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Integrating MultiWordNet with Italian Sign Language lexical resources

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ABSTRACT

A novel Italian Sign Language MultiWordNet (LMWN), which integrates the MultiWordNet (MWN) lexical database with the Italian Sign Language (LIS), is presented in this paper. The approach relies on LIS lexical resources which support and help to search for Italian lemmas in the database and display corresponding LIS signs. The lexical frequency analysis of the lexicon and some newly created signs approved by expert LIS signers are also discussed. The larger MWN database helps to enrich the variety and comprehensiveness of the lexicon. We also describe the approach which links the Italian lemmas and LIS signs to extract and display bilingual information from the collected lexicon and the semantic relationships of LIS Signs with MWN. The users can view the meanings of almost one fourth of the lemmas of MWN in LIS.

1. Introduction

Sign languages (SLs) are visual gestural languages used by deaf communities for daily communication. They are not universal and there are many separate, autonomous SLs that vary from area and culture just like spoken languages. Research into SLs has grown considerably over the past few years and with time the SL linguistics research community has given more and more importance to SL lexical resources. However, the progress in the field has been slowed down due to some data sharing and processing challenges. The reliance on the intuitions of very few informants and detached textual examples (which are not accessible to peer review) in the past have been problematic in the field of SLs (Johnston, 2008).

LIS is the primary means of communication for about seventy thousand deaf people living in Italy (Bertoldi et al., 2010). LIS is a natural language and can convey the range and variety of meanings and undergone a natural development like the spoken languages. Grammatically LIS has its own complex phonological, morphological, and syntactical structure (Geraci et al., 2011). The LIS linguistic features are different from spoken languages, due to the existence of several components affecting the context, such as the use of facial expressions, head movements and different combinations of hand movements (Meier, Cormier, & Quinto-Pozos, 2002). As of today, many language resources available for spoken language users are not available in SLs and there is a significant lack of applications (like complete online dictionaries, databases and translators) which provide access to sign language features and resources. Moreover, if these applications are available, these lack functionalities like the ability to look up LIS lemmas or explore the sign associated with the words of the same or similar sense. When people encounter a word whose corresponding sign is not available, they have to find it in a conventional paper dictionary (Radutzky, Torossi, & Fund, 2001) or rely on online dictionaries having limited scope. The paper dictionary (Radutzky et al., 2001) shows pictorial representations of the body position, orientation and movements with the help of arrow keys. These indicate the direction of movements of the sign and are not easy to understand for someone who does not know SLs (Zwitserlood, 2010). But existing LIS dictionaries lack the information about synonyms or related words. In conventional paper lexical resources, it is difficult to search for an SL lemma because these are not listed alphabetically. The existing electronic (e-lis) dictionary allows searching for sign of the word but they are generally very limited for example resources developed by Vettori and Felice, 2008 are limited. They do not take into consideration the regional variations. For example, the LIS sign for "casa" (house) is different in different areas of Italy.

This paper introduces a novel LIS lexical resource containing high-quality videos of thousands of distinct LIS signs connected to the MWN. The MWN (Pianta, Bentivogli, & Girardi, 2002) is a popular multilingual lexical database in which the words are connected through lexico-semantic relationships and organized into sets of synonymous meanings called "synsets", each representing one underlying concept. These words and concepts are linked through various lexical and semantic relationships. The mapping of LIS signs onto the MWN synset enriches the variety and comprehensiveness of the resource because each synset is linked with set of synonyms and related words. This dataset has been created as part of the ATLAS project to develop a system that allows users to find LIS meanings of textual words. The comprehensiveness of our lexical video dataset is an important aspect. This paper further

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describes the integration of the MWN synsets to the corresponding LIS signs. The newly created lexical resources cover 30% of the MWN lemmas existing within the synset. The detailed statistics are given in the Section 6. The LMWN not only provides the LIS meanings of the lemma but also provides the set of words with similar meanings and the sign associated with each lemma existing in the database. The MWN sysnsets having a corresponding LIS sign in the database are hyperlinked and can be explored. This level of semantic connections cannot be attained by a conventional paper dictionary. In this work the LMWN building process is initiated with a limited number of LIS signs to derive a large set of meanings i.e. possible word meanings associated to a specific sign and diffferent forms of sign existing in LIS. An initial study of lexical frequency in LIS provides much needed data for researchers and language teachers. This data can be used to design experiments about LIS processing and to teach languages. It has also helped to further enhance our understanding of the distribution of grammatical sign categories (and unique sign types) within LIS, across signed and spoken languages.

The paper is organized into seven sections; Section 2 discusses related work and the state of the art in SL lexical resources. In Section 3, the background and overview of the ATLAS project are described. In Section 4, the LIS lexicon creation process is outlined. More detailed information about the lexicon and its features are given in Section 5. In Section 6, the integration of the MultiWordNet integrated with the LIS information and the integration methodology of our lexicon are described along with the lexical details and statistics on the LMWN coverage. Section 7 concludes the paper with some results.

2. Related work

SLs linguistics research has been expanded through the years, although it is still way behind the linguistics research in spoken languages. William Stokoe (Stokoe, 1960) presented the first conclusions from several studies on ASL (American Sign Language).The dictionary on ASL (Stokoe, Casterline, & Croneberg, 1965) was a major turn in SL studies which employed Stokoe's insight that lexical items can phonologically be decomposed just like the words of spoken languages. Frishberg examined some historical changes in ASL (Frishberg, 1975) and showed that there is strong tendency for signs to change in the direction of arbitrariness, which was also attested for LIS (Radutzky, 1989). Radutzky (1992) and Romeo (1991) were the first dictionaries used for LIS. Pizzuto (Pizzuto, Cameracanna, Corazza, & Volterra, 1995) studied the sub-lexical organization of the semantic domain of spatio temporal relations in LIS.

There is a variety of simple lexical resources for SLs available in the form of SL dictionaries, containing a basic set of written words, each word accompanied by a line drawing or a photograph of person signing (Johnston, 2003) Clearly, there is need for the development of lexical resources containing more signs and additional information about the signs. Also, specific groups of people demanded dictionaries containing the signs for the terminologies they usually use, resulting in printed dictionaries with the focus on different domains.

Spoken languages are basically one-dimensional in nature (sounds of the words are pronounced one after another). Some spoken language dictionaries also contain information about lemma pronunciation using different symbols. The problem for sign notation is that signs are represented using three-dimensional space and have sequential (chronological) structure. This is difficult to encode in one- or two-dimensional paper representations. The compilers of SL resources have adopted different approaches to tackle this issue. Sign notation systems are used in some dictionaries, but generally these are complementary to an image of the sign. Most printed lexical resources use line drawings or photographs to represent a sign as shown in Fig. 1, taken from (Radutzky et al., 2001). Sign representation on the paper requires extra space and it is not easy to provide the detailed information. Most paper lexical resources of SL existing to date contain limited entries as compared to the spoken languages. For example, the Radutzky dictionary (henceforth referred as LIS Dictionary), to our knowledge is officially used for Italian Sign Language but the resource is very limited and contains less than three thousand signs (Radutzky et al., 2001).

As shown by Al-Ohali (Ohali, 2010), more than fifteen tools (e.g. 3D animation, video based representation, sign editor, dictionary, text analysis and speech recognition) have been developed to assist deaf in their lives and increase their learning opportunities. Virtual Characters (or Avatars) are natural candidates for the representation of signs. Many avatar-based signing systems have been developed for automatic interpretation of text into sign language (Kipp, Heloir, & Nguyen, 2011; Lombardo, Nunnari, & Damiano, 2010). There are several research projects investigating the synthesis of virtual character animations performing SL (Fotinea, Efthimiou, Caridakis, & Karpouzis, 2008). The ViSiCAST and eSIGN projects (Elliott, Glauert, Kennaway, Marshall, & Safar, 2008; Kennaway, Glauert, & Zwitserlood, 2007) allow transcripts from the database to be played back by virtual signers (Hanke, 2002; Hanke & Storz, 2006). DGS corpus compiled by iLex which allows researchers to view transcripts (Hanke & Storz, 2008). These SL avatar animations may be scripted by the user (Kennaway et al., 2007) or can be generated automatically by text to SL machine translation systems (Chiu, Wu, Su, & Cheng, 2007; Huenerfauth, 2006; Marshall & Safar, 2005; Stein, Bungeroth, & Ney, 2006).

The motivation for the creation of LIS WordNet is to provide a comprehensive lexical resource that can be used as a tool for enhancing the learning of people having hearing disability. Mapping and linking of knowledge networks has always been a problem of great interest. The mapping of the Princeton WordNet (Miller, 1995) to other knowledge networks has also received attention in the lexical knowledge network community.The coordinators of the Princeton wordnet and EuroWordNet started the Global WordNet Association (http://www.globalwordnet.org) in 2000 (Vossen, 2002). A multi-lingual linked structure of WordNets was the goal of the Global WordNet effort. Multilingual SL knowledge bases address the development of language resources by capturing the relationship between words and their corresponding concepts in SL and hence making the semantic connection between lemmas of different languages. This sort of lexical information can be useful in different communicative situations and provide the support for web pages, mobile applications and also the television broadcasting (Buehler, Zisserman, & Everingham, 2009; Lewis & Jackson, 2001). There are WordNets in more than 50 different spoken

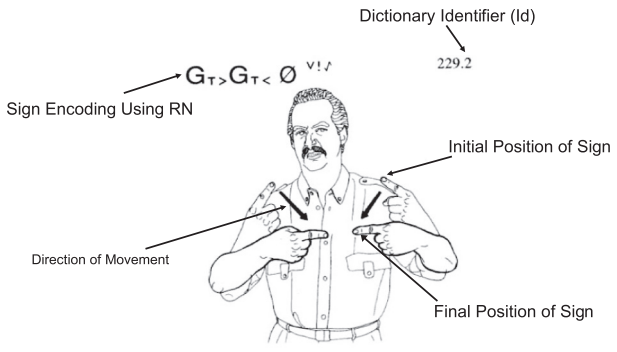

Fig. 1. Radutzky Dictionary sign for: "Nemici", "Enemies" (Radutzky et al., 2001).