RESEARCH ARTICLE

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Voice to Indian Sign Language Conversion for Hearing Impaired People

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Abstract

Sign language is a universal way of communication for challenged people with speaking and hearing limitations. Multiple mediums are accessible to translate or to acknowledge sign language and convert them to text. However, the text to signing conversion systems has been rarely developed; this is often thanks to the scarcity of any sign language dictionary. Our project aims at creating a system that consists of a module that initially transforms voice input to English text and which parses the sentence, then to which Indian sign language grammar rules are applied. This is done by eliminating stop words from the reordered sentence. Indian Sign Language (ISL) does not sustain the inflections of the word. Hence, stemming is applied to vary over the words to their root/ stem class. All words of the sentence are then checked against the labels in the dictionary containing videos representing each of the words. The present systems are limited to only straight conversion of words into ISL, whereas the proposed system is innovative, as our system aims to rework these sentences into ISL as per grammar in the real domain.

Keywords: Grammar rules, Indian sign language, Natural language processing.

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Introduction

Sign language is a universal way of communication for challenged people with speaking and hearing limitations. There have been various mediums accessible to translate or to recognize sign language and change them to text, but the text to sign language conversion systems have been seldom developed, this is due to the lack of any sign language corpus. According to the 2011 census of India, there are approximately 63 million people, which sums up to 6.3% of the total population, who are suffering from hearing problems. Out of these people, 76–89% of the Indian hearing challenged people do not understand language, either signed, spoken, or written. The reason behind this low literacy rate is either the shortage of sign language interpreters, unavailability of the ISL tool, or the necessity of researches on ISL (Figure 1).

ISL is the predominant sign language in South Asia, used by a minimum of several hundred thousand deaf signers.[1] The conventional Indian Sign Language is segregated into the following:

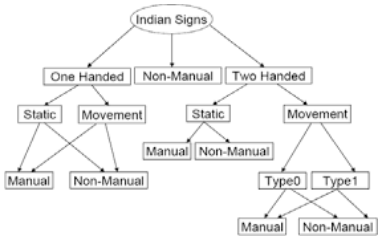

Figure 1: ISL type hierarchy

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One Handed Signs

The one-handed signs are shown by a single dominating hand. One-handed signs can be either static or dynamic (having movements) (Figure 2).[1,2]

Each of the static and movement signs is further segregated into manual and non-manual signs.

Two-Handed Signs

The two-handed signs are represented by both the hands of the person. As with the case of one-handed signs, similar segregation is often applied to two-handed signs. However, two-handed signs with movements can be further classified as type 0 and type 1 signs.

Type 0

Type 0 signs are those where both hands are active.

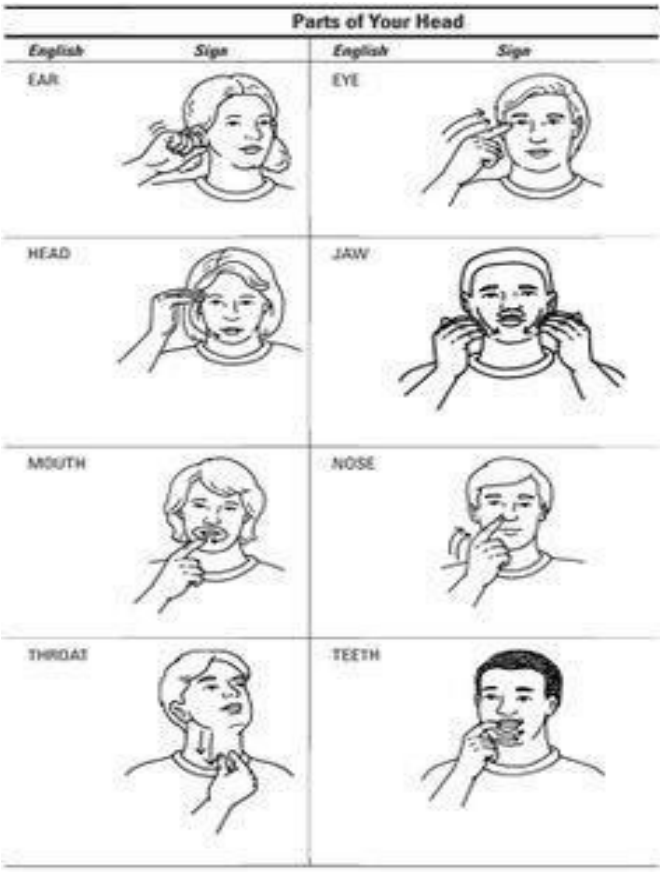

Figure 2: One-handed static manual sign

Type 1

Type 1 signs are those where one hand (dominant) is more active compared to the opposite hand (non-dominant), as shown in Figure 3.[1,2]

In common places, like railway stations, bus stands, banks, hospitals, etc., hearing impaired people face an extremely difficult scenario for communication as a hearing person might not understand the signing used by the hearing impaired person to communicate. Also, a person who is listening cannot convey any message to hearing impaired person as he/she may not apprehend the sign language. To make the communication between hearing impaired and hearing community, the language interpretation is a must. Sadly, India does not acknowledge ISL as an official language.

Related Work

There are several theories related to this field as there is more and more need of bridging the communication gap for the hearing impaired people. Several works have been proposed. A direct translation system is predicated on word to word conversion, the grammar of the target language is not taken into consideration.[2] Transfer based system translates source language to a grammatically correct target language by applying appropriate grammar rules.[2,3] A speech to sign language interpreter system (SSLIS) was made where signed English (SE) model is employed, as it is described by O. O.

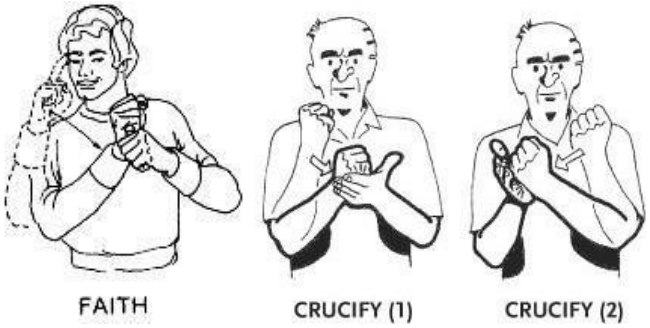

Figure 3: Two handed sign "faith" (both hands are moving)

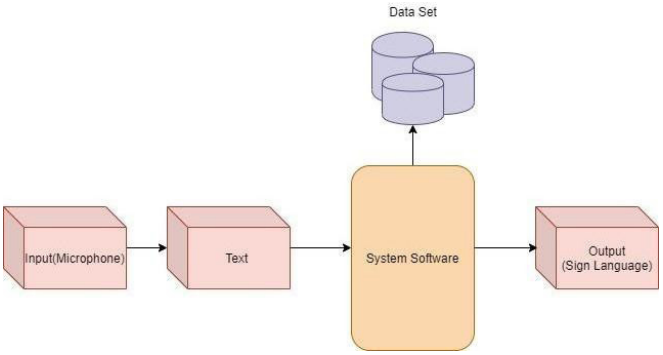

Figure 4: System architecture

K. a. H. E. Khalid Khalil El-DarymLi.[4] Simply, the recognized output text of the speech recognition engine is going to be inputted to the American Sign Language (ASL) database.[4] A project that uses template-based recognition as the main approach, in which the voice to sign (V2S) system first needs to be trained with speech patterns based on some generic spectral parameter set.[5] A framework using web services to translate text into a sign language animated GIF. When users enter a sentence, the web service will examine the sentence using the longest words from a dictionary, then generates a series of images per word and combines all images into an animated GIF.[6] There are multiple systems that convert ISL text into animated videos by converting the HamNoSYS code into SigML notations.[7] A WordNet-based machine translation system replaces the missing word with its most similar word present in the group set. An English text to ISL gloss system has been generated that converts English text to ISL gloss by applying grammar rules.

There are multiple efficient systems that are proposed in this field but not adequate research has been done in the conversion of real-time speech to ISL. There are various systems proposed for the conversion of sign language to text but lesser vice-versa. Our system aims to convert real-time voice to ISL taking into consideration the grammar rules of ISL.

System Framework

Our framework is as follows:

Data Collection

Data collected was from an authentic source (www.kaggle.com and www.indiansignlanguage.org). The data we have

Table 1: Related work idea

S. No.	*Author*	*Name of paper*	*Idea*
1	R. S. a. A. K. S. D S Sharma	Automatic Translation of English Text to Indian Sign Language Synthetic Animations	This paper presents a strong idea of generating the Sign Language video output in an animated format.
2	S. S. B. S. Vardan Gupta	English Text to Indian Sign Language	This paper shows that how English text is converted to Indian Sign Language using grammar rules. This paper also uses animatic video output.
3	P. K Lalit Kane	Towards Establishing a Mute Communication" in IEEE	This paper shows both conversion of Text to Sign Language as well as, Sign Language to Text. Comparison between different techniques are shown.
4	O. O. K. a. H. E. Khalid Khalil El-DarymLi	Speech to Sign Language Interpreter System (SSLIS	The paper presents a Speech to Sign Language Interpreter System at a lower cost for conversion of English speech to American Sign Language. They have shown how conversion into sign language can be done by using Signed English manual instead of grammar rules
5	T. J. L. a. W. W. L. Oi Mean Foong	V2S: Voice to Sign Language Translation System for Malaysian Deaf People	This paper shows how template based recognition using microphones and cameras can be done to generate a voice to Malaysian sign language translation system.
6	P. W. Teranai Vichyaloetsiri	Web Service Framework to Translate Text into Sign Language	This paper shows how a sentence can be converted into sign language by using images and creating them into GIF format.
7	S. S. a. V. S. K. Saija	WordNet Based Sign Language Machine Translation: from English Voice to ISL Gloss	This paper provides the generation of ISL gloss using the Wordnet database.
8	P. N. P. Gouri Sankar Mishra	English text to Indian Sign Language Machine Translation: A Rule Based Method	This provides a framework to generate ISL gloss as well as, ISL video outputs.

collected comprises of videos of all alphabets, about 2000 words and a few sentences.

Input Format

Input will be collected in audio format from the user using a regular microphone.

Pre-Processing

- Parsing
- Reordering the sentence according to ISL

Output Generation

After pre-processing, we used simple string matching to generate the video of the corresponding word present in the dataset using the labels of the dataset. The output video is a merged video of all the words of the sentence.

Methodology

- Input from the microphone is given to Google API for accurate text conversion.
- This text is now parsed and reordered using the natural langauge tool kit (NLTK).

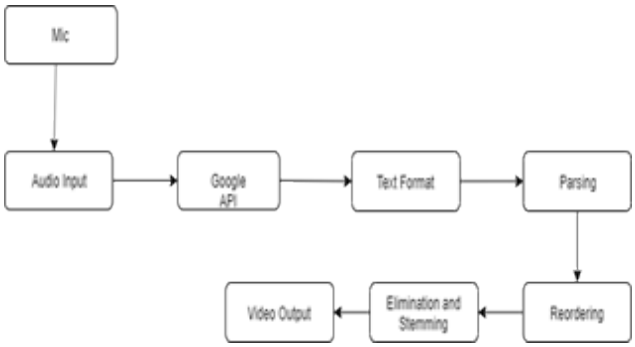

Figure 5: Process flow

- Reordering is done using the ISL grammar rules as shown in Table 1.
- The reordered text is now stemmed for getting the words into root words since ISL follows root word format. We have used the Porter Stemmer for stemming.

Porter Stemming Algorithm

Stemmers (or) stemming algorithms are used to manipulate words based on their semantic meaning significance and comparability.[7] Stemming uses a group of rules to be applied

Table 2: Grammar rules for ISL

Verb Pattern	Rule	Input Sentence	Parsed Sentence	Output Sentence
Verb + object	VP NP	Go park	(VP (VB Go)(NP(NN park)))	Park go
Subject + verb	NP V	Birds chirp	(NP(NNS birds))(VP (VBP fly))	Birds chirp
Subject + verb + subject complement	NP V NP	His brother became a doctor	(NP(PRPS his(NN brother))(VP (VBD became)(NP(DT a)(NN soldier)))	His brother a doctor became
Subject + verb + indirect object + direct object	NP V NP NP	She made coffee for all of us	(NP (PRP She)) (VP (VBD made) (NP (NN coffee)) (PP (IN for) (NP (NP (DT all)) (PP (IN of) (NP (PRP us)))))))	She coffee for all of us made

to the target word.[8] There are various sorts of stemming algorithms but the most exceedingly used one is affix and suffix removal. The affix removal algorithm extracts a base/root form called the stem, from words by removing either their prefixes/suffixes.[7-10] As an example, (addict, addicted, addictable, addicting, addicts) Æ ADDICT [stem/base/root from]. In the above example, all the variant words are extracted from a class "addict". A stemmer's accuracy highly depends on the closeness of its root form.[7,9]

Porters stemming algorithm is one of the most famous stemming methods proposed by martin porter in 1980. It comprises a total of 60 rules in five steps. It is an algorithm based on the suffix stripping technique.[8-10] The data passes from one step to another making it a multipass algorithm. The algorithm works in five steps, and at every step, rules are applied until one among them clears the condition. If the subsequent rule is matched, then the suffix is removed, and therefore, the next step is performed. The final stemmed word is returned by the algorithm at the end of the fifth step.[8,10] The rule looks like the following:

<Condition><S1> → <S2>S1 and S2 represent suffix and new suffix, respectively. For instance, a rule (m > 0) EED → EE means if the word has a minimum of one "vowel and consonant" plus EED ending, change the ending to EE. Example "disagreed" converts to "disagree," whereas "need" remains unaffected.

Porter stemmer is the most effective stemming algorithm, as compared to the other stemming algorithm.[1] Sometimes it acts as an under-stemmer but for it can be made into an over-stemmer by applying additional rules.[11] Porter stemmer works well with python,[12] and hence, we have made use of this algorithm in our study.

The Porter stemmer algorithm returns the stemmed sentence, which is then matched with the dataset using inbuilt string matching in Python. The video output is a combined video of all the words of the stemmed sentence. The words of the sentence that are not present in the dataset will be skipped as there is a restriction on the ISL corpus. The video output is an output of real people showing Indian signs of the word. This is an easy compilation because it shows the expressions as well, which gives a far better understanding of the sign.[13-19]

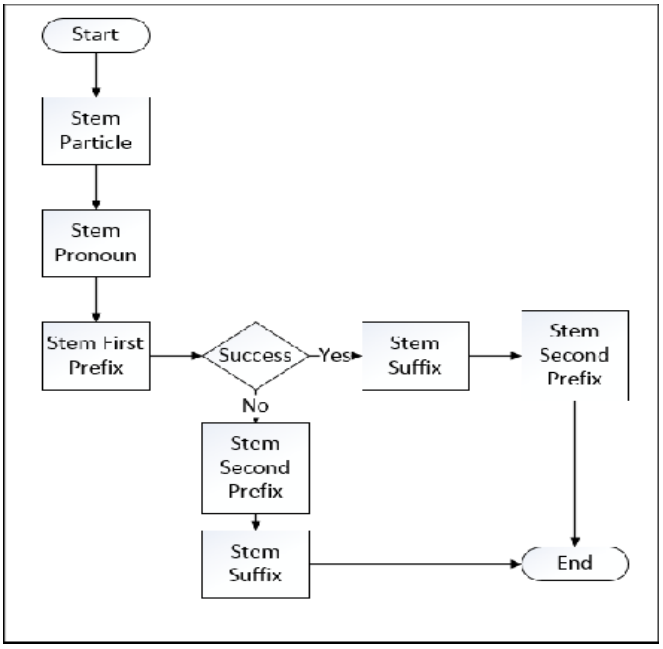

Figure 6: Process flow of Porter stemming algorithm

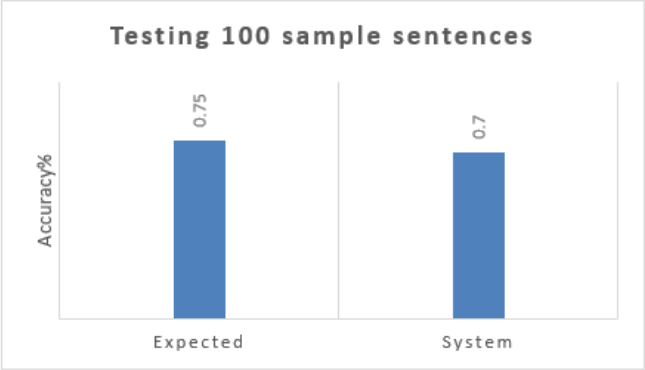

Figure 7: Accuracy of the system

Results

Our approach with realistic videos improves the overall performance as we have applied pre-processing using Natural Language Processing (NLP) techniques. NLP used with Python gives higher speed and flexibility. Also, with the help of google speech recognition API, we get an accuracy of around 95%, when translating natural English language to text. When translating into sign language our system has an accuracy of 70%. We took a sample set of 100 sentences for testing our system. 70 sentences were translated from English to grammatically correct ISL.

Some of the errors in language translation cannot be resolved. The machine cannot comprehend the emotional aspect of a sentence. Some sentences are often ambiguous. For example, she sat at the bank could also be interpreted as she sits inside a financial organization, or on the border of a lake or a river. Such errors cannot be handled by the machine and have an impression on the accuracy of the system.

Conclusion

The existing system consists of five phases, like parsing English text, recording sentences, eliminating stop-words, stemming, and video conversion. The final output of this system is in the form of visuals for non-deaf people so that they can communicate with meaningful sentences and understanding. The videos can be stored for further use. The existing systems have either animatic video displays or only text to sign language conversions. Our system ensures that it is user-friendly and gives a real-time quick response as the videos are generated in less than 7 seconds after the sentence is spoken. Real human videos are more precise than the animatic ones as the actions are accompanied by expressions as well, which gives a better understanding of the word. The proposed system is not only a real-time conversion of the sentences but it also gives an option to download the video that is then directly stored into the computer and can be accessed by the user later.

Thus, based on a literature survey and by analyzing the existing system, we have concluded that the proposed system will not only help non-deaf people to communicate but also to understand through visuals. Much more development and research can be done on this track as there is a very limited ISL dictionary.

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