



Sign Language Generation System for Punjabi Language

Rupinder Kaur¹, Parteek Kumar², Sanmeet Kaur³

*Corresponding author's E-mail:

ABSTRACT

Sign Language is a main source of communication for deaf people. This language does not exist in any documentary. Sign animation is more optimal solution for producing signs because Digital video approach is very expensive. This paper proposes a system to generate signs for Punjabi text. Punjabi sentence are given as an input to this system which use shallow parser to parse the sentence and extract root words. These root words are further converted to English and then provides the phonological annotations of sign in form of HamNoSys structure. HamNoSys string is converted into SiGML which act as input to an avatar module which produces into animated sign representation.

Keywords: .

1. Introduction

Sign language is commonly developed in deaf communities which include deaf people, their friends and families. They use their hands, face, arm and body for communication. Sign languages are complete natural languages having their own syntax and grammar. It changes from one region to another. Sign language which is used in America is known as American Sign Language (ASL) whereas Sign Language which is used in England is known as British Sign Language (BSL). In India Indian Sign Language (ISL) is used. ISL have different dialects in different parts of India however they all are same grammatically. According to linguistic studies conducted in 1978, ISL is a complete natural sign language having its own phonology, morphology, syntax, and grammar [Dasgupta, Shukla, Kumar, Diwakar and Basu, 2008]. According to All India Federation of the Deaf (AIFD), there are around 4 million deaf people in India. They use Signs for communication. To provide uniqueness in signs, a particular ISL system is required. But due to unavailability of well documented data on ISL lexicon, no such system has been developed.

This paper is divided into 7 Sections. Section 1 includes Introduction to Sign Language. Section 2 of this paper describes Indian signs and types of Indian sign Language. Symbols which are used for writing signs are discussed in Section 3.

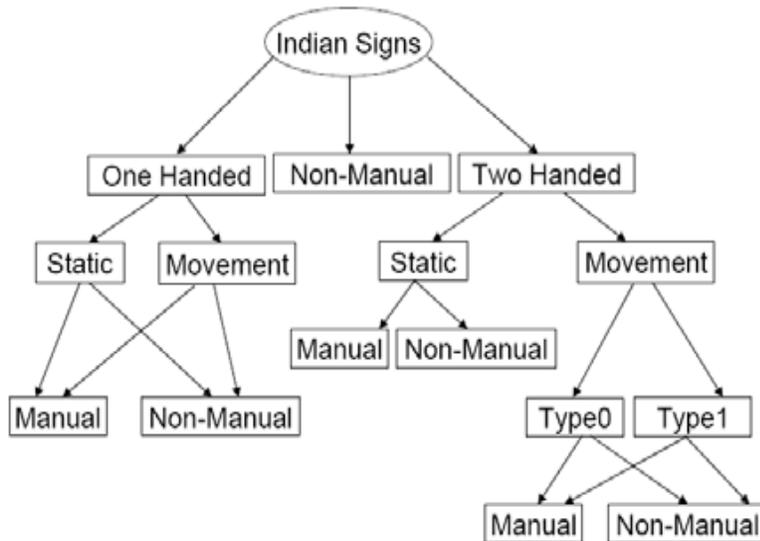
Computer Science and Engineering Department
Thapar University, Patiala, Punjab, 147001 ^{1,2,3}

Section 4 includes the existing work on Sign Language and describes tools which are available for sign language. Architecture of proposed Sign Language generation system for Punjabi language is discussed in section 5 whereas its description using example sentence is explained in Section 6. Section 7 concludes and future work of the proposed work.

To describe an event in Indian sign language, sometimes the signer uses 3D space around his body. Unlike spoken language where a word is composed of phonemes, sign is composed of cheremes [Stokoe, 1960]. Cheremes are of two kinds manual and non-manual. A manual chereme includes hand shape, hand location, orientation, movements where non manual chereme includes facial expressions, eye gaze and head or body posture.

Indian Sign Language signs can be classified into three classes: one handed signs, two handed signs, and non-manual signs [Dasgupta, Shukla, Kumar, Diwakar and Basu, 2008]. Figure 2.1 shows the overall Indian sign hierarchy.

Fig. 2.1: Types of Indian signs [12]



2.1 One handed signs

The one handed signs are represented by using single dominating hand. These signs can be either static or movement related. The static and movement signs are further classified into manual and non-manual signs. Figure 2.2 shows examples of one handed static signs with non-manual and manual components.

Fig. 2.2: (a) shows one handed static manual sign of Ear and (b) shows non-manual sign of Headache [12]



(a)

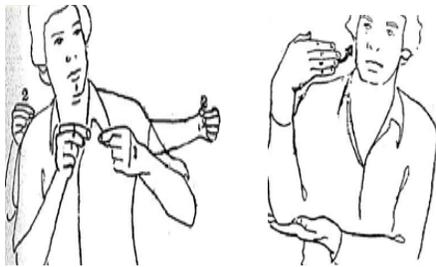
(b)

2.2 Two handed signs

Classification for two handed signs is similar with classification of one handed signs. However, two handed signs with movements can be further distinguished as:

- Type0: Signs where both hands are active (as shown in Figure 2.3(a)).
- Type1: Signs where one hand (dominant) is more active compared to the other hand (non-dominant) as shown in Figure 2.3(b).

Fig.2.3: In (a) both the hands are moving for signing "long" and in (b) only the dominant right hand is moving for signing "Flag" [12]



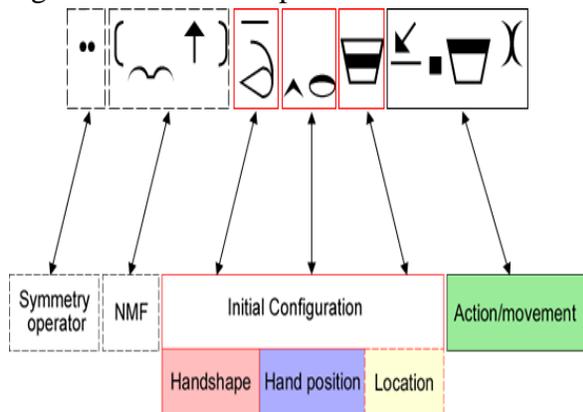
(a)

(b)

2. Literature Review

Sign Language does not have a particular written form. For defining a sign we need a notation system which will help for writing signs. The Hamburg sign language notation system known as HamNoSys is a phonetic transcription system used to transcribe signing gestures [Prillwitz, Leven, Zienert, Hanke and Henning, 1989]. HamNoSys is a syntactic representation of a sign which provides computer processing for signs. In the last 30 years many sign notation systems have been developed, HamNoSys has its roots in the Stokoe notation system which introduced an alphabetic system to describe the sub lexical parameters include location, hand configuration and hand movement to give a phonological description of signs. The parameters of a sign are written in the order of symmetry operator, non-manual components, hand shape, hand position, location and movement as given in Figure 3.1.

Fig. 3.1: Structure of parameters used in HamNoSys [9]

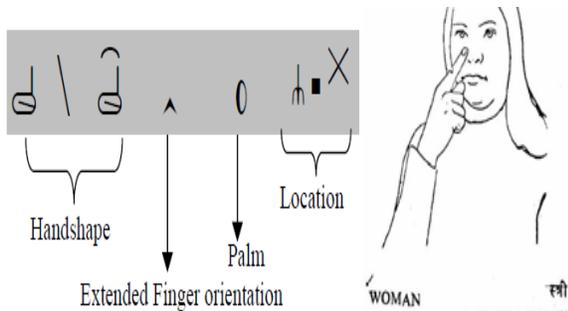


HamNoSys for a single sign describes the initial posture of the non-manual features, hand shape, hand orientation and location plus the actions which change this posture in a sequence or parallel. In case of two handed signs, Initial posture notation is preceded by the symmetry operator that defines how the description of the non dominant hand gets copied into the dominant hand.

Figure 3.2 shows the HamNoSys of the word “WOMAN” whereas its Sign is shown in Figure 3.3,

Fig. 3.2: HamNoSys
 Of “WOMAN” [12]

Fig.3.3: Sign of
 of “WOMAN” [12]



1. EXISTING WORK ON SIGN LANGUAGE GENERATION SYSTEM

An automated system which translates spoken language into Sign Language is known as translation system. These Systems take text as Input, process it and translate it into target Sign Language (SL). There is a spectrum of architectural designs along which most machine translation (MT) systems can be classified, and loosely they are classified into three basic designs. These are as follows:

- a) Direct Translation System
- b) Transfer Based Architecture
- c) Interlingua

4.1 Direct Translation Systems

These systems perform their processing on the individual words of the source language string; translation is achieved without performing any form of syntactic analysis on the original input text. Generally the word order of the Sign Language remains the same as that of the English text. But in the case of English to Indian Sign Language, target Sign Language may not follow the same word order. With this, system also assumes a strong knowledge of both the English as well as the target Sign Language. A system named "TESSA" is made based on direct translation [Cox, Lincoln, Tryggvason, Nakisa, Wells, Tutt, and Abbott, 2002]. It is a speech to British Sign Language (BSL) translation system which provides a communication between a deaf person and a Post Office clerk. Similarly Grieve Smith proposed a Text to American Sign Language (ASL) machine translation system in "SignSynth project" [VCOM3D, 2004]. This system has been evaluated in the weather information domain.

4.2 Transfer Systems

These systems analyze the input text to some syntactic or semantic level. Then a special set of transfer rules are employed which read the information of the source language structure, and produce a syntactic or semantic structure in the target language. Afterwards, a generation component is used to convert this linguistic structure into a target language surface form. The transfer grammar approach is used in text to Sign Language Machine Translation (MT) systems and in text to text MT systems. A system "TEAM" is text to American Sign Language (ASL) translation system [Zhao, Kipper, Schuler, Vogler, Badler, and Palmer, 2000], where English input text is analyzed with a TAG parser. The English lexical entries are looked up, and the ASL signs to which they corresponded is identified. Speers introduced a new system named "ASL workbench" [Speers, 2001]. It is also a Text to ASL MT system which performs deeper linguistic analysis than the TEAM system. This Workbench system included a set of specially

written rules for translating an f-structure representation of English into one for ASL. Another system based on this approach is “ViSiCAST translator” [Sáfár and Marshall, 2001]. It is English to British Sign Language (BSL) translation system in which semantic level of representation is used for performing English analysis to the BSL generation.

4.3 Interlingual Systems

In Interlingual systems, the source is analyzed and processed semantically to produce a typically language independent semantic representation structure. This structure is called as Interlingua. Then a Generation component produces the target language surface form from this Interlingua. “ZARDOZ” system is based on this approach [Veale, Conway and Collins, 1998]. It is English to Sign Language translation system which uses a set of hand coded schemata as an Interlingua for a translation component.

4.4 Dictionary tools for Sign Language

Due to variation in Sign languages from one region to another, there are many dictionary tools which are available for different Sign Languages. A multimedia dictionary tool is made based on American Sign Language [Wilcox, Scheibman, Wood, Cokely and Stokoe, 1994]. It is a Macintosh application which provides bilingual (ASL-English) dictionary for American Sign Language. A teaching tool is also available for ASL [Geitz, Hanson and Maher, 1996]. It generates 3-Dimensional Models of Manual Alphabet Hand Shapes for the World Wide Web. Similarly, A Multilingual dictionary tool is available for Indian Sign Language [Dasgupta, Shukla, Kumar, Diwakar and Basu, 2008]. This tool provides a GUI to create a multilingual multimedia Sign Language dictionary.

4.5 Some other systems for Sign Language

For providing easy communication between deaf and dumb people, an electronic hand glove is made named “Flex Sensor Glove”. This system uses five flex sensors which are fitted with length of each finger and thumb. Using different position of fingers and thumb, Indian Sign Language’s alphabets are made. Using these alphabets, word forming is made and their output is shown on the LCD [Solanki, 2013].

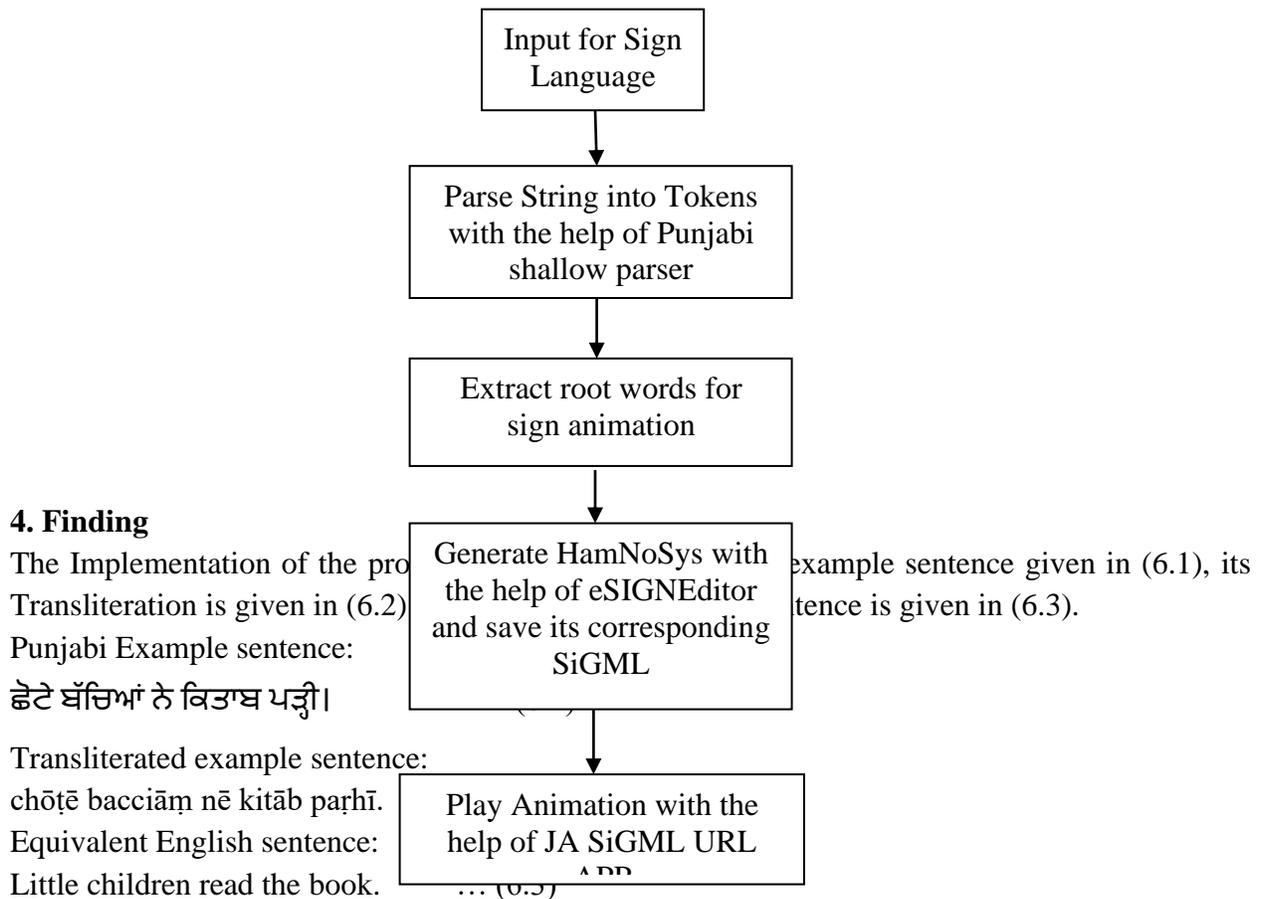
3. Methodology

For conversion of Punjabi language to Sign language, this system generates signs corresponding to spoken words. In Sign Language generation system for Punjabi language, Punjabi text is entered by the user and system works on it and generates Signs corresponding to entered text. Architecture for performing this is shown in Figure 5.1.

In this system, Input text is entered in form of text file, then this text file is parsed using Punjabi shallow parser. Punjabi shallow parser has been developed by consortium of institutions headed by IIIT Hyderabad, India. It is used for processing input Punjabi sentences. It performs the tasks of tokenization, morph analysis, part-of-speech tagging and chunking for the processing of an input sentence. It produces final output by picking most appropriate morph with ‘head’ and ‘vibhakti’ computation [Kumar, 2012]. From this output file root words are extracted. After extraction of words there is a need to write signs for these words into computer understandable language which is HamNoSys. eSIGNEditor is a tool for performing this task [Hanke and

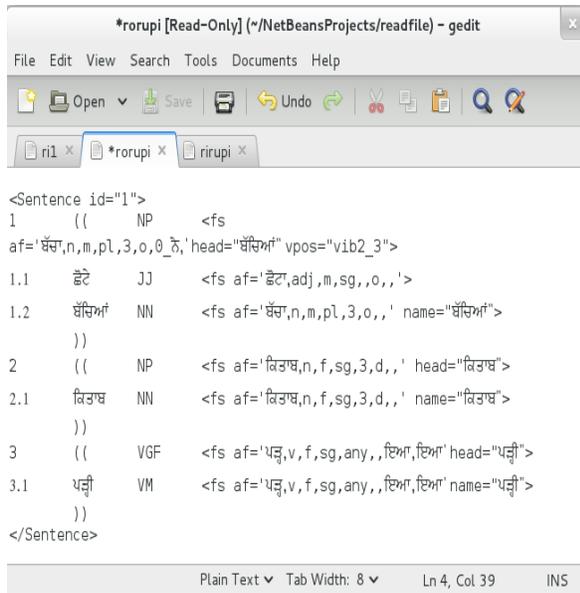
Popescu, 2003]. The main idea of this tool is to pick signed sentences sign by sign from the lexicon and apply morphological changes to individual signs or strings of signs which are necessary. An eSIGN Editor document represents a signed text. After writing signs HamNoSys code is converted into SiGML [Elliott, Glauert, Jennings and Kennaway, 2004]. SiGML (Signing Gesture Mark-up Language) is a form of XML which defines a set of XML tags for each phonetic symbol in HamNoSys. SiGML files are described as plain text thus computer can easily handle them. Generated SiGML file is browsed by tool “JA SiGML URL APP”, which play sign animation for the inputted text.

Fig. 5.1: Sign Language generation system for Punjabi text



Step 1: Create Input File and Parse it Using Punjabi Shallow Parser

Fig. 6.1:output_file generated by Punjabi shallow parser



As shown in the example sentence (6.1), it has three chunks, ‘ਛੋਟੇ ਬੱਚਿਆਂ ਨੇ’ ‘chōṭē bacciām nē’ ‘little children’, ਕਿਤਾਬ kitāb ‘book’ and ਪੜ੍ਹੀ parhī ‘read’. Here, ਛੋਟੇ chōṭē ‘little’ is an adjective with symbol ‘JJ’, ਬੱਚਿਆਂ bacciām ‘children’ and ਕਿਤਾਬ kitāb ‘book’ are nouns chunks with symbol ‘NN’ and ਪੜ੍ਹੀ parhī ‘read’ as finite verb chunk ‘VGF’. Here, ‘fs’ is the feature structure which contains grammatical features of each word and ‘af’ is a composite attribute which consists of seven attributes namely root; lexical category; gender; number; person; case; tense, aspect and modality (TAM) information. In case, no value is given for a particular attribute the field is left blank. As shown in Figure 6.1, ਛੋਟੇ chōṭē ‘little’ has a root word ਛੋਟਾ chōṭā ‘little’; lexical category as ‘adj’ (adjective); gender as ‘m’ (male); number as ‘sg’ (singular) or ‘pl’ (plural), (i.e, correct number is not resolved at this stage, so, both singular and plural forms are shown in the feature structure); person is ‘not applicable’ for this token; case is ‘o’ (oblique) and TAM is ‘not applicable’ for this token.

Step 2: Extract root words.

Root words are the smallest meaningful words which can’t be further divided. While playing sign animation only root words are considered. With the help of java code, root words are extracted and the system also provides their corresponding English. Following are the root words which are extracted from example sentence given in (6.1).

ਛੋਟਾ chōṭā ‘little’, ਬੱਚਾ baccā ‘child’, ਕਿਤਾਬ kitāb ‘book’, ਪੜ੍ਹ parh ‘read’

Step 3: Generate HamNoSys using eSIGNEditor and save its SiGML file.

Fig. 6.2: HamNoSys of example sentence given in (6.1).

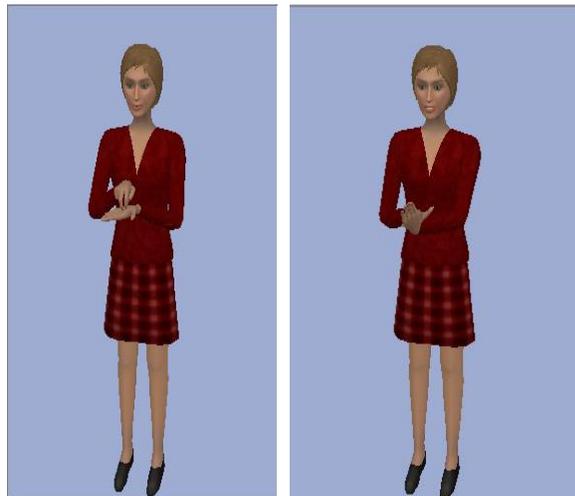
It browse SiGML file and read tags from file. According to these tags it plays animation. Figure 6.3 shows sign animation of example sentence given in (6.1).

Fig. 6.3: Sign Animation of Example Sentence given in (6.1)



ਛੋਟਾ chōṭā 'little'

ਬੱਚਾ baccā 'child'



ਕਿਤਾਬ kitāb 'book'

ਪੜ੍ਹ parh 'read'

This system has been tested for approximately 200 simple sentences. Some of those sentences are given in table 6.1.

5. Discussion & Conclusion

In this paper, a system is proposed for converting Punjabi text into Sign Language. It generates sign animation of the input text. For performing animation, system takes Punjabi text as input, processes it and generates its HamNoSys. From HamNoSys, SiGML is generated. Then Virtual human takes input of SiGML code strings and generates Signs corresponding to words given in

the string. Signs for simple sentences have been generated. In future, this system will be extended to work with some more complex sentences.

ACKNOWLEDGEMENT

Input Text	HamNoSys	Sign Animation

We are thankful to “Patiala School for Deaf and Blind” for their suggestions and cooperation during the development and evaluation of the system.

Table 6: Some Example sentences with their HamNoSys and Sign Animation

<p>Punjabi Sentence: ਮੈਨੂੰ ਸੌ ਰੁਪਏ ਦਿਉ।</p> <p>Transliterated Punjabi Sentence: mainūṃ sau ruṡāē diu</p> <p>Equivalent English Sentence: Give me a hundred rupees.</p>	<p>鍗符偽孳咯 浼苻優孳割王啞 噤偽冰刊壻菟</p>	
<p>Punjabi Sentence: ਤੁਸੀ ਮੈਨੂੰ ਸਲਾਹ ਦਿਉਗੇ।</p> <p>Transliterated Punjabi Sentence: tusī mainūṃ salāh diugē</p> <p>Equivalent English Sentence: You will give me advice.</p>	<p>浼苻儼妊僂泮妊 鴉割 浼玳優泮刊蕻壻 啞噤孳菟 鍗符偽孳咯 娉啞宥符媼鍗符 菟啞僂泮媼儼孳 菟啞協媼卦菟壻 澄</p>	
<p>Punjabi Sentence: ਅਸੀ ਸਰਵਿਸ ਦਿੰਦੇ ਹਾਂ।</p> <p>Transliterated Punjabi Sentence: asī sarvis dindē hā</p> <p>Equivalent English Sentence: We provide services.</p>	<p>葛苻優宥券劬王 敬莖够 赫鍗僂冰割王澄 啞噤孳澄莖菟 赫杆壘鍗符啞儼 冰媼傑冰菟割蕻 王啞澄鑷噤孳菟 劬鷄</p>	
<p>Punjabi Sentence: ਕ੍ਰਿਪਾ ਕਰਕੇ ਮੈਨੂੰ ਮਾਫ ਕਰ ਦਿਉ।</p> <p>Transliterated Punjabi Sentence: kripā karkē mainūṃ māph kar diu</p> <p>Equivalent English Sentence: Please forgive me.</p>	<p>鍗符優孳刊王啞 唵莖噤宥符儼妊 優孳菟 浼苻優孳刊啞噤 紉符儼冰割啞菟 浼苻浼蟠割壻</p>	

<p>Punjabi Sentence: ਉਹ ਫੁਟਬਾਲ ਖੇਡਦੇ ਹਨ।</p> <p>Translatered Punjabi Sentence: uh phuṭbāl khēḍdē han</p> <p>Equivalent English Sentence: They play football.</p>	<p>浼苻儁妊儼泮割 咕汉嘒儼妊顛泮 妊鵠菟 薜紉苻妊紉拟汕 儼孥妊鵠劔妊割 玊咄堃够 薜錚杆儁冰咕却 厥媼却厥菟堃券 壬咕堅圓堃堃嘒 錚拟妊錚儼孥菟 咕卿厥媼卿厥菟 堃</p>	
<p>Punjabi Sentence: ਅਸੀਂ ਤੁਹਾਡਾ ਸਵਾਗਤ ਕਰਦੇ ਹਾਂ।</p> <p>Translatered Punjabi Sentence: asīm tuhāḍā savāgat karadē hām</p> <p>Equivalent English Sentence: We welcome you.</p>	<p>菑苻儁宀券玊壬 截堃够 薜錚苻儼妊儁孥 割咕嘒錚苻杆儁 妊儼券妊割壬菟 够 浼苻儼妊儁泮妊 鵠割</p>	

References:

1. Armond Lee Speers. 2001. Representation of American Sign Language for Machine Translation. PhD Dissertation, Department of Linguistics, Georgetown University.
2. Éva Sáfár and Ian Marshall, 2001. “The architecture of an English-text-to-Sign-Languages translation system.” In G. Angelova, editor, Recent Advances in Natural Language Processing (RANLP), Tzgov Chark, Bulgaria, pp. 223-228.
3. Krunal Solanki, 2013. “Indian Sign Languages using Flex Sensor Glove,” International Journal of Engineering Trends and Technology (IJETT), vol. 4, ISSN: 2231-5381, pp. 2478-2480.
4. Liwei Zhao, Karin Kipper, William Schuler, Christian Vogler, Norman Badler, and Martha Palmer, 2000. ”A Machine Translation System from English to American Sign Language.” Association for Machine Translation in the Americas.
5. Parteek Kumar, 2012. “UNL Based Machine translation System for Punjabi Language,” Ph.D. dissertation, Thapar University, Computer Science and Engineering Department, Patiala.

6. Ralph Elliott, J.R.W. Glauert, Vince Jennings, and J.R. Kennaway, 2004. "An overview of the SiGML notation and SiGML Signing software system." Fourth International Conference on Language Resources and Evaluation, LREC 2004, Lisbon, pp. 98–104.
7. Sarah Geitz, Timothy Hanson, Stephen Maher, 1996. "Computer generated 3-dimensional models of manual alphabet hand shapes for the World Wide Web." ACM Press, USA: New York, pp. 27–31.
8. Sherman Wilcox, Joanne Scheibman, Doug Wood, Dennis Cokely, and William C. Stokoe, 1994. "Multimedia dictionary of American Sign Language." ACM Press, USA: New York, pp. 9–16.
9. Siegmund Prillwitz, R. Leven, H. Zienert, Thomas Hanke, and J. Henning, 1989. "Hamburg Notation System for Sign Languages." An introductory guide HamNoSys, 2nd. ed.
10. Stephen Cox, Michael Lincoln, Judy Tryggvason, Melanie Nakisa, Mark Wells, Marcus Tutt, and Sanjana Abbott, 2002. "Tessa, a system to aid communication with deaf people." Fifth international ACM conference on Assistive technologies.
11. Thomas Hanke, and Hortensia Popescu, 2003. "Essential sign language information on government networks." Intelligent Sign Editor, EDC-22124, pp. 1-27.
12. Tirthankar Dasgupta, Sambit Shukla, Sandeep Kumar, Synny Diwakar, and Anupam Basu, 2008. "A Multilingual Multimedia Indian Sign Language Dictionary Tool." Sixth workshop on Asian Language Resources, India: Indian School of Business, Hyderabad, pp. 11-12.
13. Tony Veale, Alan Conway, and Brona Collins, 1998. "The challenges of cross-modal translation: English to sign language translation in the ZARDOZ system." In Machine Translation 13. pp. 81-106.
14. VCOM3D, 2004. Sign smith products. <http://www.vcom3d.com>.
15. William C. Stokoe, 1960. Sign language structure: an outline of the visual communication systems of the American deaf. 2nd edition, 1978. Silver Spring, MD: Linstok Press.