

## Publishable summary

### *Abstract*

Deaf communities revolve around sign languages as they are their natural means of communication. Although deaf, hard of hearing and hearing signers can communicate without problems amongst themselves, there is a serious challenge for the deaf community in trying to integrate into educational, social and work environments. The overall goal of SignSpeak is to develop a new vision-based technology for recognizing and translating continuous sign language to text, being this the first step to approach this technology at levels already obtained in similar technologies such as automatic speech recognition or statistical machine translation of spoken languages. New knowledge about the nature of sign language structure from the perspective of machine recognition of continuous sign language will allow a subsequent breakthrough in the development of a new vision-based technology for continuous sign language recognition and translation. Existing and new publicly available corpora will be used to evaluate the research progress throughout the whole project.

More detailed specifications of the system are gathered in the public deliverable D1.1, available on SignSpeak website ([www.signspeak.eu/en/deliverables.html](http://www.signspeak.eu/en/deliverables.html)).

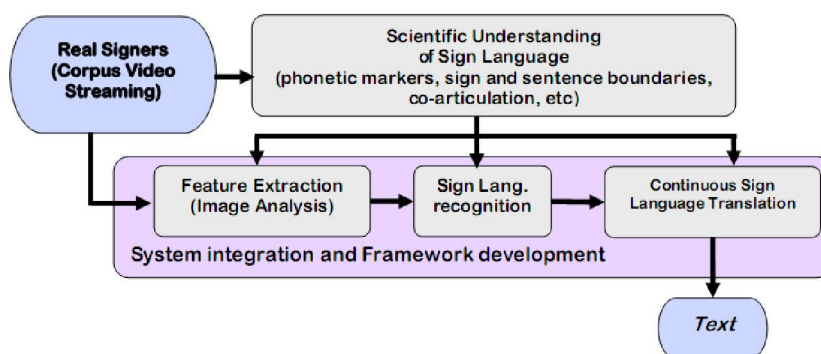
Project partners and other public information can be found as well on the project website; comments and suggestions can be sent to [info@signspeak.eu](mailto:info@signspeak.eu).



**Figure 1. SignSpeak Logo**

### *Progress at the end of the second year of the project*

A conceptual scheme of the work planned is presented in next figure.



**Figure 2. Conceptual scheme of the work planned in SignSpeak project**

The following points summarise the progress made in the different blocks:

#### - **Video Corpora:**

An overview of different corpora handled in the project is presented in the public deliverable D7.1 (Evaluation report of the three baseline prototypes of multimodal visual analysis, sign language recognition and translation); among these corpora, the consortium is expanding Corpus-NGT (Sign Language of the Netherlands) and PHOENIX (German Sign Language, DGS). The Consortium works with different corpora to show how SignSpeak works with different sign languages and databases with different features, such as different context domain, vocabulary size, word repetitions (or type-token ratio), etc.

In this second year, the expansion and quality enhancement of the Corpus-NGT and PHOENIX annotations has further progressed. Additionally, new recordings have been made and annotated for both corpora to increase the type-token ratio of some of the not-so-frequent glosses. Finally, for the non-manual annotations, attention has been focused on the one non-manual signal that appears to have a relatively unequivocal meaning and function: the use of head shakes for the expression of negation. Most of the glossed sentences have been annotated for these head shakes in Corpus-NGT and PHOENIX, so that this information can contribute to better translations.

- **Scientific understanding of signed languages:**

The overall goal of WP2 is to collect linguistic knowledge on the phonetics and phonology of sign languages, and in particular for Sign Language of the Netherlands. This is currently a highly underexplored field. The studies will help us to improve our annotations, and can potentially contribute specific knowledge to the recognition and translation of signs.

Two experimental studies have been designed in year 2, on the difference between movements between and within signs, and on the coarticulation of hand height in different types of signs. Finally, a start has been made with an empirical study on sentence boundaries in NGT, following up on the literature review created in the first year.

- **Feature extraction:**

The objective is the extraction of visual features helpful for sign language transcription. To this end, progress has been made notably in the areas of hand tracking, hand shape analysis, face tracking, and facial feature analysis. Work on local features has also advanced. Results are fed to the downstream recognition module (as showed in the figure above), and a quantitative evaluation is underway for the upcoming Evaluation Report (public Deliverable D.7.2 due to end of June, M27).

- **Sign Language Recognition:**

The primary objective of this work package is to develop sign language recognition technologies which perform isolated and continuous sign language recognition. The extended prototype provided at the end of Year 2 adopts automatic speech recognition (ASR) methods, and is based on the RWTH-ASR<sup>1</sup> speech recognition system, focussing on two major activities: the first activity has been the preparation of **external feature integration** within **multiple corpora setups for sign language recognition**; the second major activity has been the extension of the sign language recognition prototype for **continuous sign language recognition**, especially adaptation of discriminative training and feature extraction approaches. The evaluation of this extended prototype will be included as well in public deliverable D.7.2.

- **Sign Language Translation to text:**

The primary objective of this workpackage is to develop sign language translation technologies which perform an automatic machine translation of multimodal input from recognized signs transcribed in gloss notation into a spoken language. The translation system should deal with the parallel and multimodal nature of sign languages. The main activities performed in this period are: 1.- setting up of automatic translation pipelines for both the phrase-based and the hierarchical system; 2.- implementation of a technique similar to cross-validation to stabilize optimization on

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<sup>1</sup> [Rybach & Gollan+ 09] D. Rybach, C. Gollan, G. Heigold, B. Hoffmeister, J. L'œ of, R. Schlöter, H. Ney: The RWTH Aachen University Open Source Speech Recognition System. In Interspeech, pp. 2111–2114, Brighton, U.K., Sept. 2009.

small corpora; 3.- incorporation of lexical knowledge by using Morphisto<sup>2</sup> results for the training of word alignments; 4.- parsing of eaf files and preprocessing of the corpora to handle multi-tier input in machine translation. Experiments were performed on Corpus-NGT and PHOENIX; the results will be included as well in D.7.2.

- **System integration and software development:**

The main objective focuses on the design and development of a framework scalable and flexible to connect the different developments and prototypes, to obtained SignSpeak workflow pipeline. Almost every module within the framework has already been implemented and tests are in the initial stages. Additionally, a Graphical User Interface (GUI) has been designed and initially developed at the present time; this GUI will be useful both for developers, to get feedback from the functioning of the different parts, and for the deaf community, to evaluate the system. For the latter case, the design will be validated by EUD as end-users, before starting the development of this part of the GUI.

### ***Dissemination activities***

Six types of dissemination have been carried out in the project:

1. Project website updates
2. Logo competition
3. Leaflet
4. End-users: Dissemination by the EUD (European Union of the Deaf)
5. Linguistics: Dissemination of Sign Language knowledge
6. Technical: Dissemination of Technological Developments

The project website has been updated by uploading the public deliverables/publications and keeping up to date the section 'News and Events'; a leaflet has been designed and developed for reaching the general public, which can be downloaded from the main page of the site.

On the other hand, the EUD has actively performed strong dissemination of the project; just for the second year, EUD has presented SignSpeak in 9 events or conferences organised by the deaf community. Moreover, in order to create a new logo, the consortium decided to set up a competition open to everybody but especially encouraging deaf people to apply as they are the ones who will be benefiting from this new technology. To this end, the EUD distributed the announcement of the logo competition to the deaf community; as applicants have to visit the project website to get inspiration for designing the logo, deaf community was more aware about SignSpeak project; thus the competition was also a good dissemination activity to the deaf community, and a way for the deaf community to meet the project. A total of 17 designers participated in the competition, some of them submitting more than one design. The winner is the logo included in the first page of this summary (Figure 1); more details in the section 'News and Events' in the project website.

For Sign Language knowledge and technological developments, dissemination was mainly based on scientific papers and workshops; in the latter case, dissemination is not the unique objective, but the workshops aim at increasing knowledge on the fields targeted by SignSpeak by meeting other researchers carrying out work on similar goals.

So far (at month 24), SignSpeak partners have co-organised four workshops: two of them regarding the construction and best exploitation of sign language corpora, and the other two regarding sign recognition and translation; these two technical workshops have been co-organised with Dict-Sign, which is another EU funded project working as well in Sign Recognition. Additionally, the

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<sup>2</sup> <http://code.google.com/p/morphisto/>

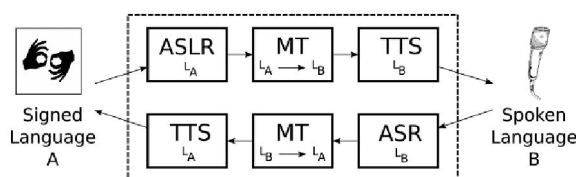
consortium is organising another workshop: SGA2011 – Second International Workshop on Sign, Gesture and Activity, in conjunction with ICMI 2011, November 18<sup>th</sup> 2011, Alicante, Spain; more details can be found at <http://signspeak.eu/sga2011/>; this workshop is also co-organised with Dicta-Sign partners.

On the other hand, three scientific papers will be submitted to specialised Journals for disseminating the *scientific understanding of signed languages* generated in the project; actually, one paper has already been accepted for publication, another one is under review and the last one will be submitted in the next weeks. Additionally, another paper has been submitted for publication gathering the developments made in sign translation (the paper is under review). The Consortium intends to make these scientific papers public by including a reference to the DOI of the journal, as already agreed with Elsevier, but for now these papers are only in the private section of the project website.

Moreover, 13 papers (11 of them in the second year) have been submitted to different workshops and conferences. All the papers submitted for workshops and conferences are available in the project website ('Publications').

### ***Potential impact and use: Towards a Sign-Language-to-Spoken-Language Translation System***

The interpersonal communication problem between signer and hearing community could be resolved by building up a new communication bridge integrating components for sign-, speech-, and text-processing. To build a sign-to-speech translator for a new language, a six component-engine must be integrated as shown in next figure, where each component is in principle language independent, but requires language dependent parameters/models. The models are usually automatically trained but require large annotated corpora. In SignSpeak, a theoretical study will be carried out about how the new communication bridge between deaf and hearing people could be built up by analyzing and adapting the ASLR and MT components technologies for sign language processing.



**Figure 3. Complete six components-engine necessary to build a Sign-To-Speech system: automatic sign language recognition (ASLR), automatic speech recognition (ASR), machine translation (MT), and text-to-speech/sign (TTS).**

Once the different modules are integrated within a common communication platform, the communication could be handled over 3G phones, media center TVs, or video telephone devices. The following application scenarios would be possible:

- e-learning of sign language;
- automatic transcription of video e-mails, video documents, or video-SMS;
- video subtitling and annotation.

Telefónica I+D, the industrial partner in the consortium, leads the study of potential uses of the technologies developed in SignSpeak, taking advantage of the experience got by developing STEPS, the Service Platform for the Deaf developed recently. TID is studying as well other potential industrial applications of these technologies apart of the applications for the deaf community.