A FLEXIBLE INTERNET BASED ARCHITECTURE FOR DEVELOPING INTERACTIVE EDUCATIONAL PACKAGES FOR DISTANCE LEARNING

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Λέξεις Κλειδιά: εξ' αποστάσεως εκπαίδευση, εκπαιδευτικό λογισμικό, τεχνολογίες Internet, δυναμικές εφαρμογές Web, εφαρμογές βάσεων δεδομένων, υπερμέσα, πολυμέσα.
Θέμα: Η Πληροφορική στην ανοιχτή εκπαίδευση και στην εκπαίδευση από απόσταση, Σχεδιασμός και Ανάπτυξη εκπαιδευτικού λογισμικού.
Επίπεδο Εκπαίδευσης: Γυμνάσιο, Λύκειο, Μεταδευτεροβάθμια, Επαγγελματική εκπαίδευση.
Κατηγορία εργασίας: Εμπειρική - Πειραματική.

ΠΕΡΙΛΗΨΗ

Στο παρόν άρθρο παρουσιάζεται μία ευέλικτη αρχιτεκτονική για τη σύνθεση εκπαιδευτικών ενοτήτων και μαθημάτων, για την υλοποίηση διαδικασιών Ανοικτής και Εξ' Αποστάσεως Εκπαίδευσης μέσω του Internet. Η αρχιτεκτονική αυτή βασίζεται στην αποθήκευση του εκπαιδευτικού υλικού σε έναν ή περισσότερους υπολογιστές (servers) με τη μορφή μικρών και αυτόνομων εκπαιδευτικών ενοτήτων. Το σύστημα έχει τη δυνατότητα της δυναμικής σύνθεσης των ενοτήτων αυτών για την παρουσίαση διαφόρων εκπαιδευτικών θεμάτων (μαθημάτων) μέσω του Internet. Οι χρήστες του συστήματος έχουν τη δυνατότητα να επιλέξουν τη θεματολογία και τα ειδικά αντικείμενα των μαθημάτων είτε από ένα menu, είτε μέσω μηχανισμών αναζήτησης με λέξεις-κλειδιά. Το κάθε μάθημα συντίθεται και παρουσιάζεται δυναμικά, σύμφωνα με τις εκάστοτε ανάγκες του χρήστη και μπορεί να συνοδεύεται από ερωτηματολόγια και ασκήσεις για την αυτο-αξιολόγηση του εκπαιδευομένου. Για τη σύνθεση χρησιμοποιείται μία βάση δεδομένων στην οποία αποθηκεύονται τα χαρακτηριστικά των αυτόνομων εκπαιδευτικών ενοτήτων καθώς και οι μεταξύ τους εννοιολογικές σχέσεις. Λόγω της ευελιξίας του συστήματος η ανάπτυξη και συντήρηση του εκπαιδευτικού υλικού είναι ιδιαίτερα εύκολη. Στο άρθρο παρουσιάζεται επίσης και μία ειδική υλοποίηση της προτεινομένης αρχιτεκτονικής βασισμένης στην τεχνολογία ASP (Active Server Pages).

ABSTRACT

In this paper we present a flexible architecture for the composition of educational packages and lessons for Internet based Open and Distance Learning procedures. The proposed architecture is based on small and autonomous educational entities stored in one or more server machines. The system supports the dynamic composition of the educational entities in order to present educational subjects (lessons) via the Internet. The users have the possibility to select the topics and the specific subjects of the lessons either by using menus or using search mechanisms based on key words. Each lesson is dynamically composed and presented according to specific user needs and it may be accompanied by questionnaires and exercises for self-evaluation of the user. The system uses a database which stores the features of the autonomous educational entities as well as their semantics and relations. Due to the flexibility of the system the development and maintenance of the educational material is convenient and easy. In this paper we also present a specific implementation of the proposed architecture based on the ASP (Active Server Pages) technology.

Overview

The convergence of computing and telecommunications technologies has created a range of new possibilities both for the communication of knowledge and for social interaction. The application of these technologies in the context of distance education has been characterized as creating a new era in terms of media and technology use [1]. Recent investigations indicate that using teleconferencing in teaching by distance education gives the students access to a flexible educational medium [2]. Distance learning is a means of providing access to instructional programs for students who are separated by time and physical location from a faculty member. Distance learning is often thought of as prepackaged text, audio, and/or video courses taken by an isolated learner with very limited or no interaction with faculty members or teachers, or other students. Advanced information technologies allow a variety of novel interactive distance learning scenarios, which can, in some cases, surpass the interactivity of a traditional classroom. These scenarios include one or more of the following types of interaction:

a) Interactions between students;

b) Interactions between teachers or faculty members and students;
c) Interactions between students and experts, and;
d) Interactions between students and resources (such as books, journals, multimedia libraries).

Based on advanced technology, these interactions or their combinations may be accomplished at any time or in any place. The use of teleconferencing tools for interactive contact between faculty members and/or experts with the students, is probably the most typical and most anticipated scenario in the domain of distance learning. However, the use of teleconferencing implies that the tutor is available according to a predefined time schedule. It is clear that the possibility of the students for accessing interactive educational resources such as multimedia libraries, is a critical factor for the success of a Distance Learning course. According to findings of a research performed by RAND Corporation on the effectiveness of technology in education, students tend to learn more in classes in which they receive computer-based instruction [3]. The design, development and delivery of such educational resources usually require significant effort to be spent by the teacher or the producer of the electronic educational material. In addition, a teacher should have considerable experience in computers and web authoring in order to produce a multimedia course tailored to the specific needs of a class or the needs of a geographically dispersed group of students. The problem of time consuming development of electronic educational resources may be faced through the use of flexible tools for the composition of electronic educational material. Using these kind of tools a teacher could easily create, enrich and maintain a body of electronic educational resources without the need of extended skills on computers and web authoring. As a result, the usage of such flexible tools may promote the introduction of information technologies in the day-to-day teaching practice.

In this paper we present a flexible architecture capable to support the needs for fast and low cost production and delivery of interactive on line lessons. In addition, the educational resources provided to the students by the proposed system may be considered as a powerful complement of teleconferencing. The key features of the proposed system may be summarized as follows: operation on low cost platforms, flexibility and customization, user friendliness and support of re-usable educational resources. The proposed system may be implemented on low cost hardware, software and communications platforms such as the combination of a PC connected to the Internet and running Microsoft Windows. It is important to emphasize that the proposed system is not a specific implementation of an online course. It should be considered as a generic development platform, which allows the creation of interactive lessons on many different topics from different areas. More precisely, the proposed system allows the educator to create electronic educational libraries of short and autonomous entities, and to compose their contents to complete lessons or courses.

The proposed architecture allows the dynamic composition of online lessons based on the combination of educational units according to varying user needs. The educational units are short composite entities of a variety of types like modules in HTML (HyperText Markup Language), virtual reality representations in VRML (Virtual Reality Markup Language), text, audio and video clips, etc. The dynamic composition of the lessons may be guided either by user defined search criteria or by other types of parameters like the desired level of lesson details, the level of relevance to other topics, etc. The proposed system named DVT (Dynamic Virtual Trainer), allows the distribution of the dynamic educational material through low cost Internet based infrastructures. In addition the system offers the possibility for self-evaluation of user's progress through a set of questionnaires which are highly configurable and flexible. Finally, the proposed architecture is open and allows the integration of supporting applications like real time video or voice conferencing packages. The overall quality of the produced lessons is a function of two factors: a) the multimedia content of each educational unit and b) the structure of the lesson which is reflected in the relations of the educational units. Courses for distance learning usually include a mix or a combination of various media. The key factors in the choice of media are the course objectives, the intended students and their geographical locations. The flexibility of the proposed system is based on the fact that any type of educational media may be incorporated in a course and presented by the system. The supported media include audio, video, text, images, Virtual Reality representations, etc. The increased flexibility of the system allows the designer of a lesson to customize and tailor the lesson according to specific student needs and, through this customization, to increase the educational effect of the lesson. The user-friendly environment for developing new educational courses is based on tools for easy composition of educational units and questionnaires. In addition the proposed system incorporates tools to setup relations and dependencies between the educational units. Finally, the educational material produced in the framework of a lesson is reusable in the sense that a number of autonomous units may be used for other courses. This is accomplished through the definition of a new relation of the educational unit in the framework of a new lesson. Based on this feature, a Virtual Reality representation of an ancient temple may be used in a course on architecture as well as in a course on ancient history, or even in a course on geometry. The proposed architecture supports the dynamic composition of related and mutually depended educational entities. The overall effect of the produced lessons depends on two major factors:

a) The structure and quality of each educational unit, and;
b) The overall course design, which is depicted in the relations between the educational units.

System Architecture

The proposed system is based on one or more servers who store the educational entities. The users are connected to the server through a common Internet browser and they have access to the introductory web pages of the server. The

most important feature of these pages is the possibility for tailoring the lesson to be presented through the selection of the focal points of the discussion, the analytical level of the lesson, the levels of accompanying information, etc. The user may select one or more predefined lessons out of a menu. A much more dynamic possibility is the real time composition of a lesson according to criteria entered by the user. The user may also use a set of questionnaires that accompanying the lesson's elements in order to self evaluate the educational procedure. The questionnaires are highly configurable (simple true-false answers, multiple choices, etc.). In addition a questionnaire may be easily formed to support the user providing tips, summarized information, etc. DVT uses the Internet-Intranet communication technologies for the distribution of the lesson [4]. The entire architecture is supported by a DataBase, which keeps the relations between the elements of the educational material. The educational material stored in the server has the form of simple and short packages of information describing a specific topic, which are called Information blocks (IBs). An IB may include HTML pages, VRML representations, text, audio or video clips or a combination of the above components. Each IB corresponds to a set of parameters called Connectivity Block (CB) which supports the dynamic composition of the lessons. These parameters are used by the DVT Data Base in order to combine each IB with other relevant IBs or in order to combine the IB with a questionnaire. Finally the CBs include a set of key words which are used to select the specific IB each time the user enters one of the specific key words. A group of IBs forms a Chapter. A Chapter is focused on a set of relevant topics. A group of Chapters forms a Book. A Book covers a wider group of topics. The above-described architecture is depicted in Figure 1. The functional model of the proposed system is depicted in Figure 2.

The core of the system is the DVT Data Base, which stores the parameters of the Connectivity Blocks and the related Questionnaires. The Data Base consists of the data and the Data Base Management System (DBMS). The second component of the system is the DVT Search Machine. It receives user defined search criteria and performs search operations on the CB parameters stored in the Data Base. The CB parameters include also references to the educational material stored in the server's File System as autonomous Information Blocks (IBs). The server stores also a set of predefined (static) pages, which support the possibility for the user to access menus or catalogues in order to select a specific Book or a specific Chapter bypassing the Search Machine. The pages are presented to the user through an Internet connection and a browser. The pages are composed dynamically by the Page Composer, a module that combines a number of Information Blocks or Predefined Pages from the server's File System according to the Search criteria entered by the user.

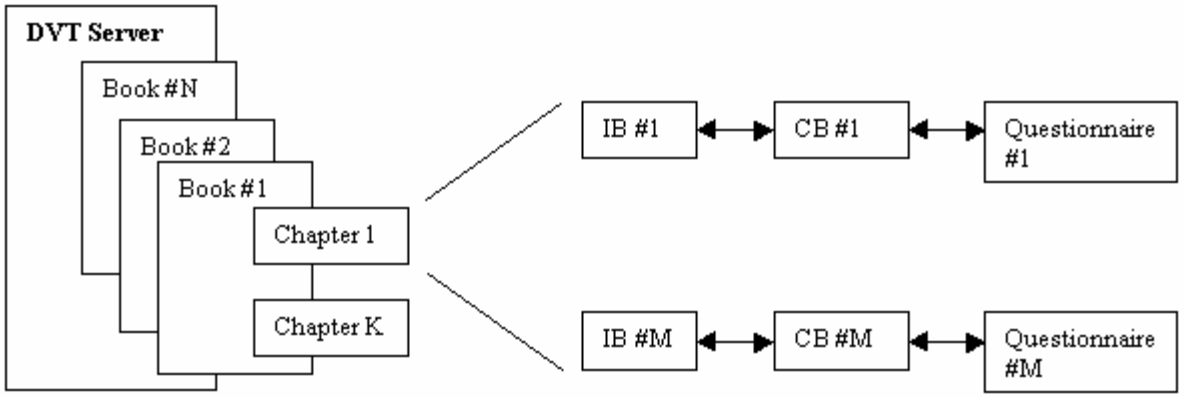

Figure 1 : System Information Architecture

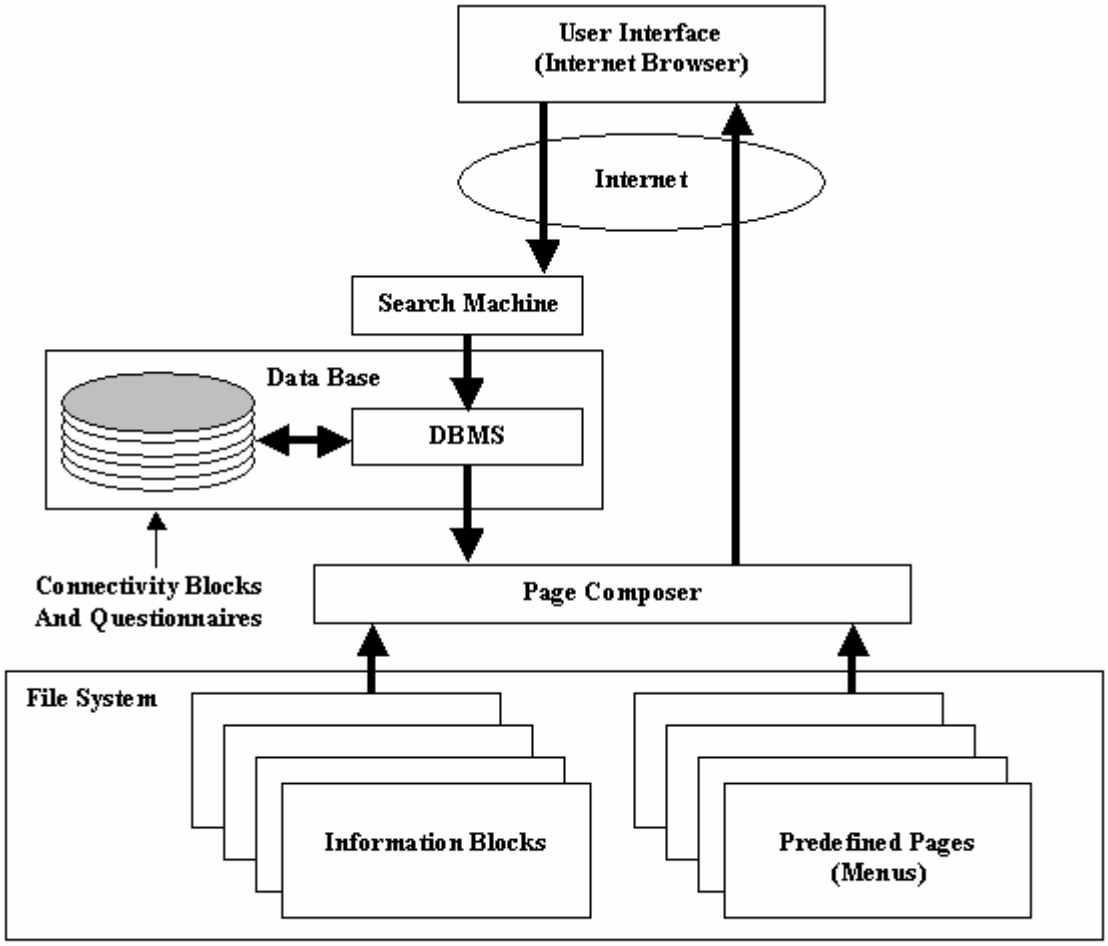

Figure 2: System Functional Model

DVT Implementation

An experimental implementation of DVT was developed under the Windows NT operating system [5]. In this specific implementation we used the Microsoft SQL Server 7.00 as the DBMS module and we developed the Search Machine as a Data Base application called **vrl**. The Page Composer module was implemented by the Internet Information Server using the ASP technology (Active Server Pages) [6]. The Internet Information Server is part of the Windows NT operating system. In order to demonstrate the capabilities of this implementation we developed three interactive lessons on three different topics: a) Telecommunication Technologies and Applications, b) Hygiene and Security in Industrial Environments and c) Maintenance of Industrial Equipment. In the design of these lessons we developed the educational material at three levels of description: definitions only, detailed descriptions plus diagrams and images and presentations of showcases. The three lessons are accompanied by questionnaires on each of the presented chapters. The questionnaires include a mix of true-false and multiple choice questions.

Figure 3 depicts a typical snapshot of the user interface used to present the above three lessons. The left frame of the window depicted in Figure 3 (the dark one) presents a menu of the available lessons. The right frame presents the search criteria entry tool. After the entry of search criteria the right frame presents the dynamically composed educational pages. As for every Data Base application, the existence of efficient support and database management tools is essential.

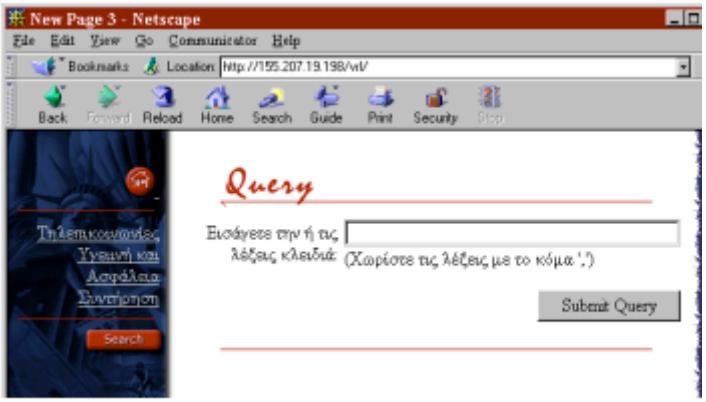

Figure 3. Vrl user interface (snapshot of the Search data entry tool

The vrl application is equipped with supporting tools for easy creation of new lessons and easy composition of questionnaires. Figure 4 depicts a snapshot of a supporting tool used for easy setup of questionnaires.

The typical procedure for the development and delivery of an interactive lesson under the proposed architecture includes the following steps:

a) Design of the lesson in terms of the required modules (Information Blocks and questionnaires) and their dependencies. Probably the design of the dependencies between the modules is the most critical step, since it allows the teacher to introduce in the lesson his/hers educational experience.

b) Creation of the autonomous educational units (Information Blocks) using third-party software such as freeware for web authoring, word processors, image processing tools, etc.

c) Creation of the questionnaires using the built-in tools.

d) Establishment of the relations between the modules in the database. This may also include the definition of several variations of the presentation of the lesson, according to different levels of analysis, or variations regarding the information volume of the final lesson. For example, the use of text plus images versus the use of a video clip, may be a critical decision if the delivery medium is a low cost Internet connection.

Steps (a) and (b) affect the quality of the multimedia educational modules to be presented in the lesson. Steps (c) and (d) reflect the structure of the lesson and the educational quality of the entire lesson.

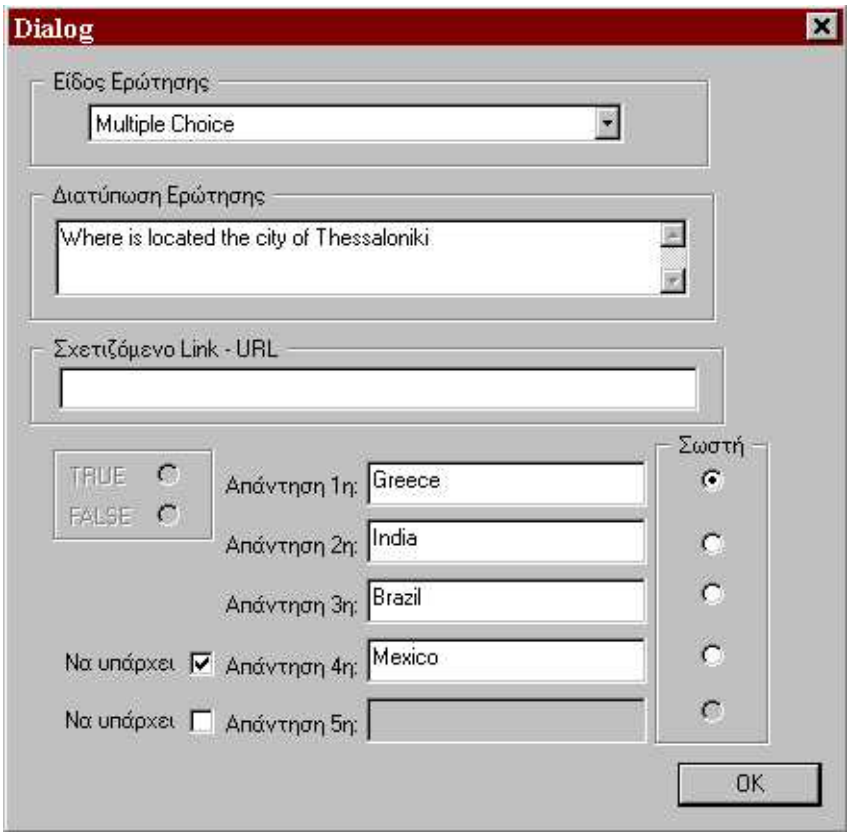

Figure 4: Snapshot of a vrl supporting tool (Questionnaire Setup)

Discussion

In this paper we present a flexible architecture based on Internet-Intranet technologies which may support a variety of Distance Learning procedures. The proposed system is a generic development platform, which allows the creation of interactive lessons on many different areas. It is proposed as a flexible tool for the development of web based lessons, which allows the teacher to easily create, enrich and maintain a body of electronic educational resources without the need of extended skills on computers and on web authoring. The key features of the proposed system are summarized as follows: operation on low cost platforms, increased flexibility and easy customizable, user-friendly interface and support of re-usable educational resources. The educational material is formed as a set of short and autonomous information blocks. The core of the system is a database, which stores and handles the relations of the information blocks. A separate module the Page Composer composes the educational pages dynamically. The composition of the dynamic pages may be guided either by user defined search criteria or by other types of parameters like the desired level of lesson details, the level of relevance to other topics, etc. The proposed architecture allows a wide variety of

different educational modules to be combined in order to setup on line lessons. The dynamically composed pages may include different types of components or media like HTML modules, VRML representations, plain text, audio and video clips, etc. The entire look and feel of the on-line lessons produced by the system depends both on the relations between the Information Blocks stored on the Data Base, as well as on the content and appearance of each Information Block. The proposed architecture allows the designer of a course to select any component of any type. It also allows the designer to establish any relation between the components and finally to create a corpus of educational material, which may fulfill the pedagogical guides relevant to the subject to be presented. From this point of view the proposed architecture is a powerful and flexible tool for on line course development and distribution over Internet or Intranet environments.

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