DICTA-SIGN Publishable Summary

February 2010 – January 2011

"Sign Language Recognition, Generation and Modelling with Application in Deaf Communication"

URL: http://www.dictasign.eu/

DICTA-SIGN researches ways to enable communication between Deaf individuals through the development of human-computer interfaces (HCI) for Deaf users, by means of Sign Language.

TABLE OF CONTENTS

PROJECT DESCRIPTION

DICTA-SIGN is a three-year EU-funded research project that aims at making online communications more accessible to deaf sign language users.

The development of Web 2.0 technologies has made the WWW a place where people constantly interact with each other, by posting information (e.g. blogs, discussion forums), modifying and enhancing other people's contributions (e.g. Wikipedia), and sharing information (e.g., Facebook, social news sites). Unfortunately, these technologies are not friendly to sign language users, because they require the use of written language.

Can't sign language videos fulfill the same role as written text in these new technologies? In a word, no. Videos have two problems: Firstly, they are not anonymous – anyone making a contribution can be recognized from the video, which holds many people back who otherwise would be eager to contribute. Secondly, people cannot easily edit and add to a video that someone else has produced, so a Wikipedia-like web site in sign language is not possible.

DICTA-SIGN's goal is to develop the necessary technologies that make Web 2.0 interactions in sign language possible: Users sign to a webcam using a dictation style. The computer recognizes the signed phrases, converts them into an internal representation of sign language, and then has an animated avatar sign them back to the users. Content on the Web is then contributed and disseminated via the signing avatars. Moreover, the internal representation also allows us to develop sign language-to-sign language translation services, analogous to the Google translator.

In this way, DICTA-SIGN aims to solve both of the problems that sign language videos have. The avatar is anonymous, and its uniform signing style guarantees that contributions can be easily altered and expanded upon by any sign language user.

RESEARCH & DEVELOPMENT AREAS OF INTEREST

DICTA-SIGN deals with four Sign Languages: British Sign Language (BSL), German Sign Language DGS), Greek Sign Language (GSL) and French Sign Language (LSF).
The project involves research from several scientific domains in order to develop technologies for sign recognition and generation, exploiting significant knowledge of the structure, grammar and lexicon of the project Sign Languages, the so called linguistic knowledge and resources of a language. Sign Language linguistic knowledge can be derived exclusively by appropriate processing of Sign Language video corpora, linked to grammars and lexicons.
To serve its goals, DICTA-SIGN combines linguistic knowledge with computer vision for image and video analysis that serves to achieve continuous sign recognition as presented in sign language videos, and with computer graphics for realistic signing animation by means of a virtual signer (avatar).

SUMMARY OF ACTIVITIES

During the second year of the project life cycle a number of initially set goals were achieved. As regards the project's language resources, the DICTA-SIGN parallel corpus creation was completed with data capture been made for all four project sign languages, manual data annotation being currently in progress, while the project's common vocabulary of minimum 1.000 lemmas per SL has also been completed and transcribed with the HamNoSys notation code. As regards work on language

modelling, the model for lexical representation has been establish, while a proposal for a grammar model is also completed. Research work on sign recognition has turned to project internal data, also having started experimentation with stereoscopic data. Work on animation has expanded the scale of animated features to non manuals, in order to achieve closer to natural sign animation, while research towards (semi)-automatic annotation has also progress to report. Finally, during the second project year, also work on bi-directional system integration has started. In parallel a number of dissemination activities have promoted the project's progress to the international scientific community and have presented the project to the European Deaf Community.

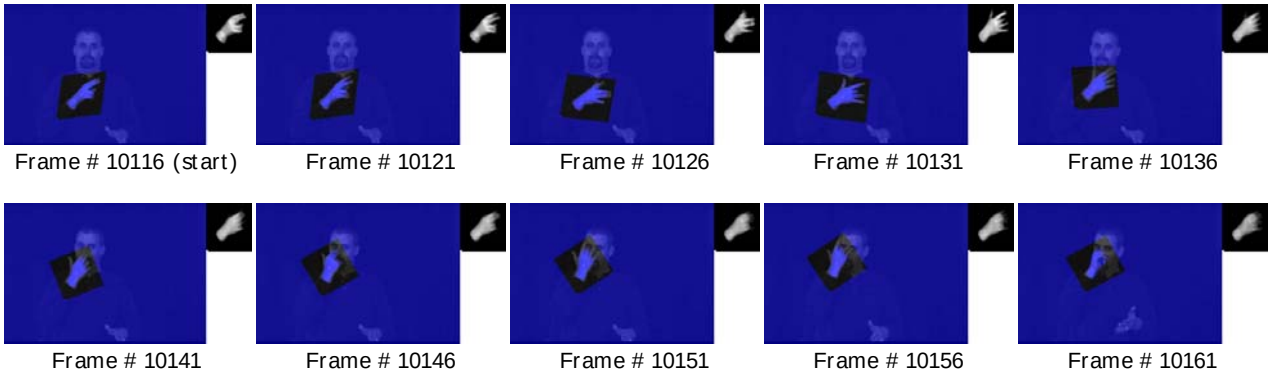


Figure 1: Regularized SA model Fitting in a video segment (BU-corpus).

As regards Sign Language Recognition, research on visual tracking and feature extraction has turned to exploitation of the project' s own language data, acquired with the DICTA-SIGN parallel corpus creation. While the consortium data is being annotated, work is continuing with the mining techniques using new feature descriptors. These low level feature descriptors encode the appearance and motion data of the subject and will be ideal candidates for future work into learning HamNoSys features. In parallel, a preliminary estimation of the hands and head locations is derived from the colour cue, while new progress has been made in sign recognition by fusing visual features with phonetic features (PDTS).

In the domain of continuous sign recognition, progress has been made in the overall proposed framework of dynamic-static classification and modelling of sign language. We investigate the new framework of dynamic-static classification and modelling that exploits basic movement-position cues and constructs data-driven sub-units. After extensive experimentation on which we explore parameter variation, comparison with other approaches and vocabulary size scaling, the presented approach demonstrates promising results of at least 14% on average performance improvement in terms of sign accuracy.

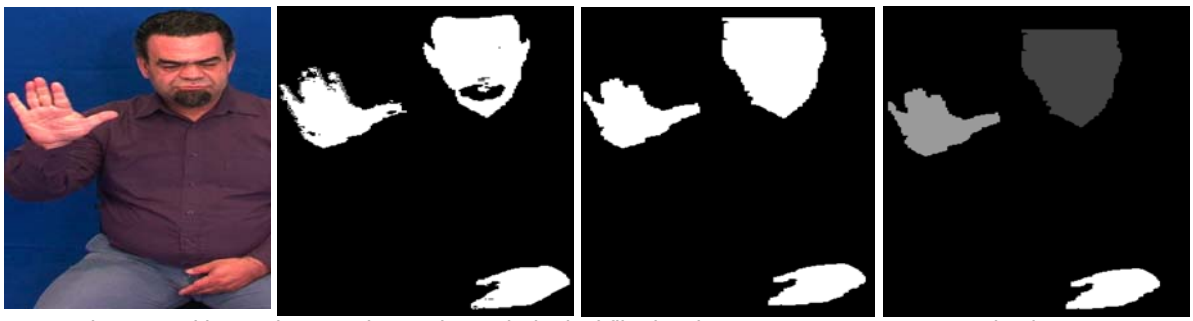


Figure 2: Skin mask extraction and morphological filtering (DICTA-SIGN corpus: GSL data)

Most of the work in Sign Synthesis and Animation during the past year related to work that has resulted in enhancements to the JASigning synthetic animation

system. Over and above those enhancements, several significant "maintenance" enhancements have been made to the JASigning system, including:

- More robust handling of errors in SiGML input,
- Support for 64-bit operation on both Windows and Mac OS X systems whose hardware permits this.
- More robust security configuration, in response to changes in the security requirements of the underlying Java platform on which the system depends,
- More flexible support for JASigning applets in HTML pages.

An additional development is the recent incorporation into the JASigning system, and the supporting ARP toolkit of a capability for ambient motion when the avatar is idle, and (if desired) as an overlay to signed animation.

The synthetic animation system is more explicitly organised internally, and presented externally, as a low-level animation system, with a range of capabilities extended to meet already identified and foreseeable requirements, together with notational mechanisms allowing higher-level models of sign language articulation and performance to be mapped down to the lower level thus extended.

DICTA-SIGN foresees a linguistic model for Sign Languages, that includes both a lexicon and a grammar model and it is intended to be used for both sign recognition and sign synthesis purposes. The definition of the lexicon model has been completed, taking into account the different representation models used by the project partners, while the proposed grammar model has made initial use of available annotated parts of the DICTA-SIGN parallel corpus in LSF, DGS and GSL.

In the framework of linguistic modelling, also the study of an annotation structure has been completed, which is currently used in manual data annotation for the investigation of sign language specific linguistic phenomena.

Moreover, a study has been carried out on depicting signs and signing space, while for LSF the design of a formal representation linked with Zebedee formalism has also started.

The specification of a complete data model for annotation of SL has been completed. We proposed a data description model, coupled with representation standards: XML-schema (W3C) Annotation Graph and IMDI (Max Planck Institute), allowing the exchange of annotation data between the different types of software used by the project partners. Currently, using this data model, we are working on the description of annotation data of the signing space annotation tool (VIES) and of the AnColin annotation environment. In respect to video annotation tools, the relevant API has been specified and a set of indicative solutions (a set of programs/source codes) are now available on the project website for A3, A3S and simple client.

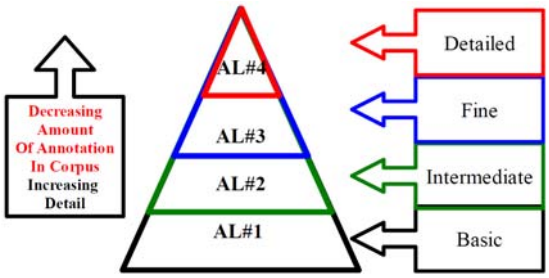


Figure 3: Annotation Levels from Coarse to Fine detail.

Regarding creation of Sign Language resources necessary to the project, the major goal of creation of a parallel corpus for the four sign languages of the project has

been achieved. Data capturing was designed and executed by means of common elicitation material and under same studio conditions in all cases. The most crucial success factor has been considered the complete elimination of environment spoken language interference. In the same period also the project's multilingual basic vocabulary of 1.000 lemmas per language has been assimilated and transcribed according to the HamNoSys notation system.

Finally, at the beginning of the second year of the project, work has started on the project's systems integration. This is essentially about combining elements from the different technological workpackages, to ensure compatibility of the various tools and systems employed. The three tasks that generate integrated applications are the ones relating to the project's prototypes, namely the Search-by-Example in Lexicon task, the Sign Language Translation task, and the Sign-Wiki task.

PROJECT APPLICATIONS & USER INVOLVEMENT

Project Applications

DICTA-SIGN is expected to result in three proof-of-concept end user applications: a sign language-to-sign language terminology translator, a search-by-example tool, and a sign language Wiki. In the second project year, work has focused on the search-by-example tool and the progress made has allowed the optimism that the more ambitious sign-Wiki prototype could undertake the role of the project demonstrator. Aside from these applications, advances in the field are also expected to push major improvements to research and annotation tools.

Sign language-to-sign language terminology translator

Just like spoken languages, national signed languages differ from one another, and create communication barriers between deaf people of different nationalities. At the same time, European integration requires more and more communication across national boundaries.

Therefore, it is expected that an SL-to-SL (sign language to sign language) translator will be useful in similar situations where web-based translators are useful. It will be domain-specific, on the topic of travel, and make use of a controlled vocabulary of around 1500 signs. The input will be the results of the sign language recognizer, as well as annotated video, and the output will consist of avatar-based animations in the target language.

Search-by-example tool

Current lexical databases and dictionaries for sign language allow the user to search for signs by using another (written) language or by constraining some descriptive parameters. Both approaches require knowledge that cannot generally be assumed; especially in sign language learners who do not yet have a strong grasp of the parameters that make up a sign. A more promising alternative consists of having the user perform the sign in question in front of a camera.

A search-by-example system will integrate sign recognition for isolated signs with interfaces for searching an existing lexical database. Aside from the obvious utility to sign language learners, this prototype will also showcase the technology behind dictation characteristics of the user interface, where multiple alternatives are shown if a sign cannot be recognized reliably, as computationally this case is very similar to a learner performing a sign with minor errors in form.

The baseline version of the Search-by-Example demonstrator has already been developed and demo videos were put on U-tube:
(http://www.youtube.com/watch?v=_xzhWs6Yx8s)

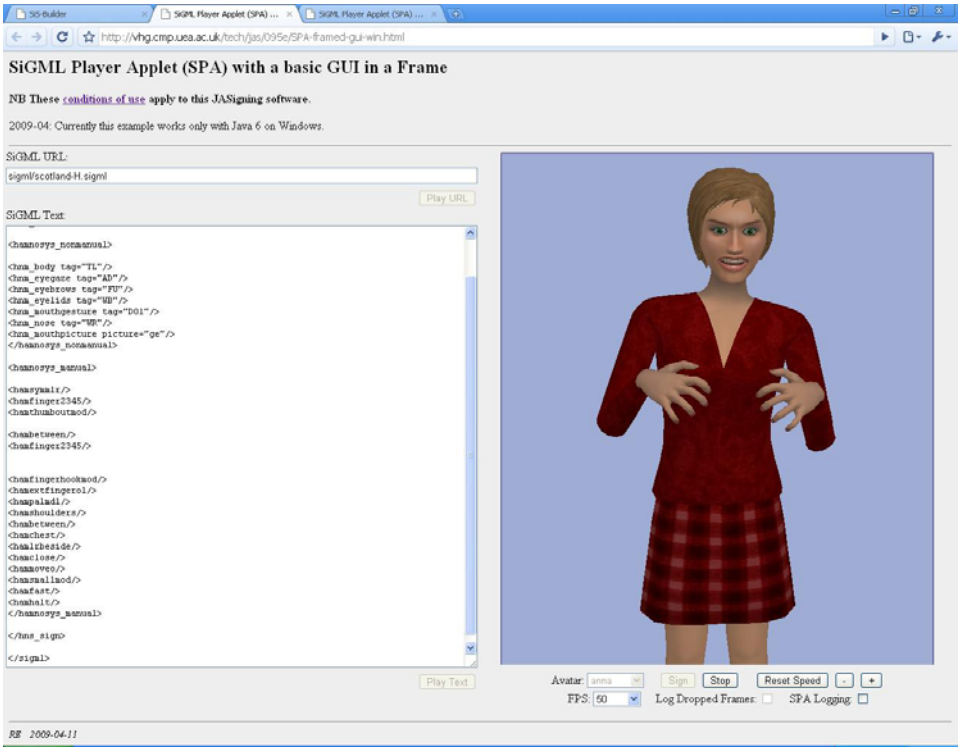


Figure 4: Sign language animation environment

Sign language Wiki

A major requirement of contemporary Web 2.0 applications is that user contributions are editable by an entire community. The oldest, and most popular, application of this type is a Wiki, where any contribution can be edited and refined, anonymously if so wished, by someone else. As the success of Wikipedia and related sites show, this type of community collaboration results in a rapid amassing of knowledge.

There is no doubt that sign language users could benefit similarly from collaborative editing. A server will be developed providing the same service as a traditional Wiki, but using sign language. Instead of using text as the output medium, a signing avatar presents information. The use of an avatar preserves the anonymity of the user, and facilitates modification and reuse of information present on the site.

The system acts as a dictation machine using sign, providing recording, playback, and editing. A user can put information onto the server using sign language by means of a web cam, or a video that is uploaded to the server. The system then analyzes the images and extracts key sign components, which are then used to generate the movements of the signing avatar. If the system interprets the sign language sentence badly, the user can correct it either by repeating only the erroneous part (for example the handshape, or facial expression).

This prototype will specifically showcase the integration of all major components of the project. At the same time, it will also demonstrate a Web 2.0 application that is accessible to the Deaf from the beginning to end.

User Involvements & Evaluation

It is a major concern of DICTA-SIGN that project results reach the Deaf Communities of the partner countries and also that Deaf users are actively involved in evaluation of all project's applications. According to schedule, familiarisation events with the project's national deaf communities have started being organised.

DICTA-SIGN and its outcomes were presented to the wider Deaf community through various dissemination actions. With regards user evaluation of the project prototypes during development, a formal user evaluation is foreseen to follow the delivery of each prototype. This activity will take part during the third project year.

Approval of the different technological achievements by the Deaf communities in the partner countries will be further ensured by user evaluation procedures which complement the formal user evaluation to be conducted in the framework of the project activities.

DISSEMINATION and FUTURE EXPLOITATION PROSPECTS

Dissemination Strategy

DICTA-SIGN web site

The DICTA-SIGN website (www.dictasign.eu) is the project's main communication tool. It contains multilingual material (written form of oral language and SL videos) that reflects the project's aims, research progress and scientific impact. This is the place where all information related to DICTA-SIGN is stored and made accessible to the Internet sharing community.

Currently the home page provides project descriptions in the eight languages of the project (English, French, German, Greek, BSL, DGS, GSL and LSF) and access to various pieces of information such as the publicly available project deliverables, the project's publications list, questionnaires targeting the interest of the sign language research community, as well as news and events organised by the DICTA-SIGN consortium.

The DICTA-SIGN website presents considerable visibility with a yearly average of 2.300 distinct visitors, and 9.800 visits.

Dissemination to the scientific community and the industry

Dissemination to scientific community is based on bilateral exchange of information with major scientific institutions as well as communication of project achievements in conferences and through publications. The DICTA-SIGN project covers a broad scientific spectrum of inter-relating sign languages technologies and linguistic study that will promote Deaf accessibility in the environment of human-computer interaction (HCI) applications.

Dissemination of DICTA-SIGN knowledge at the scientific community is done with presentation of research methodologies, strategies and outcomes in conferences interested by this topic and with articles in scientific journals.

As regards project news, views and findings, they will also be reported and posted to international online science and technology portals such as Scidev.net, AlphaGalileo.org, EurActiv.com and Ascribe.org.

Promotion of the project's innovative technologies takes place in the framework of national and international conferences, exhibitions and scientific events most attractive to the industry.

Figure 5: DICTA-SIGN home page in German & DGS

Dissemination to support organisations

During the second project year, Dicta-Sign continued contact with all industrial and academic organizations which have expressed their interest in Dicta-Sign ideas and their support to the project.

All project support organisations were invited to join the LREC Conference and the 4th Workshop on Representation and Processing of Sign Languages: Corpora and Sign Language Technologies.

Popularisation events and Dissemination to Deaf Communities

The DICTA-SIGN partners have already made initial presentation of the project to Deaf community in a number of occasions. Early in 2011, also the achievements of the first two years started being presented to the deaf community.

The first such event took take place at IRIT 26 January 2011, organised by WebSourd and UPS, in order to collect feedback for interface design and potential applications, but also aiming at recruitment of volunteers for an extended evaluation

of the project's prototypes, as well as creation and testing of a set of visual communication aids of general dissemination use by all consortium partners.

A private page of DICTA-SIGN website is currently gathering the list of the organisations which represent the European Deaf communities, with the aim to distribute a newsletter to these organizations as soon as the evaluation of the first prototype will be completed.

The project leaflet and logo are becoming familiar to the majority of Deaf communities members in the project countries.

Dissemination in view of future exploitation

DICTA-SIGN will lead to new knowledge with direct impact on the development of several tools, including tools for sign recognition, tools for image processing, tools for sign synthesis, tools for annotation and editors of linguistic models (lexicon, grammar, signing space) as well as the project's demonstration showcase and laboratory prototypes. The set of showcase and laboratory prototypes will be presented to industry in scientific events complemented with exhibitions and will also be put at the disposal of the project support organisations and the Deaf community.

The prototypes will be used by deaf people to test their usability but also to facilitate the emergence of new practices (access to information in sign language, generation in sign language) and thus to create new requirements in term of applications (tools usable by general public) and in the field of scientific research.

With regards opportunities to involve/liaise with industrial players in the field, the consortium will utilize all their links towards this end.

In this direction, WebSourd has created several pages on its website, which present the DICTA-SIGN project and which will be periodically updated to reflect the project evolution. These pages -available at http://www.websourd-entreprise.fr/spip.php?article121- are placed within the industrial section of the company's website in order to specifically address the industrial community.

Scientific dissemination activity of the project team in the period February 2010 to January 2011

Participation in refereed International Conferences and Workshops

The DICTA-SIGN consortium has a considerable presence in international conferences and workshops of high reputation. During the second project year, the consortium participated to a number of international refereed conferences and workshops with 39 papers, two workshop proceedings volumes and 6 invited talks. In all the DICTA-SIGN consortium participated in the following events:

- International Conference on Acoustics, Speech and Signal Processing (ICASSP-2010), Dallas, Texas, USA, March 2010
- LREC-2010
- 4th Workshop on "Representation and Processing of Sign Languages: Corpora and Sign Language Technologies", satellite workshop to LREC-2010
- International Conference ECCV 2010, Crete, September 2010
- "Workshop on Sign, Gesture and Activity" Satellite workshop of the ECCV 2010

- The SLCN Workshop 3: *"Annotation",* Stockholm, Sweden, 14-16 June 2010.009
- The SLCN Workshop 4: *"Exploitation and publication of signed corpora",* Berlin, Germany, 3-4 December, 2010
- International Conference on Image Processing, November 2010.
- International Workshop on Sign Language Translation and Avatar Technology. Berlin, 10-11 Januar 2011.
- Traitement Automatique des Langues Naturelles (TALN), Montréal, Canada, 20-23 July.
- Traitement Automatique des Langues des Signes (TALS) , Montréal, Canada, 20-23 July.

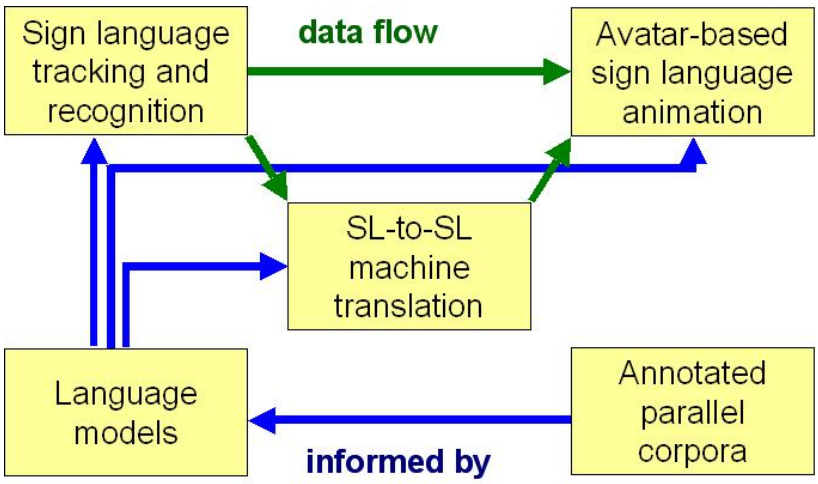
COLLABORATION

Collaboration between consortium members

The consortium was formed on the basis of a long tradition of academic contacts among most of the partners. The working groups in DICTA-SIGN are formed on the basis of laboratory expertise and specific project implementation needs.
In the current state of the project, 6 working groups are active:

- The Sign Language Recognition Group,
- The Sign Synthesis and Animation Group,
- The Grammar Modelling Group,
- The Annotation Tools Group and
- The Parallel Corpora Group

Synergies among the working groups serve the project architecture, depicted in the following diagram:



Clustering activities

DICTA-SIGN partners participate in various activities of knowledge sharing within their domains of expertise.

ILSP and UHH participate in the Sign Linguistics Corpora Network (SLCN) http://www.ru.nl/slcn/, which has organised 2 workshops within 2010:

The 3rd SLCN workshop was dedicated to corpus annotation (University of Stockholm, Sweden, 14-16 June 2010).

The 4th SLCN workshop was dedicated to exploitation and publication of signed corpora (Berlin, Germany, 3-4 December, 2010).

Besides invited presentations, DICTA-SIGN partners presented a number of contributions at both 2010 SLCN workshops.

Furthermore, a joint workshop in the framework of a renowned conference (LREC-2010) has hosted discussions and exchange of scientific advances and achieved goals with other research teams/projects in the areas of sign language corpus linguistics and sign language technologies, including the SignSpeak (www.signspeak.eu) project in the framework of fruitful clustering activity between the two projects.

In the same line, a joint workshop was organised by partners of the two projects as a satellite workshop of the 11th European Conference on Computer Vision, focusing on issues of sign and gesture recognition.

Events (co-)organized by DICTA-SIGN partners during project year-2

Fourth Workshop on the Representation and Processing of Sign Languages: Corpora and Sign Language Technologies, in the framework of **LREC-2010**, The seventh international conference on Language Resources and Evaluation (LREC): http://www.lrec-conf.org/lrec2010/

Workshop on Sign, Gesture and Activity, satellite workshop of the 11th European Conference on Computer Vision (**ECCV 2010**):

http://personal.ee.surrey.ac.uk/Personal/R.Bowden/SGA2010/

International Workshop on Sign Language Translation and Avatar Technology. Berlin, 10-11 January 2011.

http://embots.dfki.de/SLTAT/

Forthcoming event organized by DICTA-SIGN partners

GW2011: The 9th International Gesture Workshop "Gesture in Embodied Communication and Human-Computer Interaction", May 25-27, 2011, Athens, Greece: http://access.uoa.gr/gw2011

USEFUL LINKS

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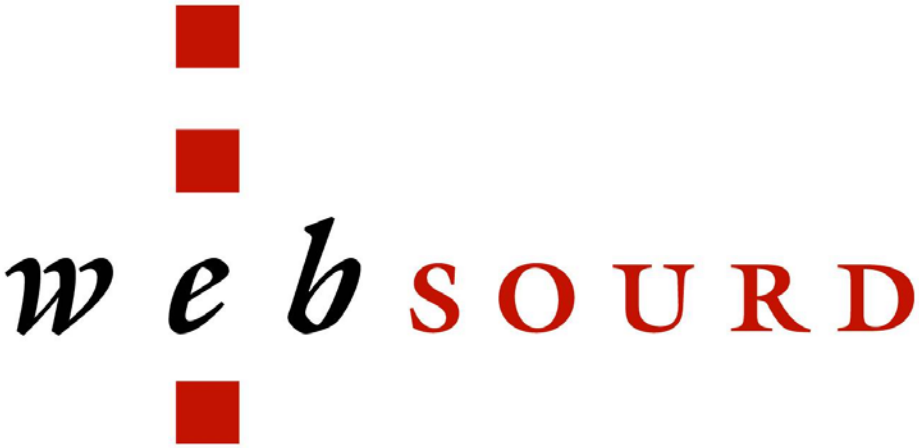

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