VIRTUAL MUSEUM – AN IMPLEMENTATION OF A MULTIMEDIA OBJECT-ORIENTED DATABASE

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Abstract: This paper describes the main characteristics involved in the process of using multimedia content in the Internet sites and it presents a proposal for an implementation of an object-oriented database, in order to assist the multimedia data exigency in a dynamic website. It is described an implementation of the proposed architecture, consisting of a virtual museum made for the Contemporary Art Museum of the USP, called Virtual MAC, which was elected as the 3rd best virtual museum of the world by INFOLAC Web 2005 (UNESCO) . The main objective of Virtual MAC is to create a virtual collection of works at art and make it available on Internet. Our analysis shows that it is more appropriate to use the Object Oriented paradigm instead of Relational Modelling due to the nature of the multimedia data and the structure of the dynamic web site used for the Virtual MAC.

1 INTRODUCTION

Nowadays there are a great variety of multimedia items, which can be inserted in a database, such as images, audio and video files. It must also be considered that this type of data has several parameters which should be take into consideration whatever may the system be, and must be stored in the database, such as the quality of a video image or the taxes of audio samples. The kinds of objects, which have some special characteristics, must be considered during the database design. The new applications on Internet have massive use of multimedia data, such as audio, video and several types of animation files. Another trend on Internet is the building of dynamic sites in order to provide a fast way to update or change information for the users. A difficult task that appears in this scenario is some limitations in the relational databases that could be used to support dynamic sites. The main reason of the difficulties is the representation of complex data in the relational database, such is the multimedia data. The limitation presented in storing and recovering complex data may increase the complexity of the site application (Rashid, 2001). In the case of a Virtual Museum, there is a huge amount of multimedia data, such as videos, pictures and animation files. It is turn not properly the use of relational database to support the dynamic site, such as Virtual MAC, and the use of an oriented-object database becomes the more appropriate approach to address a solution for the virtual museum. In order to present the structure and considerations among the Virtual MAC, following sections composes this paper. The section 2 describes the relation between an object-oriented database and the structure of web documents, such as web pages, and it is shown why the use of object-oriented database if a quite better option to build the Virtual MAC, instead of to use a relation database. The section 3 and 4 describes the Virtual MAC and the structure of object-oriented database, and the section 5 brings some final remarks about this work.

2 MULTIMEDIA DATA AND OBJECT-ORIENTED DATABASES

Multimedia contents are presenting more importance through time, since they represent new types of communication through the Internet. We can say that these multimedia data constitutes a new kind of communication, allowing the implementation of new communication ways. (Hacid, Declair, Kouloumdjian, 2000).

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The multimedia data is defined, for the purposes of this paper, as the content composed by text, audio, video and graphics or any combination of them. The multimedia data have some peculiar characteristics like larger complexity (difficulty to represent them in the relational model - e.g. an electronic circuit), multi-valued and complex structure fields (e.g. an industry plant). This leads to the use of object-oriented databases that can implement, in a more efficient way, such aspects, when compared with Relational Databases. (Elmasri, Navathe, 2003). It means that the database schemas are designed to deal specifics data types and application scenarios, and they do not consider a hybrid type of data, such as multimedia. (Woelk, 1986).

The difficulty to represent these data types in the Relational Database is the possible combination of the elements and their representation as valid Internet documents (Ishaq 1999). Nowadays, a web site is composed by more than one of these types of pages. When a dynamic web site must be built, it is complex to represent all these page possibilities in a relational database (Wen, et al. 2003).

Taking into consideration the implementation methods of such complex system, it is more appropriate to make the implementation directly in an object-oriented database management system, avoiding the problem of impedance mismatch. The option of storing complex information in an Object-Oriented Database has a clear advantage over Relational Databases: the complex information of an object could be better represented and its data may be easier accessed by the user application through an object-oriented database. The object could also be composed by other objects, which could facilitate the representation of more complex data. (Yu, Meng, 1994), (Tepfenhart, Cusick, 1997). All methods that work with the object do not need to be implemented in the application that builds pages. Instead of that, the application only use what it is defined inside the database, which simplifies and guarantees that all pages will work with the object at the same way. This encapsulation is useful in order to permit that any modification in one object of the database does not damage or interfere in any other object functionality. The approach proposed for this work is closer than Service Oriented Architecture (SOA) approach (MacKenzie, et. al. 2006), or even the usual Internet programming patterns, such MVC (Modelling, View and Control)

3 AN IMPLEMENTATION OF AN OBJECT-ORIENTED MULTIMEDIA DATABASE

The "Museu de Arte Contemporânea da USP" (MAC USP) (Museum of Contemporaneous Art of University of São Paulo) has an outstanding collection of around 8,000 pieces of art, including paintings, prints, drawings, photographs, engravings, sculptures and conceptual works, constituting a great cultural heritage with national and international influences. The main idea of Virtual MAC is to associate the information technology with art, making available all the collection that belongs to MAC. Considering that one of the purposes of the site is to divulge the MAC around the world, the information in the site is displayed in three different languages (Portuguese, Spanish and English).

The system database should contain all significant information for each work of art. Some of the most important kinds of media are high quality images, besides files of video and audio. The basic reason for the need of high quality multimedia files is that users may need to have access to images that allow the observation of the work's details. Considering the three-dimensional works, it is also desirable to have the possibility to visualize them at the same perspective of a real visitation.

3.1 A Proposal for an Object-Oriented Multimedia Database

In the Virtual MAC all pages must be dynamic because researches from museum can need to modify, add or even delete some information or picture about any work of art at any time. Each one of the work of art stored in the database has several features related to itself and also with its presentation in the website. One important target of this system is presenting the world of art for common people, and at same time provides useful information for art specialists. The Virtual MAC must also provide the better experience for the user as possible. For instance, three types of images and two types of text compose the work of art. There is one image to be shown as an icon, one for users that are connected on the Internet by a dial system; and there are another rich image for ADSL, and another for the Internet2 users. The last type of image could have more than 10Mbytes each one, and permits to observe minimal details of an work of art, such as the author's signature. The Virtual MAC has the following types of multimedia information and tools

on the Internet, which must be supported by object oriented database:

- Information about work of art: texts with useful information such as work of art description, historical information, author's life, etc;
- Work of art images: several of them were digitalized and it is reproduced in two resolutions. One it is for dialup and ADSL Internet connections, and the other is for Internet 2 connections (very high quality image);
- Animations about sculptures: the three-dimensional work of art can be view by the web site visitor at the same angles that they could see in the museum;
- Virtual tours and expositions: expositions can be built and the virtual visitor can "walk inside" the museum. He can see the work of art and select one of them to receive more detailed information;
- Videos and audios about art and the museum: videos and audios have three types of quality: one for dialup connections (until 56kbps), one for ADSL users and other to Internet 2 users (high video and audio quality).

The table 1 presents the main requirements of the Virtual MAC, in order to support all information types and pages used in the web site of virtual museum.

3.2 Involved Technologies

In order to build such complex Internet system following the proposed requirements, it was built a web site based on dynamic pages, which was developed in Active Server Pages (ASP)[1]. The choice of this development platform was based on the Application Program Interfaces available for database manufacturer. However, the same kind of system could be developed in any other development platform, such Java (using Struts, Java Server Faces or any other technologies). As it was used ASP the application server is the Internet Information Server. It was also used a streaming server in order to provide some videos.

The Virtual Mac database was Caché 5.0 and one of the main reasons to choose this tool was its availability and its development interface and some API for Microsoft's environment.

4 DATABASE ARCHITECTURE

The database used to implement the Virtual MAC was an object-oriented database. There were designed two distinct databases, the first one for the virtual collection and the second one for the dynamic site. In a dynamic site there are no pages written in HTML and their contents are stored in a database. Another characteristic is that there are no predefined pages in a dynamic site. The HTML code for each page is generated when requested by each user, through their access to the site page.

One of the main advantages of this kind of practice is to facilitate the publication of updates,

Table 1: Main requirements of Virtual MAC.

Object type	Information Requirements	Internet Requirements
Work of art	- Name of the picture or sculpture; - Author's name; - Artistic school; - Year of the work of art production; - Short description of the work of art; - Complete description of the work of art; - Images from the work of art (in different resolutions);	- What image of the work of art must be presented into website (related to the user's bandwidth); - Quality and size of the image; - The file names containing some animation or image of the work of art;
Audio	- File size; - Description about audio content.	-The audio quality that would be used in the website in each bandwidth; - Audio quality and format; - Audio location (in the hard disk);
Video	- File size; - Description about video content	-The audio quality that would be used in the website in each bandwidth; -Video quality and format; -Video location (in the hard disk);

[1] ASP – Microsoft Corporation

which may improve the usability of the site, since anyone may publish contents in the website independently of his technical skills in web technologies. In order to support all functionalities of the website, it was employed an Object-Oriented database, which demonstrated to be very suitable, because of the complex nature of the data stored. (Barbosa, 1992). The Figure 1 shows an example of a work of art available at Virtual MAC The site address is http://www.macvirtual.usp.br.

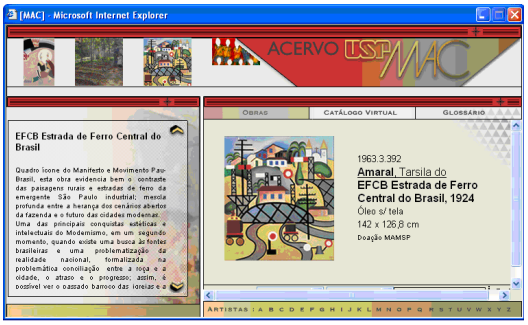

Figure 1: Example of a work of art in the Virtual MAC collection.

4.1 Virtual MAC Database for Work of Art

The main attributes of each work of art stored in the object-oriented database are name, date of creation, catalogue number, dimensions and others, justifying the creation of an object. More than one artist might have done one work and each artist may be the author of one or many works. Each author has particular characteristics, justifying another object. This structure was applied in other components of Virtual MAC, and results in a simplified class diagram shown in figure 2.

The main class, which it is the "core" of the database is called Artwork, and it is responsible by the control of all information related to pictures, sculptures and any other type of work of art. This class also has methods that manipulate its parameters, such as storing information from an object, or modifying some parameter.

The class Artwork has some inherent classes, which works as parameters of the class. One of these classes is called Object_360, and it controls the sculptures animation. It makes possible to the Internet users round the work of art and observe several details. The same happens with Description class when all descriptions have the same characteristics for any class, and the edition controls are the same for any component of the dynamic site.

The class Picture manages all characteristics belonging to all images of the work of art. This class controls the quality of the image, files size and name, and also controls what image can be used in each type of connection (dialup, broadband or Internet 2).

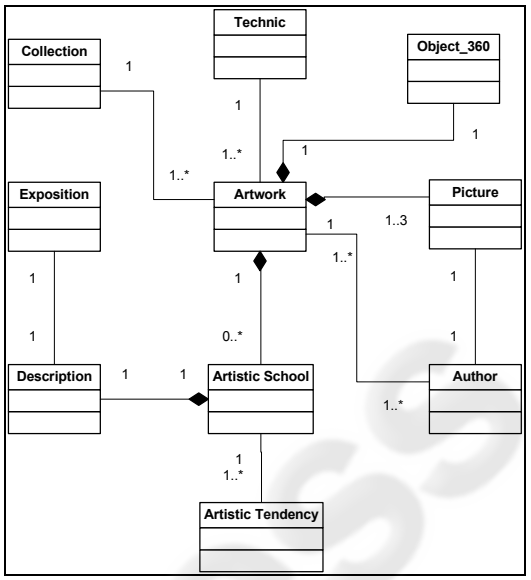

Figure 2: Class Diagram of Object Oriented Database from Virtual MAC.

The database does not copy the entire object inside another one, when an object has other object as its parameter. Instead, the object stores references controlled by the Object-Oriented Database Manager, which build the relationship between objects. A clear advantage of this is that one object can be used by several other objects, as it happens with Author class. This feature of sharing objects increase the importance of the object controls its own parameters, in order to avoid that one object changes some information and damage other one.

4.2 Virtual MAC Database for Dynamic Site

The second database implemented for Virtual MAC supports the publisher system. It maintains all data necessary for dynamic pages generation. The database follows the class diagram shown in figure 3.This database was implemented using the same database management system of the work of art database, and its main function is to store all information from website not related to the work of art, such as information about courses, the museum history and museum partnerships. SiteArea is one of the database classes containing the website areas (expositions, virtual tour, etc.). The control data of each specific item is stored in PageContent.

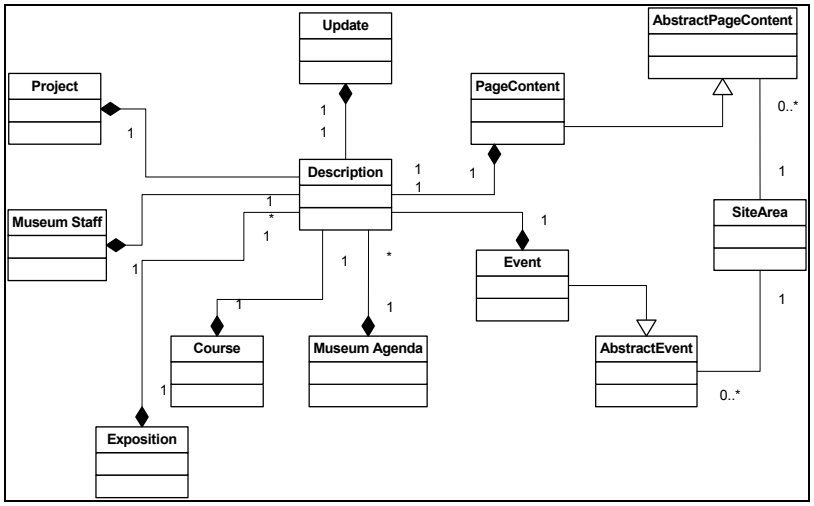

Figure 3: Class Diagram from Dynamic site.

The content is controlled by the object Description, which is common to all objects, making uniform all website contents for maintenance purposes. In the class Event, any MAC event is registered and controlled, and the class Agenda, is used to date activities like expositions, workshops and laboratories, for example. The class AbstractPageContent stores all parameters form class PageContent. This last one has all methods and inherits the properties of AbstractPageContent. The same happens with Event and AbstractEvent class, and all inherits mechanisms are provided by the database manager system. (DEV_APP 2002), (Cache_Ref 2002), (Cache_Tool 2002).

4.3 The Virtual MAC Access

According to statistics collected from the Virtual MAC website, there was a huge increase of access since the proposed system was available. The figure 4 indicates the number of access in 2002 in which Virtual MAC was online from October to December and from 2003 until March 2006. In 2002 MAC had less than 7000 access during these three months, what it is about 2190 access per month. In 2003, the first complete year of Virtual MAC, the number of access was 105.610, an increase of 401,8% (based in access per month). It may be observed that the number of accesses continuously increases during the years. In 2005 the number of access was approximately 29.572 access per month, and in 2006 this number is closer than 83.437 access per month. It reflects the robustness of the system, mainly the database, which support and store all data consulted by visitors, and the performance is quite appropriate, since it has no complain about usage or lack of resources during interaction between users and the application.

Certainly, this success (in terms of increase in accesses) is not the directly result of the technology used in the Virtual Mac development only, but the cause of the success is also the page design and the content of the museum. However, the technology presented in this work is one of the key aspects of the Virtual Mac success, since all information is based on the database and the developed software.

All website tools provide great level of interactivity and works with rich media, which implies in quite new and robust software as well as a system whom permits fast data recover and access. One of the key for Virtual Mac success is the combination of technology and rich and interesting media, which guarantee a new kind of experience for the Internet user.

5 CONCLUDING REMARKS AND FUTURE WORK

The object-oriented database demonstrates to be an interesting and powerful solution to manage multimedia content. This type of database permits to create more complex data structures, which can be used directly in the application code, since it is based on the database API. As this technique simplifies the application code implementation, this process was fast, once all methods that manipulate the objects were inside the database. All pages, independent of its location, have access to the same classes and methods, which facilitates the use of the information in the whole site.

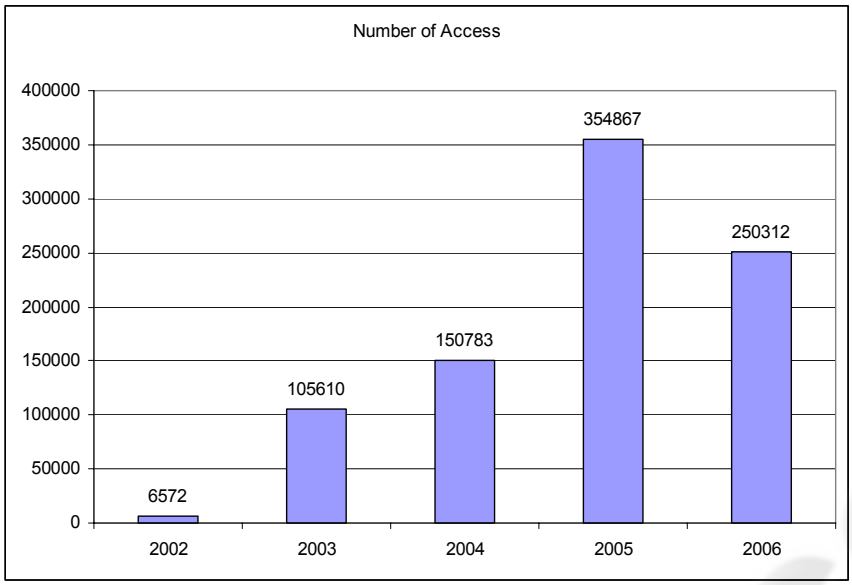

Figure 4: Virtual Mac – Number of accesses.

The actual database architecture is appropriate for the actual requirements. Although the efficiency of this architecture, it is a desire to integrate new tools and games in the Virtual MAC website. One tool is based in VRML (Virtual Reality Modelling Language), which allows that any user from Internet builds its exposition and opens it for other users. There is a prototype of this environment, but it is not integrated with the object-oriented database yet. Other tools such as puzzles can be obtained from work of art pictures and some programming in order to create an algorithm to make the picture in small pieces and to control the interaction with users. This type of tool can also be developed based in the object-oriented databases, since the pictures stored in the system could be used in order to generate the puzzle.

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