Developing an e-Learning Platform for the Greek Sign Language

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Abstract. In this paper we introduce the characteristics of the educational platform that is being developed within the SYNENNOESE project. The platform integrates avatar and animation technologies, exploiting electronic linguistic resources of the Greek Sign Language (GSL), in order to provide a Greek-to-GSL conversion tool that allows to construct, store and maintain educational material in GSL. Besides reference to tool development in the context of a specific application, emphasis is placed on the adaptability of the Greek-to-GSL converter as a tool in line with the requirement for Universal Access and the Design for All principles in the context of Information Society.

1 Introduction

The work to be presented here is being developed in the framework of the national project SYNENNOESE, which in Greek means 'mutual understanding' and is addressed to the population of deaf Greek pupils of primary schools. The aim is to set up an educational platform with animated signing in Greek Sign Language by a virtual human tutor (avatar). The test bed learning procedure concerns teaching of GSL grammar to early primary school pupils, whereas the platform also incorporates a subsystem that allows approach by the deaf learner to material available only in written Greek form by means of a signed summary. The requirement for translation of educational content to GSL, follows the official -recently reformed- guidelines for the teaching of Greek language in primary schools for the deaf. According to the aforementioned guidelines, GSL is the first language of Greek deaf students by law (Act 2817/2002), and consequently it should be their primary means of education. Moreover, according to EU principles for accessibility to information in special education (see also COM(2000) 284 final [1]), all Greek schools have been provided with suitable equipment for unrestricted Internet access, so any e-learning platform supporting GSL can be readily applicable to real life school routine.

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2 GSL Linguistic Analysis – The Background

Greek Sign Language (GSL) is a natural visual language used by the members of the Greek Deaf Community with several thousands of native or non-native signers. Research on the grammar of GSL per se is limited; till mid '90s mostly fragmentary work had been done, whereas recent studies mainly focus on individual aspects of its syntax (negation, morphology, auxiliary verbs), as well as on applied and educational linguistics (GSL acquisition and onomatopoeia). Systematic analysis and creation of linguistic resources for the language has been strongly connected with the maturing of technologies, which enabled the 3D representation of its linguistic content. As a consequence, in the recent past there have also been some serious attempts in the domain of lexicography (*NOEMA: a Multimedia Dictionary of GSL Basic Vocabulary* and *a Children Dictionary of GSL*) mainly with educational scope.

The actual linguistic data of the current study are based on basic research on GSL analysis undertook since 1999, as well as on experience gained by projects NOEMA and PROKLISI [2]. The data consist of digitised language productions of Deaf native GSL signers, triangulated with the participation of Deaf GSL signers in focus group discussions. The project follows methodological principles on data collection and analysis suitable to the minority status of GSL. Wherever the status of individual GSL signs is in consideration, the Greek Federation of the Deaf is advised upon, too.

In this respect, SYNENNOESE offers a great challenge for in-depth work on both directions, lexicography and linguistic analysis of GSL; for the first time research goes beyond mere collection of glosses, into the domain of productive lexicon, i.e. the possibility of building new GSL glosses following structural rules. From a linguistic point of view the resulting database of glosses, rules and tendencies of GSL will be a significant by-product of the project, of great value to future applications.

In the area of signed languages there have been some similar projects (VISICAST [3], Thetos, SignSynth and eSIGN among them) that SYNENNOESE uses as background (relevant sites include:

http://www.leidenuniv.nl/hil/sign-lang/sl-sites.html#technical,
http://www.sign-lang.uni-hamburg.de/Quellen/default.html,
http://www.fhs-hagenberg.ac.at/mtd/projekte/FFF/3dSign/bookmarks.html).

The linguistic part of the project is based on overall assumptions for the adequacy of signed languages as by Stokoe [4], [5], Kyle & Woll [6], Valli & Lucas [7] and Sutton-Spence & Woll [8] among many. Greek sign language is analysed to its linear and non-linear (simultaneous) components, and each sign in GSL is described as to its handshape, location, movement, orientation, number of hands and use of any obligatory non-manually articulated elements (e.g. mouth patterns, head and shoulder movements etc). In the project it was considered essential that the output is as close to native GSL as used in the Greek deaf community. In this respect, forms of 'signed Greek' or other manual codes for the teaching of Greek were excluded and the two languages (GSL and Greek) were treated as the first and second language respectively for the users of the platform, quite as other bilingual platforms may function outside the domain of special education. However, although the target of the project is to decode and automatically translate full texts of written Greek into natural Greek Sign Language, it is accepted that in the current 18-month-long project phase, only simpler syntactic patterns can be successfully recognised and presented in natural GSL.

3 Animation Applications for the Representation of Sign Languages

In general, integrated sign synthesis architecture consists of the following transformations:

1. from natural language text to semantic representation
2. from semantic representation to sign language morphological representation
3. from sign language (SL) morphological representation to a sign notation language and
4. from this notation language to the animation of a virtual actor

This sequential process is illustrated in figure 1.

Animating a virtual actor brings up a number of interesting issues that are not necessarily dealt with in the same manner in every application. More specifically, research and development in this area are usually concerned with full-body and coarse gestures, such as those found in a computer game, while in the case of signing, one would utilize more detailed animation, both for the hands and the torso. Besides this, signing is not constrained to hand gesturing but also includes concepts communicated via the signer's body stance or general movement or even facial expression, as is the case with questions; the ability to utilize these notions must be abundant in a sign synthesis system.

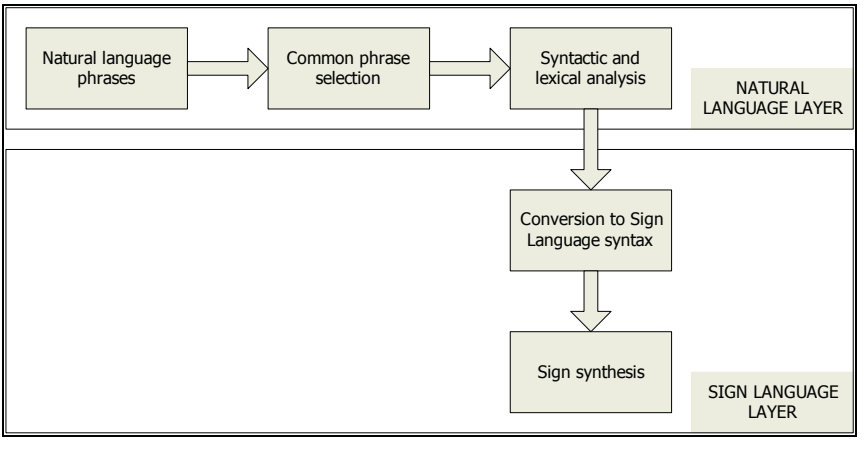

Fig. 1. Data flow sequence for sign synthesis

An interesting parameter of a virtual signer is the ability to sign letters of the written alphabet (finger spelling). This technique is useful in cases of proper nouns, acronyms, terminology or even general terms for which no specific sign exists. As a general rule, a sign synthesis system should support the concept of modularity as much as possible, so as to give the opportunity to the content design to build sequences from individual signs, using them as building blocks.

4 Adopted 3D Technologies

For the content designer to interact with an avatar, a scripting language is required. In our implementation, we chose the STEP language (Scripting Technology for Embodied Persona) as the intermediate level between the end user and the virtual actor [9]. A major advantage of languages such as STEP is that one can separate the description of the individual gestures and signs from the definition of the geometry and hierarchy of the avatar; as a result, one may alter the definition of any action, without the need to re-model the virtual actor. The avatars that are utilized here are compliant with the h-anim standard, so one can use any of the readily available or model a new one.

An integrated system based on STEP is usually deployed in a usual HTML page, in order to maximize interoperability and be accessible to as many users as possible. This page includes an embedded VRML object, which represents the avatar and includes references to the STEP engine and the related JavaScript interface. From this setup, one may choose to create their own script, for sign representation, and execute them independently, or embed them as JavaScript code, for maximized extensibility. The common VRML viewing plug-ins offer the possibility to select the required viewpoint at run-time, so it is possible for the user to experience the signing from any desired point of view [10], [11], [12]. As an example, a frame of the signing sequence for “radio” is presented in figure 2.

Fig. 2. The virtual signer signing “radio” in GSL

In SYNENNOESE, the input is written Greek text which is then transformed into GSL and appears animated on screen. A syntactic parser decodes the structural patterns of written Greek and matches them into the equivalents in GSL, and these resulting patterns are signed by a virtual human (avatar).

Tools for transcription and notation of GSL include HamNoSys, a pictographic notation system developed by the University of Hamburg for the description of the phonology of signs, and ELAN language annotator developed by the Max-Planck Institute of Psycholinguistics in Nijmegen, the Netherlands. In the ELAN glossing process the classic Stokoe model is used, including one tier with written Greek words of harsh

semantic equivalents of utterances. It is an aim of the project to transcribe and synthesize GSL signs with high accuracy and include non-manual features of linguistic importance as soon as the first stage of synthesis is successfully completed.

5 Linguistic Knowledge of the System

The knowledge of the system in respect to GSL grammar includes both lexical and syntactic aspects of information. Given the features of sign formation, a basic distinction is made between single-sign and multi-sign units. In respect to single-sign units, a further differentiation holds, between free and bound signs; the latter, in principle, correspond to the notions of free and bound morpheme of spoken language. Free signs are included as independent parts of the lexicon knowledge of the system. Bound signs are included as sign building blocks that feed sign generation in combination with other signs.

It is important to notice that, along with lexical signs, the system incorporates a library of phonological features of sign formation that include:

- The list of handshapes of GSL
- Locations of sign formation
- Palm orientations and
- Hand movements

as the set of independent structural units for the formation of grammatical GSL signs at the phonological level.

This set is further enhanced to incorporate features for mouth patterns, facial expressions and body movement, used especially for the indication of phonetically (stress) or syntactically uttered (focus position in sentence) elements of the linguistic message in spoken languages.

Multi-sing units may be composed of a) free signs or b) combinations of free and bound signs, in order to create sign sequences, according to the rules of either inflectional or derivational morphology, or in order to construct sign phrases.

Lexical resources include the whole of vocabulary to be used in the e-learning application, annotated according to HamNoSys. Linguistic resources also include a computational grammar of the core structure rules of GSL. The combination of lexical items and structure rules allows generation of infinite sign phrases. The GSL grammar descriptions are matched against the output of the ILSP parser for Greek [13], [14], [15], so that structure equivalences between input written text and output signed streams are defined.

6 Greek-to-GSL Converter as a Universal Access Tool

The above described linguistic knowledge allows for robust conversion from written Greek text to GSL signing, a tool which, in our case, is combined with an e-learning educational platform that exploits standard e-learning techniques. In this way, the e-learning system architecture is enriched to accommodate access to e-content by a special user group at the early stage of system design. Irrespective of the selected

application, the development of the Greek-to-GSL converter is in line with the main principles of Universal Access and Design for All. Under current definition, Universal Access is becoming predominantly an aspect of design that is raised to a critical quality target in the context of the Information Society [16], [17]. In this respect, the notion of accessibility crucially differs from the original interpretation of the term as concerning modification of already developed systems so as to meet the requirements that would allow their use by groups of users with disabilities [18], [19].

Accordingly, the development of the Greek-to-GSL converter constitutes, in principle, a tool independent of application environment, that supports access by deaf users to e-content in the context of Information Society Technology.

7 Extensibility Perspectives

The Greek-to-GSL converter is a fully extensible tool, in respect to both quality of performance and dynamic content.

- The tool's library that feeds the linguistic knowledge of the system, will be enriched so as to include non-manual structural components that will support signing performance of the avatar closer to natural signing.
- Enrichment of the system's linguistic knowledge will also allow for improvement of its generative capacity.
- New written texts can be launched, so the e-learning platform may receive unlimited educational content besides primary school grammar units.
- Greek-to-GSL conversion may be extended to apply to different environments, such as Greek language teaching to deaf students of higher grades, GSL teaching for hearing students, Greek for specific purposes etc.
- A database with the bulk of GSL utterances, described as to their features from the phonological up to the pragmatic level, will improve knowledge of GSL grammar and create reusable resources.
- The Greek-to-GSL conversion tool will be applicable to a number of systems, other than the e-learning platform under development. As an independent tool, it may support accessibility of content in environments of text generation, information retrieval, summarisation, etc.
- From a socio-economic point of view, the existence of a Greek-to-GSL conversion tool will greatly contribute towards ensuring equal opportunities for the deaf population in Greece.

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