An Avatar-Based Italian Sign Language Visualization System

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Abstract. In this paper, we present an experimental system that supports the translation from Italian to Italian Sign Language (ISL) of the deaf and its visualization through a virtual character. Our objective is to develop a complete platform useful for any application and reusable on several platforms including Web, Digital Television and offline text translation. The system relies on a database that stores both a corpus of Italian words and words coded in the ISL notation system. An interface for the insertion of data is implemented, that allows future extensions and integrations.

Keywords: Sign Languages, Computer Graphics, Virtual Reality, E-Inclusion.

1 Introduction

Providing deaf people the possibility to follow and understand TV, Media information, and entertainment channels is a significant step toward their inclusion in the global community and it may be considered a natural evolution of a process started by computers, internet, and mobile phones. The integration difficulties of persons who were born deaf or got deafness in the first years of life are higher because they could not acquire the knowledge of the spoken language.

Sign Languages allow deaf children acquiring a full cognitive development within their community composed of hearing and deaf persons.

Such cognitive development represents the prerequisite to a full access to the education, the culture and the inclusion in working and social environment. An increasing request for ISL interpretation in educational, legal, and healthcare context is foreseen and soon expected to be extended to the culture and entertainments. The depicted scenario makes clear the relevance of the availability of low cost system to cover, in a sustainable way, the increasing demand for a wide range of services including ISL contents.

The present paper presents a system aimed at supporting deaf people in different contexts by displaying sign language gestures through a visual character, hereinafter referred to as “avatar”. In particular, the paper mainly focuses on the sign language

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synthesis via a parameterization of the avatar gesture starting from an ISL intermediate form.

In section 2 a state of the art of this technology is presented. Section 3 exploit the architecture of the system. Section 4 gives an insight on the characteristics of the ISL grammar and how can be formalized. Section 5 describe the structure of the ISL gestures and how can be elaborated. Section 6 depicts the implementation of a database for ISL translation. Section 7 gives an overview of the graphical engine adopted in our project, whereas section 8 concludes the paper, outlining future improvements.

2 State of the Art

Several projects targeted Sign Language synthesis and significant results have been achieved to improve accessibility of the deafs to the hearing world.

The VISICAST project defined the architecture for sign language processing and gesture visualization by an Avatar [1]. VISICAST brought to the eSIGN project [2]. Additional examples of complete systems are BlueSign (University of Siena, Siena, Italy) [3] and TESSA (University of East Anglia, Norwick, UK) [4].

Most of the recent research activities focused on the creation of characters for video games and the definition of Avatars acting as virtual assistants. The Avatar animations are either synthetic or based on motion-captured data (MoCap). The former ones brought to the definition of several animation languages [5], while the latter ones offer today very reliable systems (e.g., VICON [6]). The main drawback of these systems is that they implement a translation system from the source language to the target signed language. This translation is difficult for the deaf to be understood, as the output language does not follow the rules of the sign language for the deaf.

3 System Architecture and Organization

The architecture of the overall system is in Figure 1.

The system takes, as input, written sentences in the Italian Language and provides, as output, their representation in the *Italian Sign Language*, resorting to the gesture of a virtual character (avatar), generated by a proper graphic engine.

Input Italian sentences are first translated into an intermediate form, the so called "*ISL sentences*", by an *Italian to ISL translator*. The translation phase can be accomplished in several ways, ranging from automatic machine translation, statistical and/or rule-based, to purely human manual translation, in case supported by ad hoc Assisted Editors. In some cases the translation can already be available and stored in proper databases.

The translator, regardless its actual implementation, must rely on a formally defined *ISL sentence grammar*.

ISL sentences are then parsed and analyzed by a *Graphic Engine Command Generator*, charged of generating the commands to be provided to a *Graphic Engine* to enable it to properly display the movements of a virtual character (avatar). These movements obviously represent the representation, in the ISL, of the original Italian sentence. The selected Graphic Engine is a commercial one, originally designed for

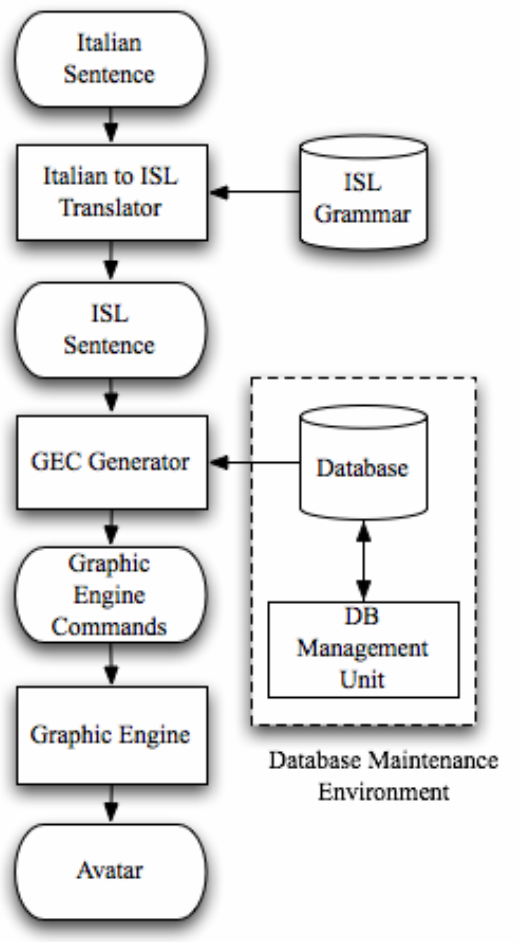

Fig. 1. System Architecture

the translation and visualization of American Sign Language gestures [7]. The tool offers a high level of realism in performing movements and commands can be expressed in an XML format.

The command generation phase strongly relies on the information items stored in a Database, including, among the others, Italian words, words representation in ISL Notation and the commands for the target avatar, represented as XML files.

In the sequel of the paper we shall focus on the various components of the system reported in Figure 1.

4 ISL Sentence Grammar

The visual communication modality that characterizes sign languages brings to an extremely different morphology with respect to spoken languages, and gives them

more flexibility. For example the signer realizes the concordance in genre and number arbitrarily by placing the words in the space or by making the concordance by the time. Thus, two signs can be made contemporarily and have a concordance on the basis of the same time in which they are signed.

An additional important ISL feature is the presence of *classifiers*, also used in the spoken Chinese language. Classifiers are signs used to mark the concordance between elements in the sentence. They do not identify an object, but a category of objects with respect of their shape or the way in which they are grabbed; more in general, they express the *type* of an object, such as "animal", "thin object", "round object", etc. They are mainly used in locative sentences but can be found in other constructs, as well. For instance, in the sentence "the ball is on the table" an interpreter will perform the "ball" sign with the left hand, and then the "table" sign with the right hand. Then she/he will sign the classifier for the round objects (the ball) above the classifier of the square surface (the table). Both the classifiers are made with the right hand. By moving one classifier above the other, she/he expresses the concept of "to put on".

Other general features of ISL include, for instance, the extensive use of personal pronouns to distinguish between inclusive and exclusive forms, as in the spoken Maori language, and the absence of defined and undefined articles, as in the Latin language.

In addition, proper names are usually finger spelled, whereas words non belonging to the basic ISL (such as, for instance, most of technical and medical terms and neologisms) must be expressed resorting to sentences expressing an equivalent semantic.

A formal *regular* grammar has been defined to represent ISL sentences. Resorting to a Backus-Naur Form (BNF), it is expressive enough to catch all the above mentioned distinguishing features of ISL sentences.

5 ISL Gestures

In ISL, as in any other sign language, several parameters are needed to properly characterize each gesture [8]. In the implementation of our system, the following parameters have been adopted:

1. *Configuration*: The form taken by the hands in the gesture
2. *Place*: The point in which the hands forms the gesture
3. *Orientation*: Position of the palm of the hands
4. *Movements*: The way in which the hands move
5. *Non-manual components*: Other movements or characteristics of the gesture such as eyes, torso and head movements.

By varying just one of these components one can create signs that slightly differ each other and that are usually referred to as "Minimal Couples" [9].

The existence of Minimal Couples is exploited during the command Generation phase.

The serious issue of how representing the set of "signs" of the Italian Sign Language has been solved resorting to the Radutzky Italian Sign Language Dictionary [10]. It gathers all the words actually present in the Italian Sign Language and represents a de-facto standard for the deaf community in Italy.

The dictionary provides a corpus of Italian words and the description of the corresponding sign by means of a picture. In addition, each sign is notated with the so called "*Radutzky Notation for ISL (RNFI)*", i.e., a sequence of symbols that codes the first 4 classes of parameters listed above (non-manual components are not included in the RNFI notation.

Figure 2 shows an example of RNFI. Each word is represented by:

1. a "base": a set of symbols coding hand configuration and orientation,
2. an "exponent", which codes the movement and provides information about the part of the body that the hand touches during the sign.

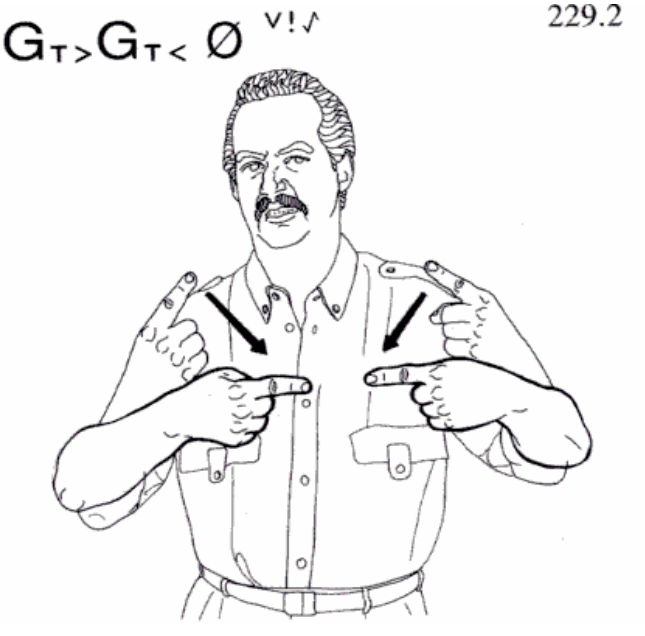

Fig. 2. Radutzky Notation for the sign: "enemies" and sign description

6 The Database

The Multilanguage Database has been designed and implemented to support the Engine Command Generation phase (Figure 1).

Figure 3 shows the database maintenance environment focusing on the relationship between the database and the overall system.

For each element of the *ISL sentence grammar* the database stores several information items, including:

1. The corresponding Italian words
2. The representation according the RNFI notation
3. The corresponding XML commands to be provided to the Graphic Engine

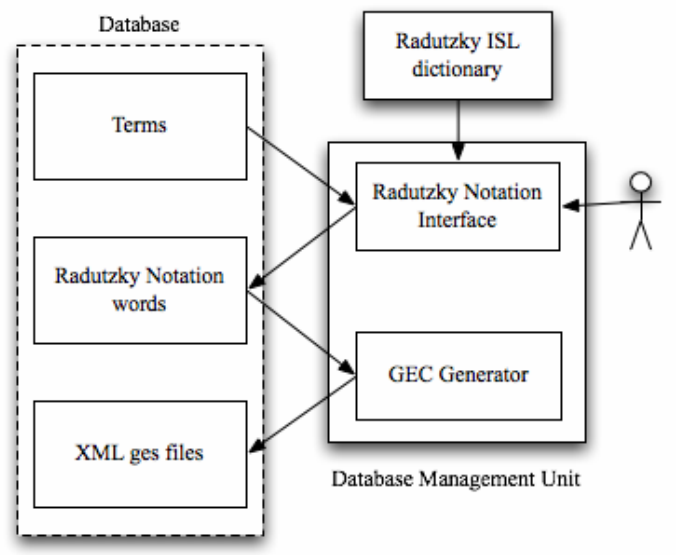

Fig. 3. Database Maintenance Environment

It worth pointing out that in Italy, ISL suffers a heavy regional influence; as a consequence, since sign languages varies form region to region, the database must store all the different "regional" notations for the a same word and provide references to the synonymous words used in other regions.

Particular effort has been devoted to the generation of the RNFI notation for each ISL element. After exploiting several generation approaches, including Optical Character Recognition of the written dictionary and using a speech to text recognizer to automatically generate the corresponding coding of each RNFI symbol read by a speaker, a manual insertion has been adopted. A custom Graphic User Interface has been developed in Java to support manual insertion of the sequence of RNFI symbol by clicking on a custom keyboard. The adopted solution proved, from the one hand, to be the fastest one, even if a training of the person charged of typing was needed, and, from the other hand, it assures extensibility towards new words and future evolution of the Italian Sign Language.

7 Graphic Engine Commands

As mentioned in Section 3, the adopted graphic engine is a commercial tool for sign language translation and synthesis used to translate American text to American Sign Language. Words are translated in commands for the avatar that displays the signs on the screen. The avatar is a VRML character that accepts XML commands; these are written in files that contain all the parameters of the gesture.

Configuration and *Orientation* are properly coded and the position (*place*) is given as a set of coordinates in the space. The *Movement* is expressed by setting configuration, orientation, and position in the space for each frame, expressed by a single XML tag.

When a sentence is given in input to the GEC Generator, it retrieves the corresponding XML commands from the database and sends them to the graphic engine for synthesis.

8 Conclusion

The paper presented the architecture and the organization of a system to support the translation from Italian to Italian Sign Language (ISL) of the deaf and its visualization through a virtual character.

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