Applying the Object Oriented Design in Combination with the Hypertext Mode for Prototyping in Different Topics

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Abstract: In this paper the object oriented design is combined with the hypertext mode to achieve an efficient system's structure which help the learner to navigate freely and stay in a certain context. Within this novel framework, tools and approaches can be shared or used while designing educational systems for different topics or didactic methodologies. Furthermore, the parallel design of educational systems for two different topics, history and physics, using the combined formation is presented. We have investigated the dependencies of objects and the sharing of tools used during the development of the two prototypes. Both systems are engaging, expandable and transferrable.

Introduction

The user interface design and the content's exploration are key issues, especially in educational applications. The interface is required to engage the user and offer aesthetic information presentation. The communication and interaction for the content's exploration should lead to knowledge aquisition. Adaptation to learner's selections and flexibility for different scenarios' execution are highly recommended. The disorientation that is created by the adaptation and the flexibility, should be eliminated (Shneiderman 1992), (Metaxaki et al. 1991a), (Kouroupetroglou et al. 1995).

The design, implementation and content development in multimedia systems are quite expensive. Thus, resuability of the content and/or a sucescfull former design approach is a requirement. In some applications, the re-use of a piece of content in the same or different format realizes educational aspects or didactic procedures (Metaxaki et al. 1991b), (Metaxaki et al. 1994).

In this paper, we present a novel approach to meet the mentioned needs. The structure of the proposed system is a combination of the hypertext mode and the object oriented architecture, implemented by embedded objects or components. There can be a design approach including objects descriptions which can be enriched by operation functions to face various needs. These functions can be interchanged by learner's selection to help him navigate freely without losing the context of the exploration (Rumbaugh et al. 1991), (Fayad and Schmidt 1997), (Aedo et al. 1996), (Wisnudel 1994).

Two applications using the same methodology have been desogned and developed to explore the dependence and the transferability of the object's description and presentation. The sharing of tools was investigated, too.

Aspects of the Combined Methodology

The extensively used hypertext mode has two main problems: the increasing number of connections over a topic and the disorientation these connections can create after some navigation steps. A novel method is required

which could add connections of data and tools to eliminate this disorientation. The object oriented architecture can be used for this purpose.

Our decision was to design, implement and investigate according to the Component Display Theory (CDT) defined by Merill as: "The CDT is comprised of three parts: a two-dimensional performance-content classification system, a taxonomy of presentation forms, and a set of prescriptions relating the classification system to the presentation forms. CDT assumes that all instructional presentations are comprised of a series of discrete displays or presentation forms. Any presentation can be described as a sequence of such presentation forms, together with the interelationships between these forms" (Merill 1984), (Merill 1983).

A main notion of the embedded component (EC) structure is the independence between the objects used for presentation and the ones used for the information presented. This allows the appearance of the same information in multiple locations and in different forms. Moreover, new objects can be created in succession, the previously constructed ones can be re-used and the new ones are easily integrated in the system. An object can be plain or enriched, active (sound, video, motion) or inactive (plain text). Objects can be concrete or embedded on other objects. The objects can be interconnected through links pre-existing or created by user queries. Using the embedded objects we can succeed in the integration of information, the integration of media, the re-use of information and the flexibility of the presentation of information on a display (Spitzer 1997), (Baecker et al. 1995), (De Diana et al. 1994).

The Design Approach

System's Objects and Modules

The Objects

The objects are differentiated as *data objects* (dao) and display objects (dio). The *dao* are enfolding the data, the implementation of the possible links, and the execution of queries. They are of two different types, the *main* and *the instance data objects (mdao, idao)*. The *mdao* include the required information for the definition of an entity. The content of the *dao* can be a maximum or minimum depending on the topic or the didactic procedure i.e. *mdao* for the lesson on physics include the maximum content for a physical phaenomenon or a minimum to be further combined. The ones for the lesson of history are usually of a minimum content and are combined to form a historical event. Each *mdao* is connected with one or more *idao*, containing data and format information.

The *dio* include all parameters needed for the formation of a presentation on the display. Their parameters depend mainly on the type and format of information. They contain, too, the interactivity functions. The execution of *dio* performs the *dao*'s presentation. We emphasize that the *dio* do not define the interconnections of this presentation.

We can say that the system communication is organized in two layers. The presentation layer and the data layer. The user interacts with the presentation layer. At this layer the learner's requests and actions are interpreted and transferred to the data layer. The data layer processes the interpreted requests and a presentation appears on the display.

The Modules

We can assume that the system consists of three types of modules (Fig. 1): the Objects Module (OM), the Navigation Tools Module (NTM) and the Main Pages Module (MPM). The Objects Module contains all the objects of the system we have already described. The NTM supports the selected navigation and contains all the constantly presented elements of the display (chapters, menus etc). The MPM includes the main thematic pages of the system. These pages are the starting point for the user's exploration. They form the base for the orientation and the structuring of user's reactions and the selected objects' presentation. The pages are intercommunicating.

Both the hypertext navigation mode and the embedded object architecture co-exist in the system. The hypertext based interaction is realised in the communication between the MPM and the NTM. The objects-based interaction is realised in: (a) the communication inter-MPM, between the MPM and the OM, (b) the intercommunication of the OM.

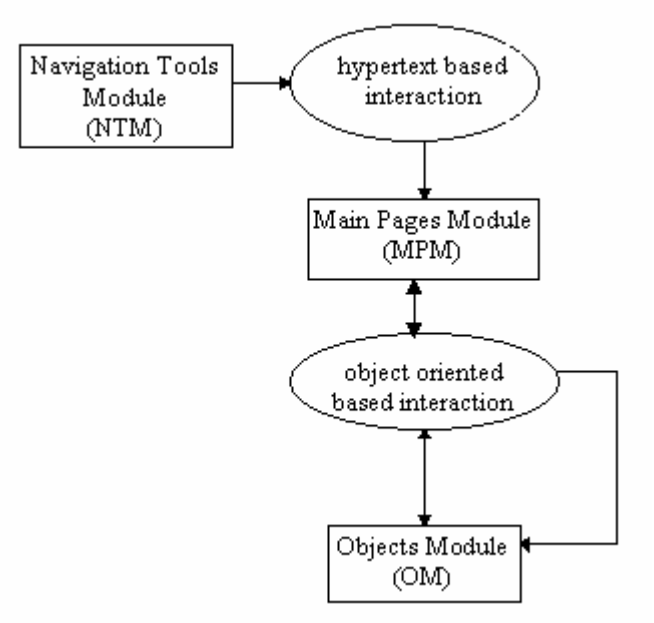

Figure 1: The General Design Approach

The combination of the two modes and the creation of the modules content create a frame in which various didactic procedures can be realized. The system can be adapted to the learner's needs.

Applications and Structure of the System.

In order to design, structure the system and investigate the methodology we have decided to prototype in parallel on two different topics with which we had already a good familiarity (physics, history). The two topics concerning their implementation were differentiated by the type of exploration depth-width and the format of the presented information. The type of the exercises, too, were different. The base of reference was to keep elements of an electronic hypermedia book (Laurel et al. 1990), (Thuering et al. 1995), (Mullin 1990), (Metaxaki et al. 1995).

Both systems include: links (for direct or nonsequential access), embedded objects, navigation bars or menus, wedges (areas offering additional information by direct access), floating windows (wedges enriched by functional characteristics), indexes and recapitulatory nodes.

In Fig.2 we present the structure of the applications. The structure is common although the outlook is different. There exist on the display the constantly shown fields and the changing ones. The constantly shown ones (menu, navigation bar, chapters etc) assist the user's orientation in a context. The user selects (links, buttons) a sub-topic, moves directly to it (main pages) and starts the exploration.

The exploration can be continued in depth or width by queries, indexes etc. The one in depth will occur by selection (links, hotspot areas etc) and the presentation of embedded objects in wedges or floating windows format. The other in width will occur by direct returns to the main pages and/or the extensive formation of interconnecting embedded objects. Windows or wedges can be opened concurrently or in sequence, overlayed or not.

Discussion and Results

The design of the two systems in parallel was proved quite succesful and spared development time. The topic of the nuclear physics needed a large amount of simulated and animated information. The topic of history was about the Emperor Carolus Magnus and needed texts and the reproduction of images. Our great difficulty was the presentation of the objects which was developed in a parametric way so that we could share programming

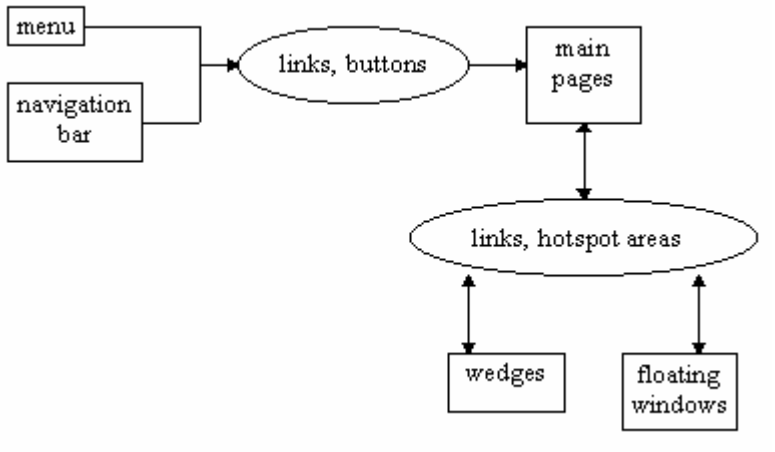

Figure 2: The common structure and communication for both prototypes

tools. The definition of the changing areas and the floating windows outlook as well as the connections of texts and pictures was scheduled in our system for the pictorial communication research (Metaxaki et al. 1996), (Kouroupetroglou et al. 1994). We can conclude that the information content was developed independently but for the presentation development we have used the same parametric tools. The objects definitions were quite short for the history in comparison with the ones for physics but they contained more data. The inteconnections between objects were less extensive for nuclear physics. This means that the objects were more concrete. The in depth exploration of the topic was achievable by the system as well as the in width exploration for history.

We work further using the same methodology and transferring tools and experience to the topic of human sciences.

Conclusions

The use of object oriented design in connection with the hypermedia mode to design educational systems is a quite successful approach. It helps the learner to navigate through the system feeling free but staying in the context. The learner can choose his own way to explore the system. The teacher or tutor can realize different scenarios taken advantage of the system's flexibility. The system can be explored in depth or width or both sequentially depending on the learning process.

The implementation of the approach needs expert programmers but the system is expandable and includes a large amount of transferability. When the system's content is existing in an intra-net server this type of design is much more powerful.

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