithic Tools". Workshop on Archaeology and Computers, Vienna (Austria), November 2004.

Delingette, H., 2002. "Bridging the gap between archeological datasets and digital representations. *XIV International Congress of Prehistoric and Protohistoric Science*, Liège (Belgium), September 2001. Abstract page 23 in preprints, full text in: B. Mafart and H. Delingette with the collaboration of G. Subsol (eds.) *Three-Dimensional Imaging in Paleoanthropology and Prehistoric Archaeology*, British Archaeological Reports International Series 1049, 89-92, 2002.

Guipert, G., Subsol, G., Jessel, J.P., Delingette, H., Mafart, B., 2003. "The FOVEA Project: a New Look at Human Past". *9th International Conference on Virtual Systems and Multimedia*, Montreal (Canada), October 2003.

de Lumley, H. 1998. "L'Homme premier : préhistoire, évolution, culture". Editions Odile Jacob, September 1998, in French.
Mafart, B., Guipert, G., de Lumley, M.A., Subsol, G., 2004. "Three dimensional computer imaging of hominid fossils: a new step in human evolution studies". Canadian Association of Radiologists Journal, Vol. 55 No. 4, 264-270, October 2004.
Pois, V. 1999. "Traitement informatique en archéologie. Mise en évidence du niveau archéologique I/J de la Caune de l'Arago à Tautavel (Pyrénées Orientales)". Comptes-rendus de l'Académie des Sciences, Sciences de la terre et des planètes, 329, 533-536, 1999.
Thomas, J.C., 2004. "Environnements virtuels pour l'interaction avec de grands ensembles de données". Master's Thesis, D.E.A. Informatique de l'Image et du Langage, Université Paul Sabatier de Toulouse, July 2004.
Torguet, P., Balet, O., Gobbetti, E., Jessel, J.P., Duchon, J., Bouvier, E., 1999. "CAVALCADE: a System for Collaborative Prototyping". G. Subsol (ed.), International Scientific Workshop on Virtual Reality and Prototyping, Laval (France). June 1999.