Using Semantics to Manage 3D Scenes in Web Platforms

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INTERNET AND 3D SCENES

Computer graphics has widely spread out into various computer applications. After the early wire-frame computer generated images of the 60s, spatial representation of objects improved in the 70s with Boundary Representation (B-Rep) modeling, Constructive Solid Geometry (CSG) objects, and free-form surfaces. Realistic rendering in the 90s, taking into account sophisticated dynamic interactions (between objects or between objects and human actors, physical interactions with light, etc.) now make 3D-scenes much better than simple 3D representations of the real world. Indeed, they are a way to conceive products (industrial products, art products, etc.) and to modify them over time, either interactively or by simulation of physical phenomena (Faux and Ellis Horwood Ltd. & Pratt, 1979; Feiner & Foley, 1990; Mortenson, 1985).

The exponential development of Internet tends toward two domains which may seem contradictory. On the one hand, we note the increasing importance of the visual aspect of the Web inasmuch as the text that initially composed pages of the first Web sites has been replaced by pictures and animation. We note the breakthrough of software such as Flash from Macromedia (2004) in this domain. On the other hand, the informative aspect of the Web has undergone major development with the interconnection of databases with HTML pages using ASP, PHP, and so on. Such information becomes intelligent, adaptived to the behavior of the connected users. The breakthrough in the interconnection of databases with the HTML pages has permitted the creation of new dynamic sites. Today, a Web site must be lively, attractive, intelligent, active, and interactive.

Nevertheless, limits do exist. In terms of the visual aspect, 3D representation on Internet is expanding rapidly. However, it is often limited to short animated sequences short animated sequences, due to the important resources needed to use 3D on the network. In terms of the informative aspect, it is often limited to the interfacing of database with the HTML code.

Large amounts of data can be generated from such variety of 3D-models. Because there is a wide renge of models corresponding to various areas of applications (metallurgy, chemistry, seismology, architecture, arts and media, etc.) (The DIS 3D Databases, 2004; The Fermi Surface Database, 2004), data representations vary greatly. Archiving these large amounts of information most often remains a simple storage of representations of 3D-scenes (3D images). To our knowledge, there is no efficient way to manipulate, that is archive, extract, and modify, scenes together with their components. These components may include geometric objects or primitives that compose scenes (3D-geometry and material aspect), geometrics transformations to compose primitives objects, or observation conditions (cameras, lights, etc.). Difficulties arise less in creating 3D-scenes, rather than in the interactive reuse of these scenes, particularly by database queries, for example, via the Internet. Managing 3D-scenes (e.g., querying a database of architectural scenes by the content, modifying given parameters on a large scale, or performing statistics) remains difficult. This implies that DBMS should use the data structures of the 3D-scene models.

Unfortunately, such data structures are often of different or exclusive standards. Indeed, many standards exist in computer graphics. They are often denoted by extensions of data files. Let us mention, as examples, 3dmf (Apple's Quickdraw 3D), 3ds (Autodesk's 3D-Studio), dxf (AutoDesk's AutoCAD), flt (Multigen's ModelGen), iv (Silicon Graphics' Inventor), obj (Wavefront/Alias), and so on. Many standardization attempts strive to reduce this multiplicity of various formats. In particular, there is STEP (Standard for the Exchange of Product model data), an international standard for computer representation and exchange of products data (Fowler, n.d.). Its goal is to describe data bound to a product as long as it evolves, independently of any particular computer system. It allows file exchanges, but also provides a basis for implementing and sharing product databases. Merging 3D information and textual information allows the definition of the project's mock-up. Indeed, 3D information describes CAD objects of the projcet and textual added information gives semantic information on geometries. The main issues are the sharing and the exchange of the digital mock-up. The next section explains how we use a digital mock-up to create an information system with the help of the semantic included in geometric information. Information is exchanged and shared through a Web platform.

BACKGROUND

With the emergence of new powerful computers, the 3D models created by computer-aided design tools are huge and very complex. The plans of a boat, plane, or architectural structure can exceed a gigabyte in size. The GigaWalk (Baxter, Sud, Govindaraju & Manocha, 2002) project is a rendering system making it possible to display projects of CAD with more than 10 million polygons. The design based on the simulation of these data cannot make a useful contribution without the possibility of generating an interactive display through a virtual visit of the model. Many optimizations and acceleration techniques for interactive display were developed for this type of data. These techniques include visibility computations, object simplification and image-based representation. All these techniques have been combined successfully in the rendering of specific data including architectural models (Funkhouser, Teller, Sequin & Khorramabadi,

1996) and urban models (Wonka, Wimmer & Sillion, 2001). The digital mock-up greatly impacts the financial and strategic choices of companies during the design phase. To improve the quality of prototyping and refined strategic choices, collaborative platforms were developed on the Web. Along with digital mock-up, these platforms allow designers and decision maker architects to work directly with geographically distant companies (Torguet, Balet, Gobbetti, Jessel, Duchon & Bouvier, 1999).

Nevertheless, these collaborative platforms do not allow the geometrical handling of a great quantity of polygons in real time without a prohibitory pre-calculates time. A way to solve this problem is to structure the 3D scene according to semantic criteria or to start from the only geometrical criteria only. Semantics is a crucial point for Web platforms because it influences the three characterizing axes of platforms, namely data, communication, and processes.

- Data is the information which is handled through the system. This information includes the data from the digital mock-up, the data of concerning model management like users and rights associated with users, and a set of meta-data allowing data management on a higher level of abstraction. This level allows the handling of the semantics of information and thus making the information more relevant to the situation of the user.
- Communication is the infrastructure which is installed to transfer information between processes and project actors. Transfer of more relevant information will limit the size of information exchanged and thus will improve the response times in the communications between processes.
- Processes carry out actions which are ordered either by another process or by an actor of the project. Processes are either generic or specialized. A set of generic processes forms the core of the system, making it possible to carry out simple actions which correspond to the use context of the platform. Specialized processes are composed of a sequence of simple processes and specialized processes to undertake a complex action. For example, a simple process will make it possible to insert an individual into a database and a complex process will make it

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