Web Enabled Teaching Aid for Non-orthographic Languages

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Abstract: In conjunction with the technological advancements of Telecommunications and Information Technology and the outbreak of the World Wide Web (WWW), the production of educational software is undergoing a shift towards the shared resource paradigm. Recognizing the need expressed by people with special needs and special education teachers in enabling students to access such resources, this paper describes the design and the implementation of a Web-based, open system for the effective support of the teaching process of non-orthographic languages for people with special needs. There will be a discussion on user requirements, system specifications and characteristics as well as the system's architecture. Features that enable learner centered education and fulfill teachers' needs to prepare, organize and update the training material in a cost-effective manner and focus on content specification and other high level tasks, while developing courses, will also be mentioned, followed by reached conclusions and plans for future work.

Introduction

Information and Communication Technologies have undergone a rapid development over the last few years, with the Internet and multimedia technologies experiencing the biggest growth. In this respect, new prospects and mechanisms were introduced to the educational community (Ewing et al, 1999), greatly affecting teachers and learners alike (Gilliver et al, 1998). Both teachers and learners seek out new forms, sources and methods for acquiring and transferring knowledge, elevating their needs and demands, while courseware shifts from the traditional monolithic model to the collaborative co-development of shared and accessible material.

While the educational community opts for open, accessible and shared courseware, there is a number of students with special needs who want to harness what education has to offer them, but because of their disabilities seem to have less chance. Especially in cases of mild-to-severe mental disability, they can't use a natural language nor communicate with speech, thus they need to use an *Alternative or Augmentative Communication (AAC)* system usually taking the form of a non-orthographic language (in contrast with a natural-orthographic one), sometimes in conjunction with written text. Non-orthographic languages in general, belong to *Graphic Representation Systems (GRS)* since they use standardized graphic symbols (ranging from photographs resembling the depicted object, to abstract linear drawings with no apparent relation to the referred object) as their building elements and to convey communication content. Apart from their specific sets of symbols, icons and associated meanings (see Fig. 1), non-orthographic languages may incorporate syntax and grammar (like Blissymbolics, see Bliss, 1965) thus requiring substantial effort and time from both sides (teachers and learners) in order to be taught efficiently. For a more detailed and comprehensive description of the various types and characteristics of GRSs one can consult (Fuller et al, 1992).

To become a literate reader though is by no means an easy task (Ehri, 1993). To teach an individual to communicate via a non-orthographic language is much more complicated, especially during the early stages of learning (von Tetzchner and Martinsen, 1992) since graphic symbols are not as easily or naturally passed on from parents to children as the words of a natural language are. For that purpose there have already been

development efforts (see Kouroupetroglou et al, 1990), while research discusses the potential results of using graphic symbol systems in the process of acquiring or developing natural language skills (Gerber & Kraat 1992).

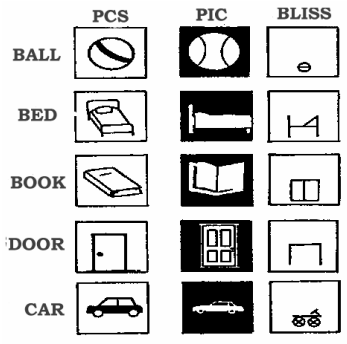

Figure 1: Representation of various concepts in different non-orthographic languages

Students with special needs have a right to equal opportunities in education, but they are more difficult to train since they require more specific and sometimes individualized training. Moreover, to use a non-orthographic language not only does the student need to be properly trained but also the teacher requires to be properly aided. However, the special education teacher is usually left alone in his/her effort though, without much technological assistance. A teaching aid in the form of a piece of software would be a major asset, and yet such software hardly exists due to its diverse nature. Let us not forget in the meantime, that teachers constitute the most important factors for the direct and successful implementation of new technological advancements especially in the field of teaching non-orthographic languages. Therefore the need to provide the teacher with easily accessible and effective support becomes obvious. Nowadays, the most promising medium to support the teacher is with no doubt the World Wide Web (Astreitner et al, 1998). The Web's potential lies in its flexibility and ease to provide properly devised educational support systems which enable access to various information resources, such as Data Bases, Electronic Dictionaries, and on-line context-sensitive learning aids (Metaxaki et al, 1988).

In the light of the above, the design and implementation of a WWW based, open and flexible system that can handle multiple natural and non-orthographic languages and their elements in a variety of formats and representations will be presented. Because of its open and flexible presentation nature in can act as an aid to the special education teacher in the course of teaching non-orthographic languages to students with special needs.

System Design

Our design was based on a vast number of technical specifications derived from a user requirements study and will be presented henceforth in brief. The main design goals though, called for multilinguality, reusability, flexibility, openness, efficient development and access to shared educational material, and most importantly the ability to offer a learner-centered education.

User Requirements and Specifications

For the last two decades, application of non-orthographic languages and graphic symbols, has become widely accepted in a vast number of cases of children who can't speak or suffer from some language disorder, and who are in need of learning a language (McNaughton & Lindsay, 1995), (Stephenson and Linfoot, 1996). Users of a standardized non-orthographic language, combine a number of graphic symbols in order to put together a sentence (von Tetzchner & Martinsen, 1992), but in order to convey communication information to a natural language speaker a link or association to a natural language needs to be present. Such a link, in written and spoken forms, becomes necessary to any kind of application used to facilitate teaching or use of a non-orthographic language for the prospect of a future transition to the natural language as well. The importance of verbal language information in the framework of multi-language AAC systems has already been recognized and described in the field (Antona et al, 1999).

The need of in-time preparation, structuring and update of the educational material in a cost effective and viable manner is also imperative for the teacher of non-orthographic languages (Norman and Spohrer, 1996). Additionally, since learner centered education is considered more appropriate for non-orthographic language students, the courseware needs to have some degree of personalization. However, the various characteristics (abilities, skills, requirements and preferences) may vary significantly for each non-orthographic language learner. One of the most important requirements though, regardless of learner characteristics has to do with the effective access and manipulation of the learner's vocabulary. The teacher would need to select, organize in sections, modify, update and expand vocabularies according to the learner's communication and language capabilities and preferences. Different educational resources should be able to be successfully unified or combined in a single educational package, and should also be generic enough so that people outside their development team would express interest in them. What's more, adaptation, modifications and update costs, language barriers and constraints, as well as cultural differences of the educational material are also important elements of the educational software distribution and must be considered accordingly. Moreover, it is well understood that certain symbols in a GRS may convey different meaning according to cultural and national context. The system's design should ensure that on the one hand such differences are compensated through the provision of alternative symbol sets and different languages and proper associations, and on the other that no restrictions whatsoever are going to be present in terms of locality, culture, language or accessibility.

Moving towards a global learning scenario, necessitates making the learning resources more accessible (Collins et al, 1996), while requirements for more effective learning call for the educational content and information to be readily accessible by the teacher. The main factors in this process are the production cost of educational material, the delivery cost, availability and delivery both in time and on demand, availability of educational material as independent as possible from specific location or time barriers. Therefore true internationalization, global access around the clock, and multilingual support should be considered. Additionally, computer-based systems designed to support such a teaching process should be open, catering for reusability, and able to offer a large number of either non-orthographic or natural languages (Kouroupetroglou et al, 1993, 1994). Moreover, such a system should allow the teacher or a team of teachers to focus on the definition and structure of the educational content and other high level activities while developing courseware.

Implementation

The developed system at large, constitutes a multilingual environment for both natural/orthographic and non-orthographic languages. It can be viewed as an on-line multilingual lexicon, able to manage, store, retrieve and depict the various language elements in a multitude of forms and multimedia representations including text, phonemic, pre-recorded speech, pictures, and video / animation. It can also hold user specific information concerning vocabularies, plus multiple modifiable dictionaries per learner. The system also provides omnidirectional "word-by-word" translation between the elements of the various defined languages, after specifying the source and target languages and desired concept for translation. The system is open and expandable by means of user profiles, languages, and language elements and representations. Since the system uses multimedia elements (as one can realize considering the variety of representational media) can fall into the multimedia application category. Interactive multimedia have earned a prominent status among software developers due to their variety and flexibility and the ease of incorporating different learning modes. However since there's no guaranteed way of applying such a technology effectively, constant evaluation is imperative. In this respect, and in order to develop the software described herein, there was an extensive use of the generic methodology and instrument for the multimodal evaluation of interactive multimedia (Kouroupetroglou, 1995).

Technology

The software has been developed as a 32-bit application to run under MS-Windows (95/98/NT). The architecture that was chosen for the web part of the application was the Server Side technology. The reasoning behind this choice is twofold, since according to that, all the time and resource consuming functionality are handled by the Web Server, while the Client receives information in simple HTML format, thus rendering our application independent form the Client software. Such architecture calls for compatibility between the various development

tools and the database and the web server. In this sense, we incorporated Active Server Pages (ASP) technology, essentially a mixture of VBScript code and HTML (ASP, 1998), which works on a Microsoft Internet Information Server (IIS) acting as the Web server software (see Fig. 2). The aforementioned combination of technologies allows for a Web Interface that caters for the dynamic construction of queries to the Data Base. The web user enters the parameters (s)he wants and the query is put together by the Active Pages engine and passed on to the CDB. Another important aspect and functionality of the web interface is the dynamic production web pages bearing the result set coming from the CDB. The Web pages used in our application were designed and developed using Home Site 4.0 and MS Front Page 98 along with MS Visual InteDev 6.0. The CDB was designed using ErWin Version 2.6 and implemented in MS-Access 97.

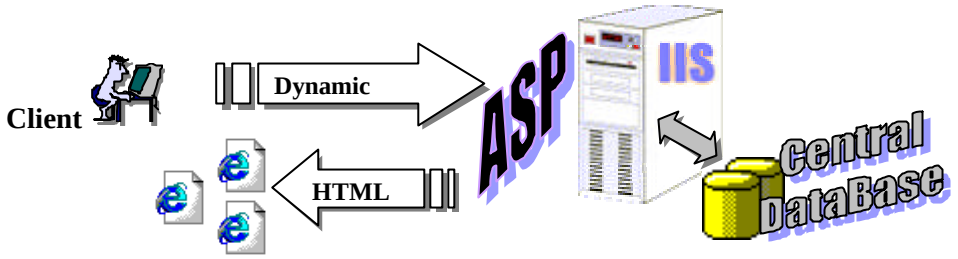

Figure 2: The general concept of Active Server Pages

Structure

The essential structure and architecture of the system (depicted graphically in Fig. 3) follows the design specifications set, and consists of the following functional components: a) a Central DataBase (CDB), where all information on users, languages, concept elements and representations is stored, b) a multi user software application to manage the CDB, c) a compact, mobile User-specific DataBase (UDB), d) a software application to access and manage the UDB, and e) Active Server Pages to access the CDB via the WWW (see Fig. 4).

The Central DataBase handles a variety of different information concerning users, languages, language elements and representations. More specifically, the CDB manages: a) a set of concepts which have a meaning independent of language (we use the notion of the interlingua for this set, see also Dorr 1993) , b) a set of orthographic and non-orthographic languages, c) sets of written (in text) representations of the various concepts in every orthographic language defined, d) a description for each concept and for every orthographic language defined, e) sets of graphic representations for each concept and for every non-orthographic language defined, f) one or more pictures, videos and/or animation for each concept (if necessary), g) three sets of spoken representations of each concept in every orthographic language defined (in prerecorded male, female, and child voice), h) onomatopoetic representation for each concept, and i) user specific information, in order to be able to map users with sets of languages and concepts.

The User DataBase, is in essence a subset of the CDB, and is produced by the teacher's actions according to the specific requirements for each individual learner. The UDB consists of one and only pair of orthographic and non-orthographic language (the learner's native natural language and alternative communication system respectively), and a subset of concepts relevant to the learner's vocabulary, along with all the associated concept representations. Extra care has been taken towards providing student vocabulary manipulation facilities, as well as offering the ability to adapt the system to the specific needs of each individual learner. In this respect, a specially designed software application allows the teacher to modify at will the UDB to better match the student's learning curve. In this respect, the teacher can make modifications to the vocabulary size (by means of defining the part of UDB "visible" to the learner), and structure (by organizing the individual language elements into subject categories according to whatever subject matter is felt more appropriate for each individual learner).

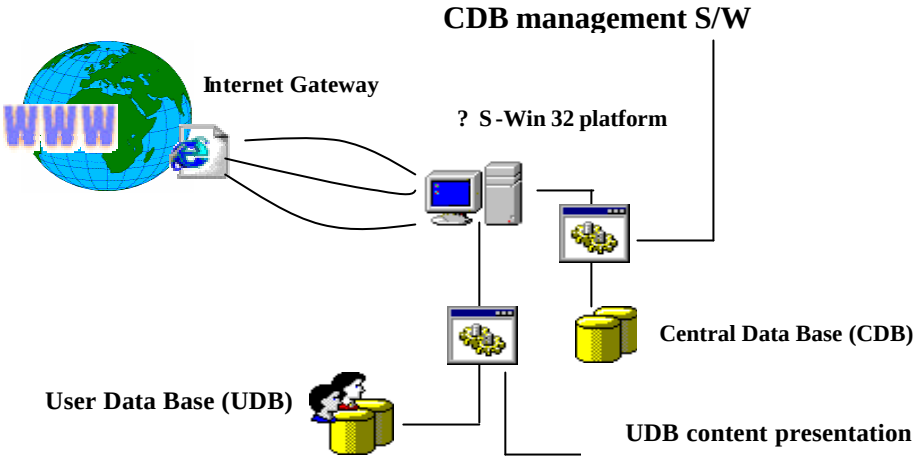

Figure 3: The system's structure

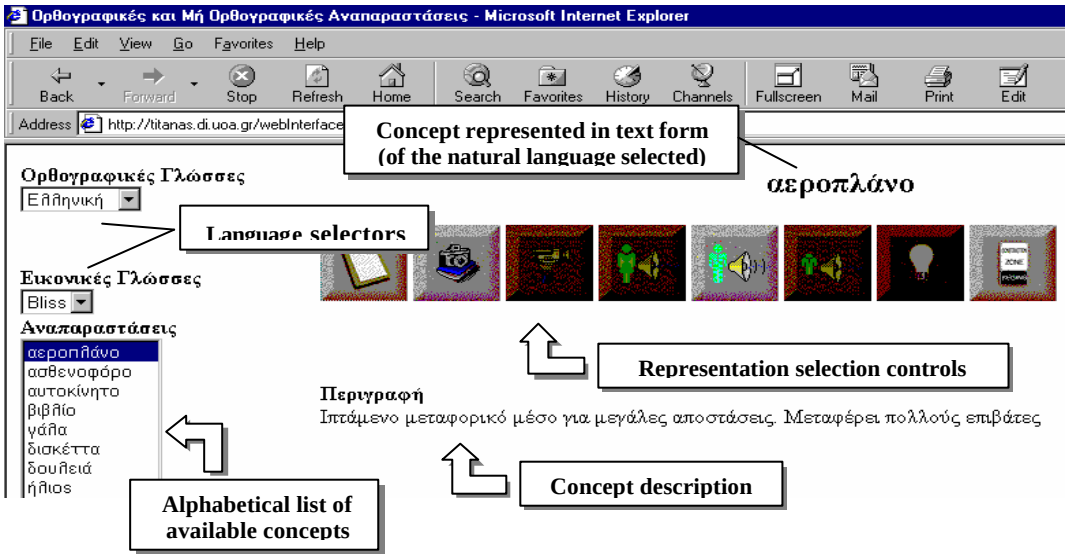

Figure 4: The Web Interface (presented in Greek)

Conclusions

The developed system fulfills the crucial need to prepare, organize and update the training material on time even online, free of any constrains brought forward by the environment or location, or even the operational platform (it is managed over the WWW). Teaching non-orthographic languages can change radically in the not so distant future by using what technology advancements have to offer. The system we have developed constitutes an integrated web-based environment that can cover the basic requirements of special education teachers to provide learner-specific educational content towards learning non-orthographic languages. The system is currently undergoing user trials in real life situations in the process of refinement and adaptation with the evolving technology and user needs. Our plans for future enhancements include, full support in all supported media representations of the BLISS language in Greek and English transcript, modification of the user interface incorporating special accessibility options for people with special needs in order to provide universal access to the system, extended user profile mechanisms holding user characteristics, skills, abilities and communication requirements, and the provision of both web-based and stand alone local versions of the lexicon, using ActiveX, JAVA and XML and ADO technologies. Another promising enhancement would be the inclusion of language specific grammar and syntax information that would allow for better and more correct whole phrase translation. The teaching process would also benefit even more should our system cooperate with other computer aided teaching applications specifically in the non-orthographic language domain.

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