# South African Sign Language Machine Translation Project

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**Abstract**

*We describe the South African Sign Language Machine Translation project, and point out the role that the project is playing in the larger context of South African Sign Language and accessibility for the South African Deaf community.*

## 1. Introduction

The South African Deaf community is marginalized in its access to information. The reasons for this marginalization include the scarcity of and excessive cost of hiring interpreters, the lack of published information about South African Sign Language (SASL), and the low literacy rate (especially in disadvantaged communities). The aim of the South African Sign Language Machine Translation (SASL-MT) project is to increase the access of the Deaf community to information by (a) developing a machine translation system (the SASL-MT system) from English text to SASL for specific domains where the need is greatest, such as clinics, hospitals and police stations, (b) providing free access to SASL linguistic data and (c) developing tools to assist hearing students to acquire SASL.

In this paper, we give a broad overview of the design and current status of the SASL-MT system. The SASL-MT system consists of three sub-projects, namely, a linguistic and support toolset component, a translation component, and an output component. We describe each of these components in the next sections.

The reader may note that sign languages are natural languages with their own syntax and grammar, but are visual-spatial instead of spoken languages. This modality of sign language causes unique difficulties in the machine translation process. For example, the space where signs are executed relative to the body of the signer, is known as the signing space – in the sentence generation phase of the translation, this signing space has to be constructed, with objects correctly placed in the signing space. Note that in sign languages, when a person or object is initially mentioned, a position in the signing space is indicated, and for subsequent references to it, the position is then indicated. For example, in the sentences *Harry eats a chocolate. He likes chocolates.*, the person *Harry* will be assigned a position in the signing space, and the pronoun *He* has to be translated as the signer pointing to that position.

Another essential aspect of sign language is the so-called non-manual signs, which comprise facial expression and body posture. The non-manual signs form an intrinsic part of the grammar of sign languages. For example, a question which is not accompanied by a questioning facial expression, is simply meaningless. For the generation of non-manual signs we use a solution based on text-to-speech algorithms. This is, to our knowledge, a novel approach.

## 2. Linguistics and Toolsets

There is almost no published information available on SASL. In particular, when the SASL-MT project was initiated, there was no freely available electronic data that could be utilized in the project. The first stage of the project therefore involved data gathering. Our data gathering followed standard guidelines [8], and we specifically set it up to minimize code switching. Our video data was analyzed and transcribed by SASL interpreters, mostly by hand. We currently have an annotated word list of approximately 800 words, and a bilingual English-SASL phrase book with commonly used phrases. This data has been made freely available, and has proved to be in high demand, especially by (hearing) people who are learning SASL. This is currently the only electronic source of freely available SASL data in the country.

## 3. Machine Translation Component

In the SASL-MT system, we wanted to re-use existing freely available data and linguistic tools in order to minimize the development time spent on the analysis of English text. We hence followed the design of the TEAM project [10], where a synchronous tree adjoining grammar (STAG) parser was used to translate English into American Sign Language. We developed our own Early-type tree adjoining grammar (TAG) parser, and re-used the English grammar definitions of the TEAM project [10].

We next constructed SASL grammar trees, and rule-based transfer rules from the English trees to SASL trees. These trees and rules were constructed by hand from a prototype set of sentences. As the linguistic knowledge about SASL expands, more trees can be incorporated into the system. When the system is due for user testing by linguists and the Deaf community, we will also be able to refine and improve our initial set of rules. This will provide a unique linguistic opportunity for a detailed investigation of SASL, and will thus be an important spin-off of the project.

In order to place objects in the signing space, we run a pronoun resolution algorithm on the original English text. Any pronouns in the current sentence is then associated with the appropriate object in the signing space data structure. Initial results were good, but highlighted the fact that the identification of co-referential noun phrases [9] would be essential for the correct placement of objects in the signing space. For example, in the sentences *Harry eats a chocolate. That boy likes his chocolates!*, the person *Harry* must be assigned a position in the signing space, and the system must recognize that *That boy* refers to *Harry* and hence must refer to the same position in the signing space. We are currently considering practical ways to incorporate noun phrase co-resolution in the SASL-MT system, but this is by no means an easy extension.

For non-manual signs, we note that these may be considered analogous to intonation and stress in speech [2]. For example, a frowning expression occurs for a question in sign language, while a change in pitch occurs for questions in spoken languages. We undertake prosody (that is, intonation, pitch and accent) analysis by means of concept-to-speech algorithms [5], which we run on the original input text and then flag the English parse tree with metadata. We also flag the output tree with expressiveness (such as happiness or anger) and accent information, in order to aid in the final SASL sentence generation.

## 4. The Signing Avatar Component

One of our major goals with the signing avatar was to develop a pluggable and re-usable signing avatar. Currently, most signing avatars are either commercial and not freely available, or are purpose-designed and fully integrated into other systems [3]. Such integrated avatars do not lend themselves to re-use, and we wanted a stand-alone generic signing avatar that can be used freely in other projects.

To make the avatar as general as possible, we based it on the H-Anim standard [4]. Since H-Anim lacks enough features to model facial expressions in sign language, we extended it to include these features. Our animations were developed separately in Java, and the animation capabilities are defined relative to the size of the avatar. For example, in physiological terms, a shoulder joint should move maximally one-third of the length of the upper arm. This means that any reasonable avatar can be coupled to our animation code. To activate the animations in the signing avatar, we use a notation similar to XSTEP [6]. If the output from another system produces the correct notation, our animation code can let an H-Anim avatar execute the sign.

## 5. Conclusion

The SASL-MT system is still under development. In summary, we have completed: the TAG parser for English, the metadata generator for pronoun resolution and generation of emotional, stress and accent flags, and the signing avatar. Based on prototype linguistic SASL data, a given English sentence can be analysed, and a selected parse tree translated to a SASL tree. Given a description of a sign, the avatar can sign it correctly.

We are now working on combining the separate modules above into a single integrated system. This entails: automatic selection of the best parse tree from the parses generated by the TAG parser, sentence generation from the SASL parse tree, and an interface between the machine translation component and the signing avatar.

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**ASSETS'06**, October 22–25, 2006, Portland, Oregon, USA.