

SignMatch: find the meaning of an approximate sign

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Date: 16/12/2010

Abstract: The aim of the project is the development of search tools in the dictionary of sign language on the specifics of signs execution the user is not exactly remember. A distinctive feature of this search method is not search accuracy but its completeness. For example, as a result of one query can be selected gestures that have the same shapes of the hands, but different directions of movement or hand position. The project results can be useful not only for the benefit of teaching sign language, but also for linguistic studies of the language.

Project objectives

A disadvantage of known dictionaries of sign language is the inability to find the sign by its image (still or movie), the search is carried out only by sign names. This makes it difficult for the student develop skills in translation from sign language to verbal, especially that between the words and gestures are often no one-to-one correspondence, one sign can be transmitted not only a word, but a combination of words, and sometimes a whole phrase.

In recent years, methods for gesture recognition are actively developed. In general, the system recognizes physical gestures of a human and reacts in accordance with the interpretation of gestures. It can be used in computer interfaces for interpreting signs (for example, in multytouch systems), in the management of industrial or recreational applications, or for various other purposes. In these applications accurate recognition of gestures is required.

However, such gesture recognition systems, useful for pre-indexing of stored data can not be used for entering search queries in the process of learning sign language, especially when the learner wants to know the meaning of gesture unknown to him that he had seen early, but the execution of which he remembers is not exactly. Error in the handshape, inaccurate localization will lead to the desired gesture will not be found in the dictionary. Thus, if the main requirement of the gesture recognition systems is the accuracy search in the library of etalons, more important characteristic of the system for teaching sign language is the completeness of search, providing search of signs that are sufficiently close, but not always coincident with the student's description.

The project objective is to provide the search in the dictionary of sign language based on a rough description of sign. Description of the manner of execution of sign may include, for example, an indication of one or more handshapes and/or an indication of one or more positions of the hands in space relative to the torso, as well as other parameters such as direction of hand movement, traffic, etc.

The result of the project learner will have the opportunity to find the proper sign of sign language for a rough description that includes, for example, an indication of the values of positions and shapes of hands regardless of the order of execution and the exact correspondence of position and shape. This corresponds to the case when the user does not know exactly how to perform the desired sign. It provides the opportunity to find gestures corresponding to all of these student's options or to some of these options. The student will be have an opportunity to not only to see all the features of found gestures, but also to read the comments explaining the semantic meaning of concepts transmitted by signs, as well as other explanations that facilitate the learning of sign language.

The method can be used not only for training purposes: to introduce the student with the meanings of signs having these or other variants collected in the dictionary of sign language, but also for studies of sign language, for example, grouping and classification of gestures, performed in a particular area of space or containing a certain shape of hands. Also it provides an opportunity to sample from the dictionary signs having some grammatical meaning in sign language. For example, if the parameters of selection are the directions of movement of the hands, the gestures can be retrieved from the dictionary that act as verbs of verbal language. This opens new possibilities for linguistic analysis of sign language of the deaf.

Background information

One of the problems of self-education is the search for explanations of new knowledge. This problem manifests itself particularly clear when referring to information provided by different modalities. After hearing a new word, we are looking for his interpretation in the dictionary, hoping that we can guess how to spell that word based on the auditory image. But a person who saw the unknown gesture of sign language of deaf (http://en.wikipedia.org/wiki/Hand_signs) and wants to know its meaning have an even greater problem when there is no an adviser who could explain the meaning of this gesture.

A disadvantage of known dictionaries of sign language is that the search of gestures carried out only by their names. To solve the problem described above requires that the dictionary will be searched for images of gestures.

To retrieve graphical objects from a database they must be properly indexed. This method is known for a long time, see eg *Patent US5867150 (A), published 02.02.1999, «Graphic indexing system»*.

In the *Chinese Patent CN101577062 (A), published 11.11.2009, «Space encoding-based method for realizing interconversion between sign language motion information and text message»* a method for searching in the dictionary of sign language is described. Parameters of search are the handshapes perceived by special glove and the location of hands. Here, however, does not take into account that the beginner in learning sign language may specify the handshape not accurately. In addition, this system is focused on exact search of the sign and can not simultaneously displays signs with the same parameters, but with differences in performance. This phenomenon is observed for sign language gestures recorded at various areas. For example, a Russian sign language gesture "month" in the dictionary created in St. Petersburg is recorded in variant when the arm moves from the forehead to the nose, but in dictionaries created in Moscow - when the arm moves from chin to forehead, while in both variants the handshapes are the same.

Near to the described problem is posed in *Japanese Patent JP11250063 (A), published 17.09.1999, «Retrieval device and method therefor»*: Find a word in a foreign language dictionary when a user request formed by pronunciation of the word, even if some parts of pronunciation are lost or distorted.

For general information about databases (DB) and references see <http://en.wikipedia.org/wiki/Databank>.

Post-relational databases represent a particular interest to this problem, eg such as ADABAS (<http://en.wikipedia.org/wiki/ADABAS>, represents an interesting example of post-relational database, developed before the advent of relational databases), and methods for maintaining of denormalization (<http://en.wikipedia.org/wiki/Denormalization>), especially *multivalued fields* (or multiple fields).

Multivalued fields are useful to describe many phenomena of reality and are used in different databases, including those usually attributable to the relational. As a reference example is the treatment of multiple fields in MS Access 2007 (<http://office.microsoft.com/en-us/access-help/guide-to-multivalued-fields-HA001233722.aspx>). In relational databases multiple fields can be simulated by using a separate tables related to the main table. For processing information stored in these tables, you can use the procedure language SQL (<http://en.wikipedia.org/wiki/SQL>).

Detailed technical description:

Technical description

Russian Sign Language Explanatory Dictionary RuSLED includes functions of explanatory dictionary as for entered word, so and for gesture representation. On input of dictionary any form of word can be entered, and at the output variants of gesture interpretation of given lexeme are shown.

Dictionary contains 2537 words (with interpretations of their meanings) and 2343 video images of gestures (including variants of the sign) which represent meanings of the words. For 1592 gestures (68% from total number in dictionary) additional explanatory, concerning to manner of execution of gesture or describing semantic nuances are given.

Separate input of dictionary (separate recording in table of database) is used for everyone semantic value of lexeme (and gesture). This dictionary feature is very convenient for user, and is recommended by lexicographers.

Now the dictionary added the search of gesture image, which includes a hand shape (up to several meanings for one gesture) and the position of the hands (also multiple values). To implement this search function we index now the dictionary. The indexing is scheduled to finish at the seminar.

We would like to discuss and create the optimal interface for using several indices, as well as the interface for using the dictionary as a tool for lexicographer which working with sign language.

In addition, we would like to discuss and create a prototype of the search for the gestures presented in the form of control scenarios for virtual characters. Notation HamNoSys can be used, for example, as these scenarios.

Since the task of finding words in a dictionary on the user's pronunciation is close to our problem of gesture searching, it would be interesting to experimentally verify the applicability of our proposed method in the first problem. However, since we have not worked previously in the field of speech recognition, this work can be done only if interest of other participants more experienced in this field will be showed.

Resources needed:

Facility: room for 5+ working participants

Equipment: a PC for each participant – **bring your own laptops!**

Software: Multimedia Dictionary of Russian sign language will be provided to all participants of the project free of charge, relational database management system (we recommend MS Office Access, because it has a convenient graphical user interface) provided by the project participants themselves. Software for recognition and transcription of speech - provided by participants with an interest in this part of the work.

Staff: See **Profile of Team**

Project management

The project leader is responsible for the global project management. After the splitting up in teams, one on the team will be appointed as team leader for the management within that team.

Two times a week there will be a progress&plans meeting, during which the schedule can be adjusted and new plans can be made if required by new developments.

Work plan and implementation schedule

Preparation

Due to the restricted duration of the workshop, there is some preliminary work to be done before the official start. Participants are expected to read recommended literature, and already think about the group they would prefer to be in. The software will also be available in advance, so participants can already try to set it up. Short tutorials will be made available to give everybody an easy start. The protocol and questionnaires for the main experiment will also be developed in advance, as far as possible.

Workshop schedule

	Everybody	Avatar&Notation group	Speech recognition group
Week 1	Kick-off meeting: split into groups. Setting up computers with the necessary software	Formulation of the problem and discuss the possibility of its realization	Formulation of the problem and discuss the possibility of its realization
Week 2	Indexing dictionary. Experimentation and development of prototype	Experimentation and development of prototype. Discussion of current results. Assessment of continuing work. Make the necessary changes	Experimentation and development of prototype. Discussion of current results. Assessment of continuing work. Make the necessary changes
Week 3	Indexing dictionary. Experimentation and development of prototype	Depends on the previous results	Depends on the previous results
Week 4	Demonstrate prototypes. Discussion of results. Review meeting: discuss future work and cooperation		

Benefits of the research:

The aim of this project is to implement "fuzzy" search of signs images in the dictionary, which is a relational database. Here "the fuzzy search" means a way to expand the query and, consequently, the completeness of search. It allows you to find images of gestures, not only exact matches to the user search query, but others that have the attributes described in the request.

This allows you to:

- correct inaccurate user request;
- find the meaning of the gesture, the execution of which the student remembers inaccurately;
- classify gestures in parameters of their performance.

Thus, there are new opportunities in learning sign language and study its features.

Software packages: Multimedia Dictionary of Russian sign language (MS Access 2003 application used as tool for designing and debugging) will be provided free to all participants of the project. As a project result, all participants will have an indexed version of the dictionary, from which they can build their own training manuals and tools, converting solutions using various tools and programming languages (eg, using MS Visual Studio).

Profile of team:

Principal Investigator

Alexander Voskresenskiy got an engineering degree (= MS) in Electrical Engineering and Mechanics in 1971 at the Moscow Electrotechnical Institute of Communications (now the Moscow Technical University of Communications and Informatics). For several years he worked on projects for automation of technological processes in the major sites of postal services, has 8 inventor's certificates in this field. Revolutionary changes in Russia in the late 80's - early 90's led to a temporary decline in the area, prompting the A. Voskresenskiy to change the profile of his work and to abandon the prepared Ph.D. thesis which has lost relevance. In 1989 - 90 years, he developed a software package for calculating labor costs and production costs in diversified production, which was used in the industry until 1993 when there was a collapse of major industries in Russia. Since 1993 he has worked in education. Since 1997 – at a school for deaf children. In 2003, he received degree (= MS) in Education with the right to manage the implementation of ICT in education. In 2007 - 2008's, he lectured at the College of Management, Law and Informatics of Moscow University of Economics, Statistics and Informatics (MESI).

In 2001, a reference to his work was included in the list of developments for people with special needs of the UNESCO Institute of Information Technology in Education (the first and only Russia's contribution to these resources). In 2004 he received the Medal of J. Korczak for winning the Russian contest "Pedagogical Innovations". In 2005, he received a diploma and an award for winning the contest "Russian Innovations". Participant of project ELSNET-2 of IST programme (5th Framework Programme). Participated in the INTEL Corporation (with support from Microsoft) program "Education for the Future". Member of the National Association of Innovation and development of information technologies (NAIRIT) and the Russian Association of Artificial Intelligence. He has more than 50 publications, mainly in Russian. He currently works as an independent researcher, led the informal research team.

Proposed Staff

Two under graduated students of Moscow University of Economics, Statistics and Informatics (MESI) and two under graduated students of The Moscow State University of Psychology and Education (MSUPE), Faculty of Informational Technologies. Specific candidates are currently selected.

Other researchers needed

Experts in the field of ontologies, computational linguistics, speech recognition and image recognition. Specialists (perhaps senior students) who have experience in programming (C++, Java) objects of virtual reality, virtual characters.

References:

In these references are quite extensive literature indexes:

http://en.wikipedia.org/wiki/Hand_signs

<http://en.wikipedia.org/wiki/Databank>

<http://en.wikipedia.org/wiki/ADABAS>

<http://en.wikipedia.org/wiki/Denormalization>

<http://office.microsoft.com/en-us/access-help/guide-to-multivalued-fields-HA001233722.aspx>

<http://en.wikipedia.org/wiki/SQL>

Additionally:

Graphic indexing system, Patent US5867150 (A), published 02.02.1999.

Retrieval device and method therefor, Patent JP11250063 (A), published 17.09.1999.

Space encoding-based method for realizing interconversion between sign language motion information and text message, Patent CN101577062 (A), published 11.11.2009.

Other information:

We present an informal group consisting of specialists in various fields. The study of sign language and its comparison with the verbal language is interesting for us not only because we hope to get the means to facilitate communication between deaf and hearing people, to enable for deaf people a better understanding of verbal language to gain access to quality education. We believe that a comparison of sign and verbal language allows you to better understand the mechanisms of transmission of meaning in the statements, to find ways to solve the problem of understanding speech by computer. This is necessary not only for the problem of sign language translation, but also for other problems of machine translation, as well as in constructing the Semantic Web, see, for example:

Majumdar, A., J. Sowa, and J. Stewart. *Pursuing the Goal of Language Understanding*. Proceedings of the 16th ICCS / P. Eklund and O. Hammerlé, eds. LNAI 5113, Berlin: Springer, 2008, pp. 21-42.

Some of our results in this direction see, for example:

Voskresenskij, A. *Text Disambiguation by Educable AI System*. // The First Conference on Artificial General Intelligence / P. Wang et al. (Eds.). Amsterdam: IOS Press, 2008. - P. 350 - 361.

Alexander Voskresenskiy and Sergey Ilyin. *About Recognition of Sign Language Gestures*. // Abstracts of 4th Workshop on Corpora and Sign Language Technologies / Seventh International Conference on Language Resources and Evaluation. LREC 2010 Satellite Workshops, May 17-18 & May 22-23, 2010, Mediterranean Conference Centre, Valetta, Malta. - P. 97.

Full text of the paper:

<http://www.lrec-conf.org/proceedings/lrec2010/workshops/W13.pdf> - P. 247 - 250.