Paving the Way to Sign Language Processing*

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Résumé - Abstract

Le systéme SIGNWRITING c'est un systéme practique pour l'écriture des langues des signes des sourds. Il est composé par un ensemble intuitive des symboles graphique-schematiques, et par des rules pour les combiner dans des répresentations des signes. Le language SWML c'est un language basé sur XML, pour la codification des textes, écrits en langue des signes en utilisant le systéme SIGNWRITING, d'une façon qui est independent des application et des platformes des ordinateurs. Ainsi, des textes écrits en langue des signes, representés en SIGNWRITING et codés en SWML, peut étre pris comme entrée par - et aussi obtenus comme sortie des - toutes sortes de programmes qui font l'application des téchniques de traitement automatiques des langues naturelles (stockage, récuperation, analyse, géneration, traduction, verification orthographique, animation, automation des dictionaires, etc.). Ça ouvre tout le sujet du traitement automatique des langues naturelles aux langues des signes des sourds. L'article présent les élements d'une telle abordage au *traitement automatique des langues des signes*.

The SIGNWRITING system is a practical writing system for deaf sign languages, composed of a set of intuitive graphical-schematic symbols and simple rules for combining them to represent signs. SWML is an XML-based language for encoding sign language texts, written in SIGNWRITING, in an application and computer platform independent way. Thus, sign language texts, written in SIGNWRITING and encoded in SWML, can be entered as input to - and also got as output from - any kind of computer program applying any kind of language and document processing technique (storage and retrieval, analysis and generation, translation, spell-checking, search, animation, dictionary automation, etc.). This opens the whole area of text-based natural language processing and computational linguistics of written texts to the deaf sign languages. The paper presents the basic elements of such approach to *sign language processing*.

*This paper is an updated full version of the short paper that appeared in (Costa, Dimuro, 2002).

1 Introduction

Since the pioneer work of Stokoe (Maher, 1996), deaf sign languages have long been recognized as true natural languages, not as artificial codes. In the same way, deaf culture has been acknowledged as a true minority culture, developed by deaf people when they socially organize themselves within the surrounding hearing society in which they live (Cuxac, 1990).

However important writing systems can be for the consolidation of a culture, deaf people have never developed a practical writing system for sign languages, in spite of such interesting early efforts as Roch-Ambroise Bébian's (Lane, Philip, 1984). Even nowadays the value of writing systems for sign languages find themselves having to be "proven" useful, to be able to gain space in the education of deaf children (Rosenberg, 1999).

Notwithstanding that, deaf educators and individual participants of deaf communities, as well as sign language linguists, have been proposing well-founded notations for deaf sign languages, such as the HAMNOSYS and the SIGNWRITING systems.

The HAMNOSYS system [1] is a scientific notation system, specially designed to be used by linguists in their detailed analytical representation of signs and sign phrases. On the other hand, the SIGNWRITING system [2] is a practical writing system, composed of a set of intuitive graphical-schematic symbols and of simple rules for combining such symbols to represent signs.

Although it can surely be used in linguistic analytic tasks, the SIGNWRITING system is essentially designed to be used by common (deaf) people, in their daily life. It is conceived to be used in writing sign languages for the same purposes hearing people commonly use written oral languages: taking notes, writing letters, reading books and newspapers, learning at school, making contracts, etc.

This places the SIGNWRITING system in a privileged position to be taken as the preferred writing system for sign language and sign document processing systems, as such systems can thus be put into real practical use by common (deaf) people.

Given the graphical-schematic nature of the SIGNWRITING system, an appropriate encoding of its symbols is necessary, in order to allow the computer storage and processing of sign language document files, as well as the use of written sign languages in interactive control components of computer program interfaces.

That is the purpose of SWML (SIGNWRITING MARKUP LANGUAGE [3]), an XML-based language that is being developed to allow the computer-platform independent representation of sign language texts written in SIGNWRITING and to allow, thus, the interoperability of SIGNWRITING-based sign language processing systems.

In the following, Section 2 gives an overview of the SIGNWRITING system. Section 3 firstly reviews XML and its role as a meta-language providing for computer systems interoperability. Then, it briefly explains the current version of SWML, the role SWML can play for future sign language processing systems, and the relation it has to the SW-EDIT editor that we are developing for the creation of SIGNWRITING texts and dictionaries. Section 4 pictures the overall scenario of SIGNWRITING-based sign language processing, as envisioned by the approach proposed here. Section 5 brings the Conclusion.

[1] http://www.sign-lang.uni-hamburg.de/Projects/HamNoSys.html
[2] http://www.signwriting.org
[3] http://swml.ucpel.tche.br

2 The SignWriting System

2.1 Conceptual foundations

Valerie Sutton, the inventor of the SIGNWRITING system, took the stance that, from a practical and intuitive point of view, sign language notation should be visually driven and graphically displayed. Such stance came from her previous experience with the development of a writing system for choreographic movements, the `DanceWriting` system (Sutton, 1973) [4].

Sign language notation was, thus, conceived as just another case of *movement writing*, so that the same principles of DANCEWRITING could be applied, and the SIGNWRITING system came up as a *visual notation* for writing sign languages (Sutton, 1999).

Sure, the system was construed to tackle phonetic aspects of sign languages, as they are usually identified by the mainstream of sign language linguistics, e.g., (Valli, Lucas, 1995): hand configurations, hand and finger movements, locations, face expressions, contacts, segmentation, etc. That was necessary because the *visual* aspects of sign languages are precisely what is specific to their linguistic features at the phonetic level (Martin, 2001).

However, in its conceptual foundation, the system was kept as a *movement writing* system, and that is exactly what makes it intuitive and usable for common people, not specially trained in linguistics. Also, that is what makes the SIGNWRITING system neutral with respect to the alternative linguistic frameworks, and thus compatible with otherwise linguistically incompatible theories.

For instance, the SIGNWRITING system is neutral with respect to the various ways to analyze *timing aspects* (sequentiality, simultaneity) in sign language phonology (Valli, Lucas, 1995), and thus is neutral with respect to the *movement-hold segmentation* versus *single segmentation* debate (Uyechi, 1996). It seems to be highly compatible, e.g., with the *visual phonological* approach introduced by Linda Uyechi in (Uyechi, 1996), which was developed well after SIGNWRITING was invented.

2.2 The Graphical Notation

There are various groups of graphical symbols in the SIGNWRITING system, each corresponding to some important (phonetic/phonological) aspect of sign languages. The system is permanently evolving, aggregating new elements as they are needed. The two main versions are the SSS-1995 symbol set and the SSS-2002 symbol set.

Figures 1 and 2, below, illustrate the symbols of the SIGNWRITING system, as in the SSS-1995 symbol set. Figure 1 shows the way the system represents basic handshapes. Figure 2 shows the modifications the basic handshape symbols may be submitted to, in order to represent different hand orientations. The sample signs are in ASL (American Sign Language).

Figure 3 shows how a text written in SIGNWRITING looks like. It is an extract of an ASL text about ASL grammar, written by Karen van Hoek (Hoek, 1995), and made available free with the SIGNWRITER program. The text is formatted vertically, the preferred orientation of sign language texts for most deafs.

[4] `http://www.dancewriting.org`

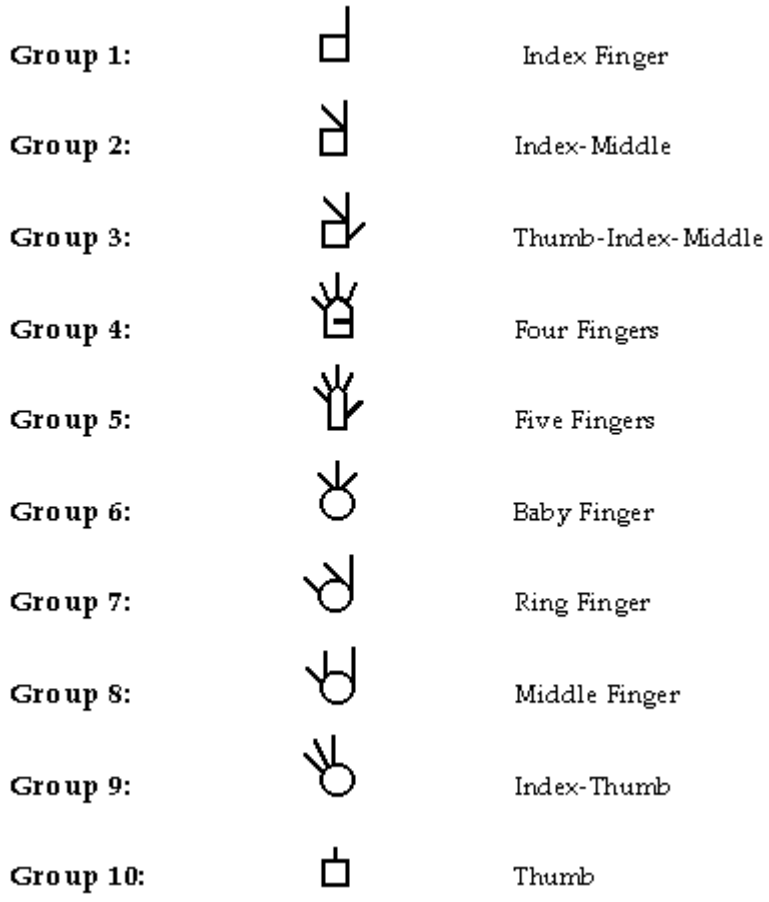

Figure 1: The ten basic handshapes.

3 SignWriting Markup Language

3.1 XML and the Interoperability of Computer Systems

The development of the Internet furthered the need for the interoperability of on-line systems, and XMLis the solution proposed by the WORLD WIDE WEB CONSORTIUM (W3C) to such problem [5]. XML is a meta-language allowing the definition of platform- and application-independent languages, dedicated to the storage and processing of information on the Web.

The flexible set of rules incorporated in XML, and the wide availability of both free and commercial software (parsers, checkers, validators, etc.) supporting it, as well as the strong commitment to the language by the main computer manufacturers and software vendors, turned XML into the favorite interoperability tool in every software development initiative concerned with that matter.

As it is easy to envision the wide range of applicability of SIGNWRITING on the Internet (email messages, document databases, on-line dictionaries, webpages, chats, etc.), the need of an XML-based format to represent SIGNWRITING files can also be easily understood. The SWML format, explained below, attempts to fulfill such need (Costa, Dimuro, 2001).

[5] `http://www.w3.org/XML`

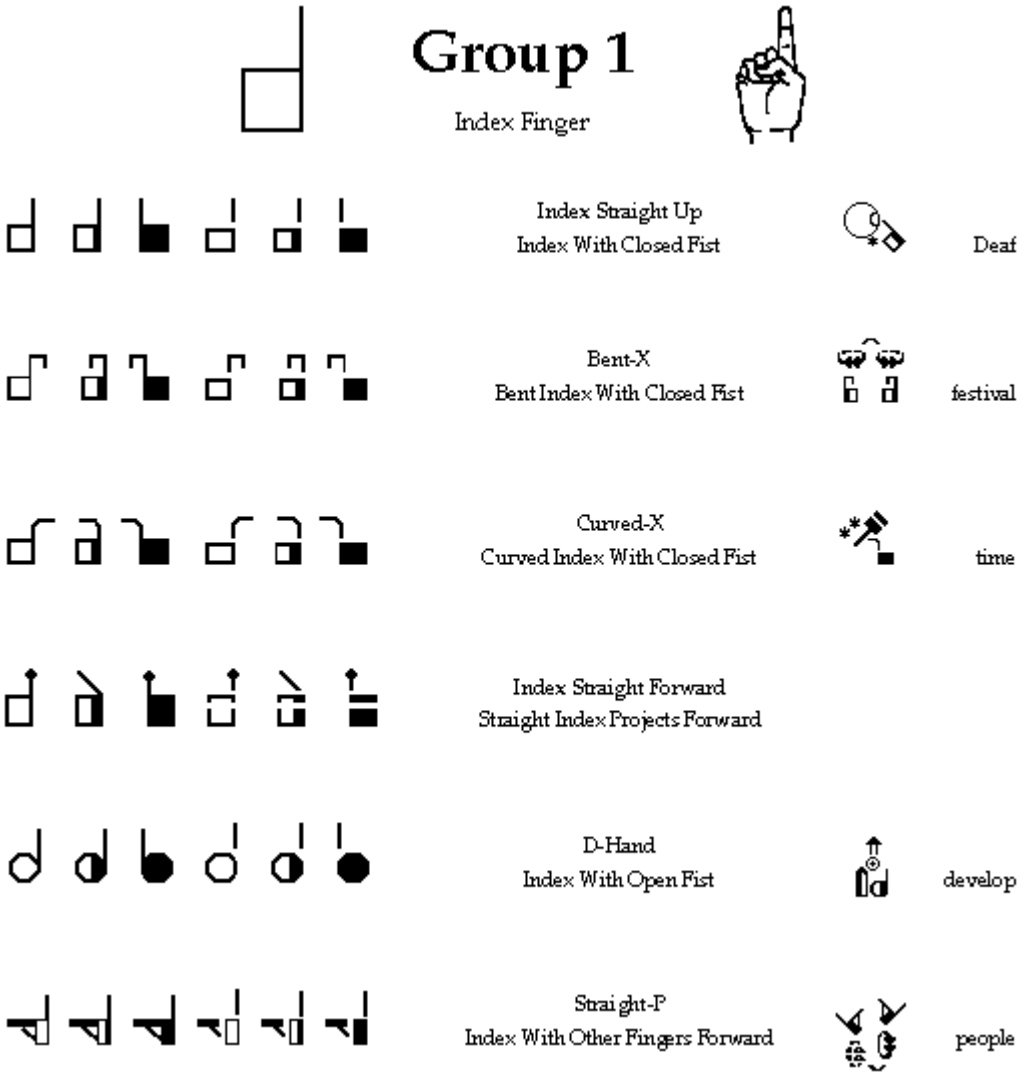

Figure 2: The various modifications of the Index handshape (10).

3.2 SWML

The SIGNWRITING MARKUP LANGUAGE (SWML) is an XML-based language that is being developed to allow the interoperability of SignWriting-based sign language processing systems.

The current version of SWML is `version1.0`, defined by the DTD available at `http://swml.ucpel.tche.br/dtd-version1.0.htm`. Its main features are the following:

- ◇ SWML can represent both SIGNWRITING texts and dictionaries, as they are generated by either the SIGNWRITER and the SW-EDIT programs.
- ◇ For every sign in the text or dictionary, there is a `<sign_box>` comprising the set of `<symbol>` s that together represent the sign.
- ◇ For every `<symbol>` in a `<sign_box>`, a `"number"` attribute identifies the `<shape>` of the symbol, and attributes `"x"` and `"y"` its coordinates within the `<sign_box>`.

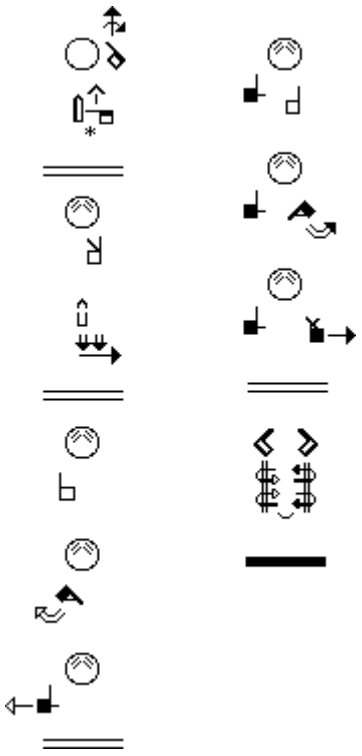

Figure 3: An extract of the *ASL Grammar Lessons*, by Karen van Hoek, written in ASL.

- ◇ Besides, for every symbol, a set of attributes (`"variation"`, `"fill"` and `"rotation"`) identify the `<transformation>` s to which the symbol was subjected when included in the sign.
- ◇ Two optional attributes, “category” and “group” serve specifically the SSS-2002 symbol set.
- ◇ To support the editing features of the SW-EDIT program, which is a full-fledge, multi-plataform, GUI-based editor, the SWML format defines elements like multi-page documents, page format attributes, inclusion of images, symbol colors, etc.
- ◇ The final result is that the various features (both textual and linguistic) of any sign language text can be extracted from its representation in SWML, thus making the format serve the various purposes of the text and language processing techniques that can be applied to the texts it may represent.

Figure 4 shows the sign for BRAZIL in the Brazilian Sign Language (LIBRAS). Figure 5 shows the SWML file that encodes such sign. Comments were added afterwards, to ease the reading of the file.

Figure 4: The sign for BRAZIL in Brazilian Sign Language (LIBRAS), written with the SIGNWRITER program, using the SSS-1995 symbol set.

4 SignWriting-based Sign Language Processing

We use the term *sign language processing* to denote the application of methods and techniques of *natural language processing* and *computational linguistics* to deaf sign languages.

Such methods were originally developed to process oral languages and were, since the beginning, strongly connected to - and even dependent on - methods and techniques of processing oral sentences and discourses presented in *written form*. That was a natural start, given (1) the easiness with which oral (Western European) languages could be represented in computer systems, with the Roman alphabet embedded in the ASCII code, and (2) the socially determined dominance of oral languages.

The extension of that work to non-Western European languages posed (and still poses) interesting technical problems, but has not changed the conceptual foundation of the area, because it still targets only oral languages.

The Gesture Workshop series (Harling, Edwards, 1997; Wachsmuth, Fröhlich, 1998; Braffort et al., 1999) is one of the forums where an alternative goal for natural language processing has shown up, namely, to consider the problem of processing gestures and sign languages.

That work started by dealing with sign language captured visually, in videos or in real time, which was also a natural start, given the lack of standardized (i.e., universally accepted) written form for sign languages.

Some works presented in those workshops dealt with notations for sign languages (e.g., (Lebourque, Gibet, 1999; Vogler, Metaxas, 1999)) but the notations were either linguistically oriented (e.g., based on the STOKOE (Maher, 1996) system or on HAMNOSYS) or computationally oriented (i.e., modeled after some programming language).

Our approach proposes the processing of sign language texts as they may be originally produced by native signers that have no special training in linguistics, and to tackled the problem of common (deaf) user interaction with computer programs using written signs.

Such kind of work, which may well bring to light interesting problems concerning the foundations of natural language processing methods and techniques, can only come up with the help of concepts and tools similar in style to the SIGNWRITING system and SWML.

To pave the way for such kind of work is that we have engaged in the area of sign language processing using the approach explained in the present paper. We are developing very simple computer programs and tools, such as sign counters, manual part-of-speech taggers and simple semantical lexicons, in order to hint on the conceptual problems that should be tackled in the future, when more sophisticated sign language processing systems and techniques may be conceived and proposed.

```
<?xml version="1.0" ?>
<swml version="1.0-d2" symbolset="SSS-1995">
   <generator>
      <name>SignWriter</name>
      <version>4.3</version>
   </generator>
   <sw_text>
      <sw_text_defaults>
         <sign_boxes>
            <unit> pt </unit>
            <height> 60 </height>
         </sign_boxes>
         <text_boxes>
            <box_type> graphic_box </box_type>
            <unit> pt </unit>
            <height> 60 </height>
         </text_boxes>
      </sw_text_defaults>
      <new_line/>
      <sign_box>
         <!-- the B hand -->
         <symbol x="8" y="13">
            <shape number="21" fill="1" variation="1" />
            <transform flop="0" rotation="0" />
         </symbol>
         <symbol x="7" y="25">
         <!-- the movement -->
            <shape number="108" fill="0" variation="1" />
            <transform flop="1" rotation="4" />
         </symbol>
      </sign_box>
   </sw_text>
</swml>
```

Figure 5: The SWML file corresponding to the sign BRAZIL shown in figure 4.

5 Conclusion

A SIGNWRITING-based approach to sign language processing is possible. Such approach requires a means to guarantee the interoperability of the sign language processing systems based on it. The SWML file format is one such means.

From the point of view of the common (deaf) computer user, such approach may be highly practical and useful, since SIGNWRITING needs no special linguistic training for its use, requiring only that the user learn how to read and write her sign language in such system.

As the SIGNWRITING system was created to be a writing system for daily use, the approach to sign language processing proposed here seems to be in accordance with the system's original intention.

Basic computer programs for processing written sign languages should be developed, to take advantage of texts written with the already existing sign language editors, the SIGNWRITER and the SW-EDIT programs.

As the set of such programs evolve, and users effectively trained in reading and writing sign languages with SIGNWRITING progressively produce growing amounts of sign language texts, and also progressively feedback their experiences in interacting with computers using written sign languages, the stock of sign language processing problems will grow, and assessment of the validity of currently available natural language processing methods and techniques, when applied to sign languages, will be possible.

Sign language processing, besides suffering all the difficulties common to all minority languages, brings a shift in language modality, from the oral-auditive to the gestural-visual modality, that seems to promise interesting new problems for computational linguists.

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