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Development of Indian Sign Language Dictionary using Synthetic Animations

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Abstract

Objective: Development of Indian Sign Language video dictionary is essential in the today's world of computerization. Though a lot of human video sign language dictionaries are available, we aim to develop the Indian Sign Language dictionary using synthetic animation which uses the computer generated cartoon rather than real human. **Methods/Statistical Analysis:** Sign Language cannot be spoken or written unlike other languages like English, Punjabi, Hindi, etc. The most commonly used words in Indian Sign Language are categorized and then these words are converted into the sign language writing notation (HamNoSys - Hamburg Notation System). This HamNoSys notation is then converted into SiGML (Signing Gesture Markup Language) using which the synthetic animation (using a computer generated cartoon) of the sign is generated. **Findings:** The synthetic animations are better as compared to human videos in terms of memory consumption, standardization, and flexibility. Synthetic animations can be modified as per the requirement whereas the human videos cannot be modified. The only drawback that seem is, these synthetic animations may lack the natural non-manual component of sign. **Applications/Improvements:** The synthetic dictionary created in this work can be used for translation system in which spoken or written sentence can be converted into the sign language animation. The dictionary created can be used to education to hard of hearing people. Display boards can be created for displaying the important messages in Indian sign language at the public gathering.

Keywords: HamNoSys, Machine Translation System, Natural Language Processing, Sign Language, SiGML

1. Introduction

Sign Language is visual-spatial language which is used as the communication medium by hard of hearing people to convey their thoughts. Using sign language, communication is done using hands, arms, face, and head and body postures irrespective of speech in spoken languages. The signer uses 3D space around his body to describe the event. Despite the misconception, sign language is a complete natural language which has its own grammar rules though the grammar rules are not well defined. Even the sign language is not common universally, it varies region to region.

There are approximately 7105 known living languages in the world divided in 136 different language families. Sign language is one of these 136 families which are used by deaf and hard of hearing people to convey their message. This family of the language contains 136 sign languages all over the world depending upon the region of the world[1]. In India, sign language is known as Indian Sign Language (ISL). It is argued that the same sign language is used in nearby countries like Nepal, Sri Lanka, Bangladesh, Pakistan[2]. Out of nearly 6.7 billion people on earth, nearly 72 million are deaf and hard of hearing. Out of such a big number, approximately 4.8 million (6.7%) people use Sign Language. Rest of nearly 67 million (93.3%) deaf and hard of hearing people do not use any proper sign language to communicate. Thus, nearly 90% deaf have a very limited or no access to education and other information[3]. In India, situation

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is worse as there are approximately 5.07 million people who suffer from hearing disability. Among them, more than 30% people are below 20 years of age and about 50% are between 20 years and 60 years of age[4]. These people are generally unable to speak properly because of which they use sign language to communicate with others. As sign languages do not have well defined structure or grammar, therefore there is no or very less acceptability of these signs outside the small world of these differently abled people. In[5] research on American Sign Language proved that sign language is a full-fledged language with its own grammar, its own syntax, and other linguistic attributes[5]. To prove the same for other sign languages, there are some efforts including Indian Sign Language[6]. Particularly, research on ISL started in 1978 and it is found that ISL is a complete natural language with its own grammar and syntax. Communication for the hearing impaired people in common places like railway stations, bus stands, banks, hospitals etc., is very difficult because a hearing person may not understand the sign language used by the deaf person to communicate. Also, a hearing person cannot convey any message to deaf person as he/she may not know the sign language. To make the communication between deaf and non-deaf community, the language translation is must. For any language translation system, the most important requirement is bilingual dictionary. In case of English to Indian sign language, a dictionary of 1000 signs was released in which signs are the graphical icons[7]. Such a static dictionary lacks the phonological features like movements and facial expressions. Because of its limitation, it becomes hard to understand the signs. So, there is a need to create an animated dictionary which can relate each spoken word to animated sign.

Two types of animations can be produced:

- Each spoken word is associated with video (natural human producing the sign).
- Each spoken word is associated with synthetic animation (a computer generated character producing the sign).

Among these two approaches, the synthetic animations are much better for its benefits in symmetric representations of the signs and a little memory usage as compared to real human videos. A lot of work has been done in building the dictionary of sign language but most of the work has been done with real human videos. A little work has been carried out with synthetic animation of signs.

2. Facts about Sign Language

Sign language is natural language which has some facts with which the people are not aware off. Some of the facts of the sign language are:

- Sign language is not same all over the world.
- Sign languages have their own grammar though the grammar is not standardized.
- Have much smaller dictionary than the other spoken natural languages.
- Finger-spelling for the unknown words.
- Words may be joined e.g., to represent dinner, one might show the sign of Night and then Food.
- Most of the sign languages put the adjective after the noun e.g., Car Red.
- Never use am/is/are/was/were/(linking verbs).
- Never use word-endings/suffixes/prefixes.
- Always sign in the Present Tense.
- Do not use articles. (a, an, some, the).
- Do not use I, but uses me.
- WH-questions are at the END e.g., "You go where?"
- Have no gerunds. (-ing).
- Use non-manual expressions as well e.g., use of eye brows, eye lids, facial expressions, head and shoulders movement.
- NOT been invented by hearing people.

3. Sign Language Dictionaries

A lot of work has been done in dictionary implementation of sign language worldwide. Dictionaries have been created in the form of books which is obsolete today in the age of computerization and digitization. Video dictionaries are available for sign languages of many countries like America, Britain, Italy, and even India. These video dictionaries can be categorized as real character (human being) producing the sign or computer generated animated character (avatar). No Indian sign language dictionary is available which uses computer generated character (avatar) technology though an initiative was taken to develop a tool for Indian sign language[8].

- In January 1999, the Ramakrishna Mission collaborated with CBM International, Germany for a project on

sign language dictionary. The goal for the project was to standardize Indian Sign Language. On November 24, 2001 the first Indian Sign Language dictionary was released which contains over 2500 signs from 42 cities in 12 States to provide a common sign language code all over India[9]. The signs in this online dictionary are videos of real human.

- **Spread the Sign**, an international project by Leonardo da Vinci supported by the European Commission through the Swedish International Program Office of Education and Training. The goal of this project is to share various sign languages from different countries over the internet. The drawback of this work is that it has videos for the words rather than animations which take a long time to load as compared to synthetic animations[10].
- **Hands peak** created by in[11] American Sign Language dictionary. The dictionary is released on the domain handspeak.com in 2000. The website contains the ASL signs, some variants of ASL signs, some verb inflections, and more, produced and signed by native ASL bilinguals.
- **Sign Smith**[12] is a 3D illustrated dictionary of ASL. It is used as educational software for the hearing impaired people of America. It is also an authoring tool to create ASL content.
- In[13] developed a multimedia ASL dictionary tool, which prerecorded digital video frames.

4. Sign Language Notations

Sign language is visual spatial language which cannot be written or spoken. But, for the dictionary implementation using avatar, a written form of each sign is necessary. The written form/notation of sign is useful in sign language translation. Researchers have suggested various writing notations for the signs.

4.1 Stokoe Notation[13]

William Stokoe as a scholar at Gallaudet University developed a method of writing American Sign Language (ASL). In 1965, he published a dictionary for sign language of America. He developed a writing system for the signs using some characters for hand location, hand shape and hand movement. The writing system was for manual signs and no written form for non-manual features were included. Also, it was not meant for writing full sentences. Each sign is written in sequence, the location of hand, shape of hand, and movement of hand.

4.2 Sign Writing

Sign Writing is the writing notation of the signs which was developed in 1974 by a dancer named Valerie Sutton. This notation is visually iconic as the shape of characters is like pictures of hands, body, face. The notation is capable to write manual as well as non-manual signs. The characters used for this notation are Unicode characters.

4.3 Hamburg Notation System (HamNoSys)

In 1984, a group of researchers at the University of Hamburg developed a system for writing signed languages. The Hamburg Notation System (HamNoSys) is a phonetically based notation system that was developed by in[14]. This system, like most other representation systems, was initially handwritten, but a machine readable Unicode is available from the University of Hamburg. An XML encoding of HamNoSys called Signing Gesture Markup Language (SiGML) is also available. It was developed for the ViSiCast project by in[15]. Ham No Sys is the writing notation to write any sign language. Along with manual signs, non-manual signs can also be written using this notation system.

5. Results and Discussion

For creation of bilingual dictionary of English to Sign Language, following flow chart is used, Figure 1.

To implement the dictionary, writing notation for the sign language, HamNoSys (Hamburg Notation System) is used. This notation system is widely used for writing

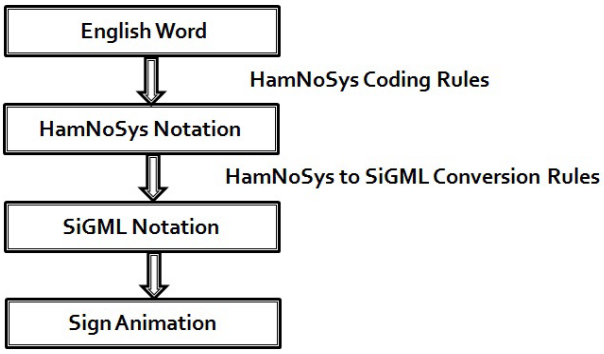

Figure 1. Architecture to produce the animation from English word.

the sign worldwide as it can express the manual as well as non-manual signs. An XML encoding of HamNoSys known as SiGML (Signing Gesture Markup Language) is used to produce the animation of the sign. For converting the HamNoSys to SiGML, a third party tool, e Sign Editor has been used. This SiGML code is required to be sent to SiGML player that produce the animations of sign. Sign language has a limited word list that is used for communication by hard of hearing people. A list of most commonly used 1818 words is taken for dictionary. These are the words which are most commonly used in the form of sign by deaf community during their communication. All the words are categorized as verbs, adjectives, nouns, pronouns, prepositions, interrogatives, Table 1. Among these words, coding (in HamNoSys notation) of 1478 words has been completed to its perfection. Each sign is accompanied with lips movement representing like speaking the word itself. Non-manual component of all the required words has been taken care. A list of composite signs/words has also been created. Composite signs/words are those signs/words which are the combination of two or more words/signs. For example, the sign for breakfast is made up of two signs for morning and food (breakfast = morning+food). Here are some words whose sign's snapshot are shown Figure 2 to Figure 5. For words which have no signs for them, e.g., names of the persons, the signs are creating by the combination of alphabets. For such alphabetic signing, the signs of all the alphabets have been created. Also for the numerals, all the numbers from 0 to 9 have been coded. Rest of the numbers can be produced using combination of these 10 signs. For accuracy, these signs corresponding to English words have been compared with videos of Indian signs available with Ramakrishna Mission Vidyalaya, Coimbatore. The signs have been shown to the interpreters and students of deaf

Table 1. Statistics of words implemented

Word Category	No. of Words	No. of Words Implemented
Adjectives	188	174
Adverb	48	48
Determiner	8	8
Noun	1139	851
Preposition	32	32
Pronoun	29	27
Verb	364	329
Interrogative	10	9

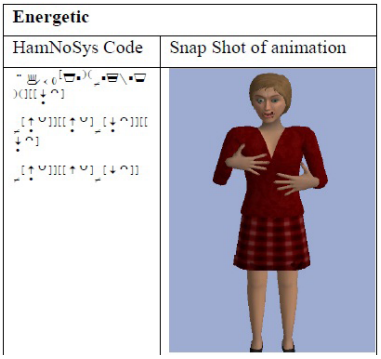

Figure 2. Snapshot and HamNoSys notation of word energetic.

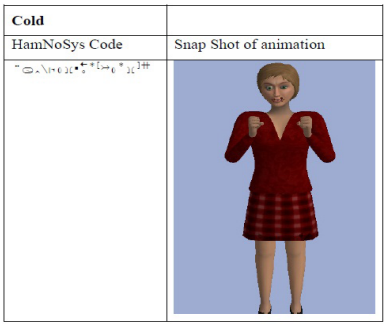

Figure 3. Snapshot and HamNoSys notation of word cold.

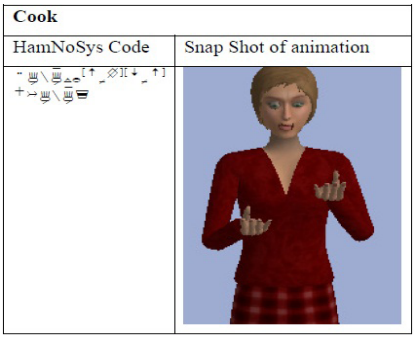

Figure 4. Snapshot and HamNoSys notation of word cook.

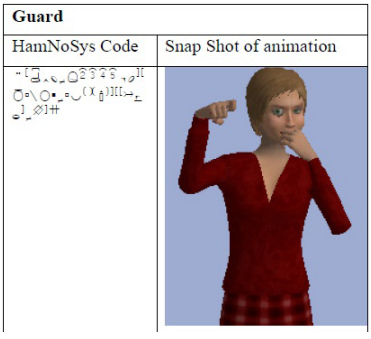

Figure 5. Snapshot and HamNoSys notation of word guard.

schools. The words shown to them were well understood and the work was well appreciated.

6. Conclusion

Automatic conversion of spoken language to sign language is a challenging task because of non-standardization of sign language of any country. This paper presents the approach for building the synthetic animation dictionary. Synthetic animations though are not natural, are efficient in terms of conversion time and computer memory used. These synthetic animations can be uploaded/downloaded over the network without any delay producing the real time conversion from English word to sign. The work can be carried out to implement the automatic conversion of English sentences to Indian Sign Language.

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