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An Environment for Deaf Accessibility to Educational Content

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Abstract

Here it is attempted to present a platform environment that allows development of various educational applications fully accessible by deaf users. Subject to Design for All primes, the environment is built on methodological principles which adopt sign language as the basic means for communication of linguistically uttered educational content. It also makes extensive use of visual objects to support comprehension and navigation at all levels of human-computer interaction. Currently available instantiations of the environment have incorporated both video for content presentation and an avatar based dynamic sign synthesis mechanism. The educational applications to be referred to when discussing the design principles and user requirements taken into account, include one web-based and one off-line GSL teaching tool for the same school level (early primary school) as well as a vocational training tool for adult users.

1. GSL: an official minority language

Sign languages (SLs) are natural languages articulated in the 3D space, where the linguistic massage is organized according to geometrical parameters for the expression of semantic-syntactic relations, visually represented on and with the signer's body or in the space in front of him/her [21], [22], [18].

The Greek Sign Language (GSL) has been developed as a minority non-written language system, in a socio-linguistic environment similar to those holding for most other known sign languages. It is a natural language system used as the mother language of the Greek deaf community, where estimations raise GSL natural signers to about 40,600 (1986 survey of Gallaudet Univ.). In addition to the above, there is also a large number of hearing non-native signers of GSL, mainly students of GSL and families of deaf people. Records of the Hellenic Federation of the Deaf (HFD) show that in the last five years the demand for classes of GSL as a second language has radically increased [12]. This fact finds an explanation in the recently increased demand for GSL knowledge in the local language market, given that in the year 2000, GSL was recognized as an official language of the Hellenic State (Law 2817/2000), with a direct consequence for the use of the language in education and official communication services.

Following the national policy for integration of people with disabilities in the society, a recent increase of deaf students in mainstreamed education is to be noticed. Nonetheless, a considerable proportion of the deaf student population still remains scattered in other institutions, minor town units for the deaf and private tuition. Beyond legislative requirements though, integration of the Deaf in the society is heavily based upon the quality of education they receive, and although GSL is the official language for education of the Deaf population in Greece, educational material and tools still remain very poor. This is partly due to the widely holding misconception that since deaf people may see, they can access written material. However, born deaf individuals find it extremely difficult to make associations between concepts and written forms. This happens because the written form of an utterance is a convention for the representation of sounds, which is incomprehensible in the case where no perception of sound is possible. According to statistics of the Hellenic Pedagogical Institute [14], the average reading capability of deaf adults corresponds to mid primary school level. This fact seems to be verified by measurements and estimations from other sign languages as well [7]. On the other hand, the nature of the language per se acts as an obstacle

against systematic production of representations of its linguistic content in huge quantities, if the requirement is to preserve quality of the delivered message to native utterance level. This happens because video – though a rather static, not easily reusable source of linguistic content– is currently the only representation means that fully preserves naturalness of the signing utterance. In the seek of a solution to the limitations put by the use of video and towards satisfaction of the requirement for Universal Access [19], continuously growing in the framework of the Information Society, the demand for efficient solutions to the problems of deaf human – computer interaction, also entailing accessibility to e-content by the deaf, has led to research for the development of dynamic systems for the representation of sign language utterances by means of avatar technologies [5], [6], [13], [15].

This paper focuses on architecture design and implementation of an educational environment, fully accessible by deaf users, that allows development of various educational tools both Internet based and off-line.

2. The language barrier in education of the Deaf

Unrestricted integration to an open society is heavily based upon quality of education received by the different groups of population. In other words, one initial barrier is related to discriminations with respect to one's level of literacy.

Most native speakers of minority languages experience the need to attend school in a linguistic code other than their mother language. The case of deaf populations is even more complicate, since born deaf individuals develop a specific type of bilingualism [11], [16] deriving from the demand to raise in a language environment that uses not only incomprehensible articulation means, but also it structures concepts and relations of the linguistic message on completely different grounds than sign languages do.

From the legislative point of view, inclusion is supported by incorporation of deaf students either directly to mainstream education or to special education units inside mainstream schools or even by modernizing special schools for the Deaf. In all cases, offered educational content should be delivered in sign language. Nowadays, sign language use in classroom is supported by mature multimedia and digital image technologies, parallel to the development of especially user friendly interfaces for end-users who may not be previously familiar with computer use [1]. Moreover, appropriate methodologies for content presentation allow systematic development of tools for the deaf, on the basis of Design for All principles, where the key characteristic of such systems is the use of sign language in order to convey meaning of linguistic content at any level of interaction with the user.

In this context, teaching of a sign language (GSL in our case) up to complete mastery becomes crucial, as it provides the necessary linguistic background for full academic development of deaf individuals.

In line with the above, we discuss next the main characteristics of an environment, which supports sign language teaching as well as teaching in GSL, incorporating educational material presentation and testing mechanisms, that make it fully accessible by deaf end users, pupils as well as tutors.

The environment instantiations used to exhibit multipurpose implementation of the same basic architecture, involve a range of educational software products addressing needs from language teaching in primary school up to vocational training objects. For the purposes of discussing architecture principles, environment ergonomics and content creation methodology, we make extensive reference to "MTN 1" (from the initials of the full title "I learn the signs" in Greek) (Figures: 1, 2, 3, 4, 5), the first of a series of educational software products intended to teach GSL. The educational goal of this specific show case is to introduce vocabulary primes at early primary school level. The same educational goal is served by a web based prototype system that allows structuring and presentation of GSL educational material and linguistic resources, addressing the needs of GSL grammar teaching to early primary school pupils. In this case, dynamic sign synthesis through the use of avatar technologies for 3D sign representation of linguistic content, is tested as an alternative to the use of video (Figures: 6, 7, 8) [12], [4], [19].

Figure 1. MTN1 main menu screen.

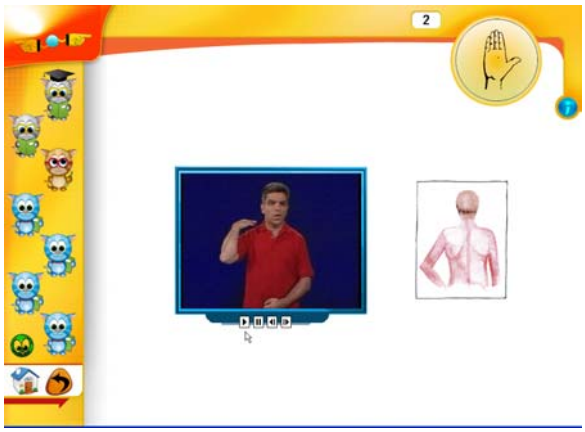

Figure 2. Handshape teaching.

Figure 4. Handshape checking exercise.

Figure 3. Handshape based interactive vocabulary presentation.

Figure 5. Commentary on exercise execution.

3. Environment design principles and implementation instantiations

Basic environment architecture is built on general principles applied to design of educational software along with the presupposition that linguistic content has to be represented 3-dimentionally. Image or video (capture) are the only means for concept clarification, where decisions on of graphics style and use of cartoons or photographs depends on age group of users and educational object. Design modifications, for example, required for the development of MTN 1, were organized on the basis of the main educational goal and user group needs of very young pupils and their tutors; known through extensive evaluation procedures of various prototype versions of the environment.

The use of graphics, bold colours and game-like screen layouts, as well as incorporation of student awards for correct responses to lesson exercises and unit tests derived from design principles applying to small children. Similarly, user need studies defined that video ought to be the means of representation for GSL in the specific case, whereas other basic functionalities should be adopted, as the need for user-driven repetition of the educationall linguistic message, as well as the need for navigation details and button functionalities, presented in GSL and combined with graphics. The use of graphics in this case follows an organization with clear semantic structure.

Standard educational means incorporated in this software for the teaching of vocabulary of GSL are drawings for visual representation of concepts and video for the accurate 3D representation of sign articulation. Video also provides clarifications and instructions as regards educational goal, execution of

exercises and help at all levels of the software. Educational content is strictly presented by a native signer tutor. Presentation of all other linguistic information is provided by the tutor's assistant, in GSL also.

The use of drawings for concept representation as well as the graphical navigation are product specific design characteristics. The use of drawings and the respective complete absence of photographs, in this case, intend in relating a concept with the wider possible range of objects this may find in real world. The rational that led to presentation of all navigation functions with graphics is that graphical navigation has proven worldwide to be a popular way for children interaction with computer environments. A general design characteristic is the strict absence of written language for presentation of educational content (except for cases of multilingual terminology as in Figure 9). Written language may appear only after selection of the relevant functionality, for use by hearing tutors, when viewing lists such as tables of contents.

The educational software MTN 1 reflects the structure of GSL with respect to principles, features and rules applying to the vocabulary of the language [2] while at the same time complies with methodological principles, thematical structure and educational activities proposed in the Analytical Curriculum for the teaching of GSL, set by the Hellenic Pedagogical Institute.

The MTN platform utilizes GSL as the sole means of communication, excluding the use of written Greek in all levels of communication with the students. MTN supports personalized teaching of the language, adoptable to individual learner needs, to guarantee efficient comprehension of the teaching subject by the student, especially in classes where students present different levels of command of the language.

Implementation of the MTN educational platform was based on the available architecture [1], [19] and on selection of appropriate educational content with respect to the age of the students; user needs as reflected in the Hellenic Pedagogical Institute's Analytical Curriculum for GSL (http://www.pi-schools.gr/special_education/kofosi-a/), as well as the needs/requirements set by user needs studies of the specific target group (deaf students / GSL teachers) as recorded via informal evaluation procedures undertaken to educational prototypes [4]. In addition, for the development of the MTN platform, studies regarding teaching conditions of a sign language and world-wide creation of educational curricula have also been taken into account [17]. The Internet-based prototype that exploits avatar potentials for sign representation adopts the same architecture with the goal to supprt distant learning.

Figure 6. Full graphics based navigation with avatar performed vocabulary presentation.

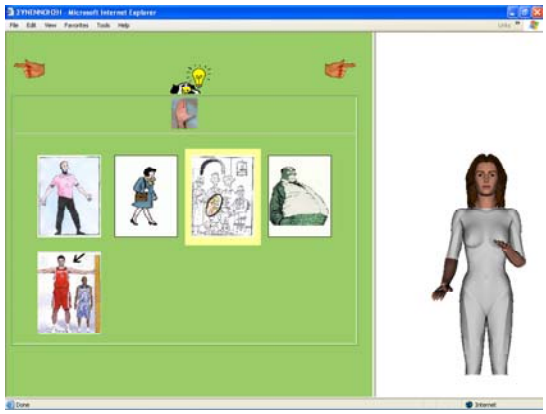

Figure 7. Handshape based vocabulary presentation with avatar in frontal view.

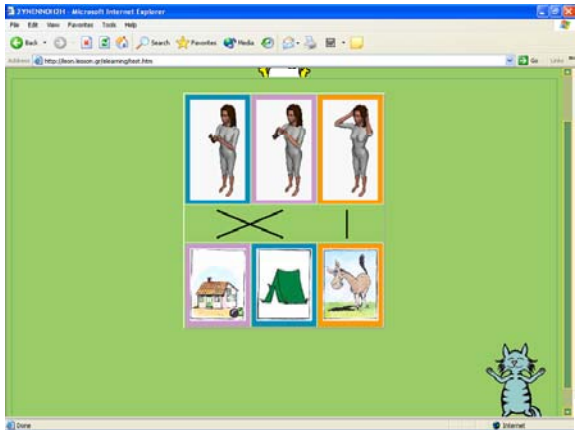

Figure 8. Color code matching exercise.

4. GSL educational content

Educational software instantiations which are developed making use of the basic environment design, derive linguistic content from an open pool of reusable resources as regards both vocabulary items and grammar rules of GSL.

Vocabulary resources are organized in a lexical database for signs (the lexical units of sign languages), where lexical entries are marked for phonological composition, grammar behavior and semantic characteristics [2].

Grammar rules of GSL are coded in the form of a computational grammar, based on results of basic research on a representative sign language corpus [3].

In the case of development of vocational training software, a further parameter of content creation is the demand for introduction to GSL of the domain terminology. Creation of new terms in any natural language follows standard procedures [8], [9], [10]. Moreover, since terminology is usually introduced to receiver languages from the language in which it was originally created, terminological lists are multilingual in the default case. To fulfill this task, the environment is supported by a methodology for term creation in GSL [2], which allows trilingual (GSL-Greek-English) representation of terminology items in terminology intensive educational applications. In this case, definitions of terminology concepts are visually available (window at down right side of the screen Figures: 9, 10, 11).

The currently available GSL resources have fed a number of applications, which include, except for the applications discussed in this paper, a bilingual dictionary of basic GSL vocabulary, with 3.000 entries, a children dictionary of 500 entries and an NLP based conversion tool from written Greek to GSL.

As regards MTN 1, educational content is organized in 5 chapters with 70 lessons and 600 lemmata, which teach methodology of sign formation in basic signs, complex signs, synonyms-antonyms and word families.

The here presented vocational training software provides educational content for basic computer skills (7 ECDL topics) with 350 trilingual terminology items and 650 demonstrators of term usage, covering all possible appearances of a term in the related thematic units.

The here presented environment is subject to continuous evaluation cycles and optimization, while the linguistic resources databases for GSL content are constantly updated.

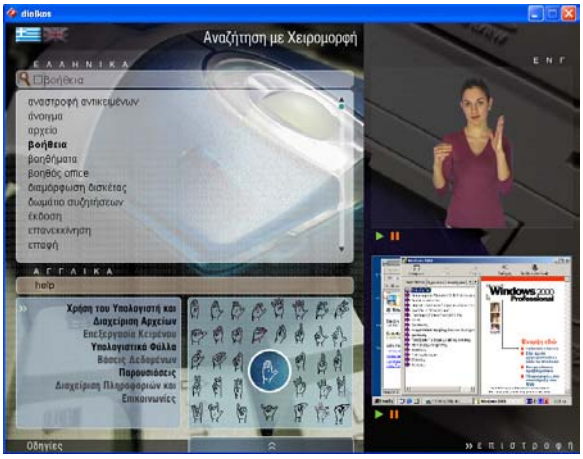

Figure 9. Trilingual terminology presentation for computer skills with term search by handshape and video capture example of term use.

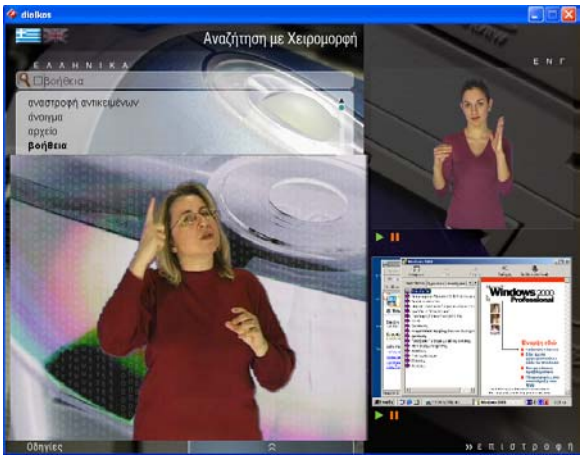

Figure 10. Instructions in GSL, supported by term presentation and example of use.

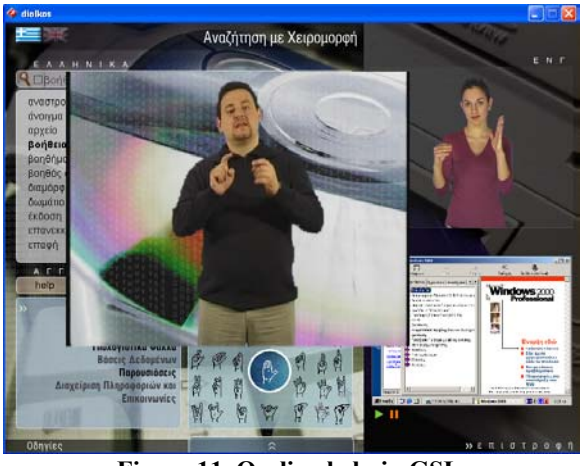

Figure 11. On-line help in GSL.

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