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Research Article

ENGLISH TEXT TO INDIAN SIGN LANGUAGE TRANSLATION SYSTEM

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Abstract: Communication is one of the most important aspects of daily life. English is a well-established language, and a lot of research has been done on the language and its grammatical constructs. However, for the differently abled people, with respect to communication, the medium of communication is sign language. This paper presents a model for converting English text to Indian sign language (ISL). The input is any English sentence which is parsed using the Stanford parser. ISL, has its own grammatical syntax. Hence, the parsed sentence has to be reordered and converted, into a sentence that is compatible with ISL. From this reordered sentence, an elimination module, removes all the unnecessary words, which are not a part of the ISL vocabulary. ISL signs are always made in present tense; hence a lemmatization module has been added to convert the words into their simplest forms. Once, this is done, we obtain the final 'ISL sentence', from which each word is mapped to its corresponding video. These videos contain individual ISL signs. Finally, all the videos of that sentence is concatenated and displayed in sequence. The proposed system provides an innovative way to serve the needs of the differently abled by acting as an excellent translation medium during conversations between people. The system can also function as an exceptional teaching aid.

Keywords: Indian Sign Language (ISL), Lemmatization, Parsing, Language Processing

1. Introduction

Communication is one of the most important aspects of daily life. For the differently abled i.e. for the non-hearing and non- speaking the medium of communication is sign language. Sign languages [5] are gestural languages, in which the signer uses his arms, expressions and the environment around him to convey meaning. Sign languages are fully fledged languages, with their own grammar and lexicon. Each country has its own sign language; however, countries with shared borders have similar sign languages. For example, India and Pakistan have similar sign language, called the Indopakistani sign language (IPSL). Similarly, India and Nepal, America and Canada, also have similar sign languages [1]. There are around 137 such sign languages around the world. The main difference between spoken and sign language is that spoken language is aural and linear, while, sign languages are gestural and three dimensional. Signs are formed by hand shapes, orientation of hands, location of the sign and movements, as well as facial expressions. In India, there are around 5 million hard hearing people, for who there exist only 250 certified ISL interpreters. So, there is a wide gap that has to be bridged. Also, this provides an opportunity for a translation system that directly converts the sentences to signs (videos or animation), to exist. We are exploring such a system in this paper. The system can function as an excellent translation medium or a communication medium during conversations between people. The system can also function as an exceptional teaching aid.

2. Comparison of English Grammar and ISL Grammar

English is a well- established language, and a lot of research has been done on the language and its grammatical constructs. English has a subject-verb-object construct for its sentences. The English language has a lot of inflexions. An inflexion changing of the word form typically the ending to express different grammatical meanings such as tense, voice, gender, etc. The vocabulary of the English language is also very extensive and developed through the long years of history. However, in the ISL language, there is limited research conducted. The structure of ISL sentences are of the form subject-object-verb. ISL largely ignores any inflexions such as, gerunds, suffixes and other forms of the words. The dictionary of the ISL is also very limited (not more than 3000 words). Also, there are many other rules such as WH-question words are placed at the end, and ISL has no conjunctions or linking words.

3. Methodology

A. The database

Since, we have intended to produce the output using videos, creation of a formidable video repository was extremely essential to the project. The videos were obtained from an open source database [2]. Database consists of clips of 780 words. These videos clips were suitably labelled for further processing and sorted in local repository covering extensive array of signs.

B. ISL syntax

Sign languages are fully fledged languages that have their own grammar and vocabulary. In order to effectively translate words to signs, a good understanding of the ISL syntax and its grammar is required. There are many grammar rules [1], some of them are-

1. WH-question words are placed at the end.
2. Signs for family relationships are preceded by male or female.
3. It does not use any articles.
4. It does not use gerunds or linking verbs.
5. Uses finger-spelling for any unknown words.

C. Architecture

The system architecture is shown in below in figure 1.

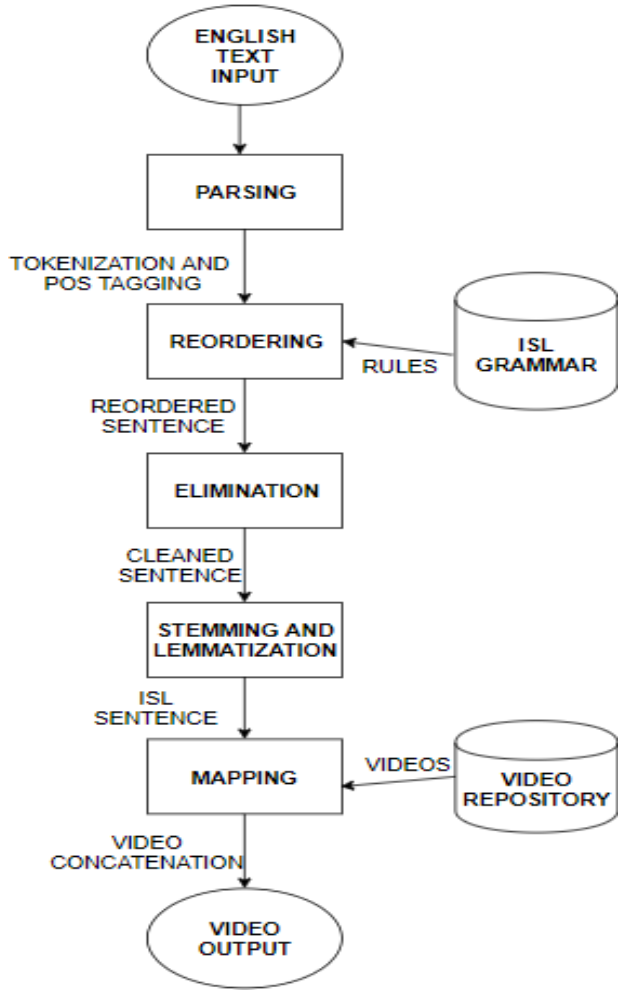

Figure 1. System architecture for converting English Text to Video Stream representing communication through Sign Language

The system takes an English language sentence as input. This sentence is parsed and tagged according to the parts of speech. Then the sentence is reordered according to the sign language grammar and then any unnecessary words not in ISL vocabulary are eliminated. Now, each word of the reordered sentence undergoes stemming and lemmatization. Now we map each word to its corresponding video and concatenate them and display them in a sequence.

D. Parsing

Parsing [4] is a technique for resolving a sentence into its components and describes their syntactic roles. Hence, parsing is a very effective way to obtain the grammatical structure of the input. We are using the Stanford Parser. It produces outputs in various formats such as Penn Treebank format, Parts Of Speech (POS) tagger, typed dependency format, i.e. grammatical relations between words... etc. The parser used with in conjunction with the NLTK to create the parse tree and POS tagging in the sentence. This is the first step in translation.

E. Reordering

Both the spoken and sign language have different grammar rules, so it becomes more complex to translate them. Therefore, after the POS tagging and tree creation in the previous step, we have to reorder the sentence according to the grammar constructs of the target language, ISL. ISL require all the verbs to be shifted after the corresponding noun occurrence. This makes reordering the tokenized sentence essential for conversion.

F. Elimination

As mentioned above, ISL does not have many words and grammar syntax that the spoken language has, such as articles, gerunds or linking words. Removing such words is necessary. Hence, we have included an elimination module that deletes any unnecessary words that are not a part of the ISL vocabulary. We have used stopwords, which is essentially a bag of words that has all the words, unused by ISL.

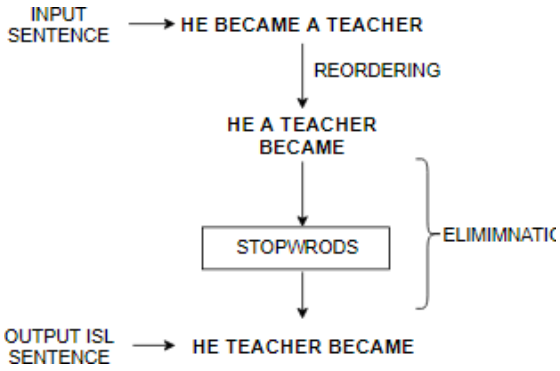

Figure 2. Elimination phase flow for removing words and grammar syntax not contained in an ISL

Also,herearefew moreexamplesofhow theEnglish sentence gets converted to the ISL compatible format, shown in Table 1 below

Table 1. Sample sentences depicting output of Elimination Phase

Input Sentence	Reordered Sentence	Sentence After Elimination
What is your name?	your name what i s	your name what
Iwillmeetyoutomorrow	I you tomorrow will meet	I you tomorrow meet
I am going to the university	I the am universitygoing To	I university going
Bring me coffee	Me coffee bring	Me coffee bring
He sat under a Tree	He a tree sat under	He tree sat under
Put the books on the table	The books the table put on	Book table put
The castle was heavily bombed during the war	The castle the war washeavily bombedduring	Castle war heavilybombed during

G. Stemming and Lemmatization

Stemming [3] and Lemmatization are Text Normalization (or sometimes called Word Normalization) techniques in the field of Natural Language Processing that are used to prepare text, words, and documents for further processing. ISL uses root words in their sentences. Hence, we are using the Porter Stemmer rules to convert the words to their root forms. It is shown in the figure 3 below.

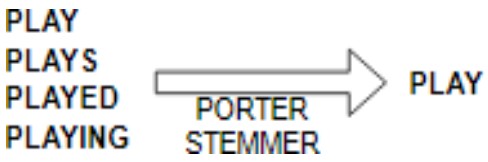

Figure 3. Stemming and Lemmatization of different forms of a sample word

H. Mapping

This is the last step in the translation system. After all the previous steps we obtain a sentence that is compatible with the ISL sentence structure. In this stage, we find the matches for each word of the sentence in the video repository. These videos are concatenated and displayed in sequence.

4. Output Generation

The system aims at generating the sign language depiction for any given English sentence in the form of videos.

Output from the ISL conversion phase of input sentence is passed to video generation phase where, for each word in the sentence is mapped to the database for its corresponding video. Then these videos are all concatenated to produce an easy to understand visual depiction of Indian Sign Language. Consider the following input sentence to which the generated ISL translated sentence and video output is given in the figure 4,5 and 6 below.

Enter the String to convert to ISL: I am going to school ISL converted sentence: I school going

Video output: ISL sign for “I”

Video output: ISL sign for “School”

Video output: ISL sign for “Go”

5. Results andDiscussion

The proposed translation system has been implemented using different NLP technologies like StanfordParser,NLTKandotherpackagesavailablefor pythonimplementation.Atotalof100Englishsent, consisting of both 50csimple and 50 complex sentences wereinputtothesystemtotestitsaccuracy.Theoutput obtained in the form of sign language clips were cross verified with a linguistic expert. Table 2 shows the accuracyoftheresults,with50sentencesforeach category.

Table 2. Translation Accuracy

Type of Sentence	Number of input sentence	Number of Properly Translated Sentences	Translation accuracy
Simple sentence	50	50	100%
Complex sentence	50	48	96%

The structure of the ISL format is contrasting from the English language. The sentences, in order to achieve the accurate output, should be reordered. This is done by using a Stanford parser. The NLTK transfers sentence to Stanford parser. The parser categorizes individual words into its parts of speech. Using a tree function, the words are reordered to form a proper ISL format. Certain words have to be stripped down to base form of the word after lemmatizing and stemming. The final ISL output is generated. The generated output is split into individual words. Each word has a video clipping. It is mapped and concatenated using movie.py package. The final concatenated video is displayed as the output.

The most obvious advantage of the translation system is its use in aiding the hard-hearing community. It would tremendously help them in communicating with normal or another challenged person. Also, in In India, there are around 5 million hard hearing people, for who there exist only 250 certified ISL interpreters. Our system will help to bridge this vast gap. There is not much research being done on this topic. We are sure that our system will definitely help to increase the quality of life of the hard hearing people. Moreover, the translation system will also make for a very effective teaching and training aid. The simple architecture makes it a simple implementation. It is a simple system to use, because all the user has to give as input is a proper English sentence. The output also is in understandable format making the system a user-friendly system. From the results obtained it's evident that proposed system is actuating in handling the English sentences used in day to day activities.

As the ISL is new and not much development has been done on this topic, many new videos for different words can be added to the dictionary to widen its scope. Moreover, text to speech integration can be performed in the project to enable better communication strategies which will allow users to convert text to Indian Sign Language with manually entering the input sentence. Also, the system can also be extended to be a two-way translation model which translates both text-to-sign and sign-to-text. There can even be made provisions to translate an English sentence with slight grammatical errors to sign language as well. Also, the other punctuations used in written languages such as, the colon (:), semicolon (;) and hyphen (-), have not been implemented as they not frequently used in spoken languages. However, the system can be extended to include these in the future.

6. Conclusion

A system that would be helpful for the hard hearing people having communication difficulties has been proposedinthispaper.Wehaveproposedasystemthat wouldhelptheminexpressingthemselvesclearlyand Our model successfully converts the entire input sentence into a series of sign videos according to the ISL syntax. First the input sentence is parsed and tagged according to the POS. We have to reorder the sentence according to the grammar constructs of the target language, ISL. ISL does not have many words and grammar syntax that the spoken language has, such as articles, gerunds or linking words. Removing such words is necessary. Hence, we have included an elimination module for this purpose. Stemming and Lemmatization have been employed to obtain the root words. Then each word is mapped to its corresponding videos. These videos are concatenated and displayed in sequence. Much more development on this track can be done as the ISL dictionary is still small and needs to grow eventually.

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