Improving the Efficacy of the Virtual Indian Sign Language Interpreter

Ankit Rajiv Jindal
Friends for Inclusion
ankitrajivjindal@gmail.com

Mahesh Raja
Friends for Inclusion
maheshbamdc@gmail.com

Sparsh Nagpal
Friends for Inclusion
0sparsh2@gmail.com

Rahul Murthy
Friends for Inclusion
dopaminedimension@gmai.com

Abstract : An improved version of a virtual Indian sign-language interpreter that functions upon translation of the Indian Sign Language grammar, using the avatars. The pipeline of the system consists of a rule-based English-to-ISL gloss Machine translation framework followed by an animation module using hand-crafted animations playing the output sequentially. ISL follows its own form of sequenced grammar much different from the English grammar. The team studied through all possible resources to understand and implement the logic to generate the right sequence and use the appropriate set of words. The program utilized Natural Language Processing tools and libraries along with certain Deep Learning based approaches to follow meticulous details.

Keywords : *Natural Language Processing, India Sign Language (ISL), Rule Based Machine Translation (RBMT)*

1. INTRODUCTION

The Indian Sign Language (ISL) is a not so technologically established language as there is a lot of recent development and the language partially varies from region to region in our country. Also the sign language translation is much different from a general spoken and written language and hence, developing a translator was not termed as easier in the earlier days. With recent enhancements in Deep Learning and NLP, it has become is feasible approach.

This research envisions bridging the gap of knowledge delivery and streamline this process through the means of recent technical advances. With very limited dataset being available for true grammatical form of ISL sentences, we didn't move ahead with a complete Seq2Seq [2] deep learning approach since it would require a large dataset not available. The challenges also came across due to limitation of usable words, and the meanings of words being used rather than a set of specific vocabulary.

The research succeeded in figuring out the granular aspects of the Indian sign language and made replication of its grammatical form successful to a much larger extent than before. We referred to certain papers like *Indo-Pakistani Sign Language Grammar: A Typological Outline* [2] which enabled us to implement the correct rules in our translational module. We also consulted expert Indian Sign Language Interpreters who assisted and reviewed the progress of the language model, as well gave feedbacks at every stage for grammar as well as the animation enabled for the sign language.

The new and improved ISL Interpretation model is one of the most detailed, precise, and efficient ISL models present currently. The animation understandability was rated very high by the expert interpreters as well as the grammatical approach.

It holds a high potential for real word utilization. India constitutes about 1.8 million deaf and dumb citizens and they lack easy resources to learn and have smooth communication with other people. This efficient ISL model plans to bridge that gap in our community while there's a constant effort on improving the efficacy of the translation model.

2. MATERIALS AND METHODS

2.1. Methods

- We use python Natural Language Processing tools to splitting the input real-time sentences into multiple sentences determining the position of sentence end indicators. Depending on the language, the sentences are modified to English since the processing takes place in that language. Now for translating, there are two types of Sign Language

translations. One is SEE or Signed Exact English [3], where the word order remains the same and each word is further signed. The other method is a more fundamental Sign Language approach where the Language possess its own form of grammar different from other languages [2]. Here we translate the sentences to closest possible true grammar of the Indian Sign Language.

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English Sentence	Signed Exact English Grammar	ISL English Grammar
Vikram is going to school	V-I-K-R-A-M is going to school	school V-I-K-R-A-M go

2.2. ISL Grammar and its Implementation

The ISL Rule Based Machine Translation follows the given architecture:

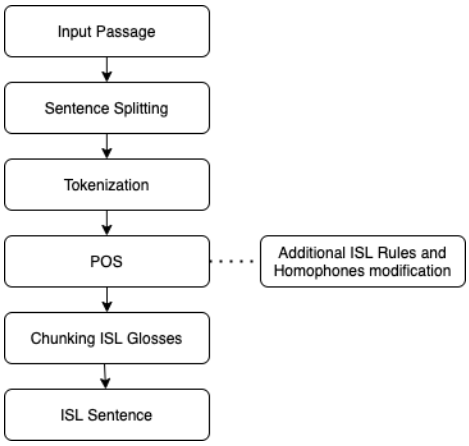

Figure 1 - Architecture of the proposed method

The sentences are split based on full stops. Each sentence is taken as a separate input in the function. The function first performs tokenization on the given words. [1] The tokens then go through ISL grammar rules [2] using their respective POS identified by NLP tools. The rearranged words are then passed through the set of ISL vocabulary where identified words are pulled while the other ones are split into characters.

Rules:

1) POS and Grammar

The sentence always begins with the Time (Indicated by date and Time tags) and Location (Indicated by GPE and pobj tags). Post those details, the rules give priority to second person or the object a preference in the order (dobj) which follows by the subject (nsubj) or root of the sentence (root). Each place/subject/object is tagged along with their respective adjective mentioned along. Towards the end of these there are verbs and their adverbs present. The elements are then followed by negative annotations like ‘not’ in the sentence if present any. For questions, the sentences end with the question tags like ‘why’, ‘what’, ‘where’, ‘how’, etc.

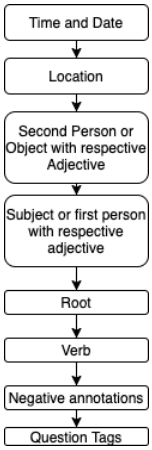

Figure 2 - ISL grammatical order

**To understand tags better you could refer their full-form and resources*

2) Eliminate unused words

There are certain words, also termed as stop-words at times which are only used in SEE but not in the actual sign languages. Words like articles (a, an, the), few conjunctions, etc which are usually eliminated. Words like auxiliary verbs, 'is', 'are', 'am' aren't used in a direct way but they represent the tense of sentences.

Example,
*English – I **am** going **to** school*
ISL – school me go (-present-)

3) Tense

The ISL when translating from English or any other grammar loses the tense attribute of the word while signing it in specific. In order to distinguish, there are symbols indicating the action or verb belongs to present, past or future.

Example,
*English – I **am** going **to** school*
ISL – school me go (-present-)

*English – I **was** going **to** school*
ISL – school me go (-past-)

4) Split of words into letter

The ISL vocabulary is limited and with proper nouns especially, there is a limitation of symbols. To indicate a name or a word that the vocabulary lacks, ISL splits the word into its corresponding characters and signs it one after another.

Example,
English – My name is Diana
ISL – D-I-A-N-A my name (-present-)

5) Numbers

The possibility of permutations and combinations of numbers are infinite. While there's a system of wording numbers in English, in ISL, the number is represented by signing each digit present in it one after another.

Example,
*English – I have **10** candies*
*ISL – Candies **one zero** me have (-present-)*

6) Subordinate Conjunctions

When two simple sentence are joined by a subordinate conjunction (since, because, as) , the ISL interpretation flow is different from that of a typical English structure. The sentence is broken in form of a question and answer where one simple sentence is the answer while other is the question.

Example,
*English – He went to restaurant **because** he was hungry*
*ISL – restaurant he go **why?** he hungry*

*English – **Since** he was smart, he came first*
*ISL – he come first **why?** he smart*

7) Limited vocabulary

The ISL works upon the context of the word, it signs the meaning but the official in terms of words listed in the Official ISL Dictionary, there's a huge limitation.
The dictionary might have just the 'Good' but the words for example 'Well' and "Nice' interpret the same meanings at situations.
The application finds the suitable word in the ISL dictionary so that the correct context could be represented.

Example,
*English – The Matrix is a **good** movie*
*ISL –movie **good** matrix*

*English – I am feeling **well***
*ISL – feel **good** me*

*English – Have a **nice** day*
*ISL – day **good** have*

8) Relations

When it comes to family relationships, belonging to a specific demography or being associated by something else, ISL breaks the understandability in two words.

Examples,
Brother - Man + Sibling
Sister - Woman + Sibling
Indian - India + person
Cricketer - Cricket + Person

9) Homographs

Homographs are the words having same spelling and sound but different meanings. Semantic recognition of the correct context from these words is important.

Example,
*Sentence 1– I am always **right (correct)***
*Sentence 2 – I took a **right (direction)** turn*

Using Natural Language Processing tools, successfully managed to pull the correct sign for the given homograph. We curated our own dataset with respect to the ISL words list to give accurate results.

3. Output

Sentences	Ram went to his big house
Tokens	**(**Ram), (went), (to), (his big house)
POS	(ram – NNP and nsubj), (went – Vbd and Root), (to- prep and IN), (his – poss and PRP$, big – amod and JJ , house – pobj and JJ)

POS rearrangement and elimination	(His big house : Object), (Ram : Subject), (Went : Verb)
Modifications	(House big his), (Ram), (Go)
Final Sentence	House big his r-a-m go

4. ADVANCES

We worked upon certain factors which give improved efficacy over previous Indian Sign Language Interpreters researched and developed.

Most of the ISL virtual interpreters utilize SEE or Signed Exact English. Our interpreter model uses rule based machine translation which on translation comes very closes to the actual ISL grammar [5] used by the expert interpreters. True ISL grammar follows a set of rules which are stated above and set to be followed for the better understandability of the deaf and dumb community.

Along with grammatical translations, issues like limited Indian Sign Language library being developed and having the correct usage of words, for an instance, homographs, are resolved in our implementation. We developed algorithms along with the use of NLP toolkit functions which would enable us pull the correct set of words in ISL vocabulary for the accurate semantic representations.

The above stated rules are implemented by using both, NLP tools and libraries as well as state-of-art Deep Learning models to follow the grammar as well as pre and post processing of data.

The model also keeps in mind of the very basic sentence based grassroot level issues like irregular results with conjunctions or comma while translating them to the desired forms. It process in an hierarchical manner processing at sentence levels, then then the words level.

We also developed a Lexical Simplifier using transformers [4] which on integration could make the complex input sentences simpler and hence, easier to translate.

5. CHALLENGES

The given model is a rule based model and highly depends on the grammar and formation of sentence. Due to lack of high grammatically literacy in India, use of highly incorrect grammatical form of sentences could be a challenge at times in order to identify true meaning of sentence and it's grammatical aspects . We are also introducing multi-lingual input options for the users who lack knowledge of English.

Along with incorrect grammar, use of exclamations or onomatopoeias are some places the translator model could target on improving by labelling them for certain signs or expressions.

6. CONCLUSION

We successfully programmed an English to ISL grammar model which pulls the respective animation files for the give words in order. The model is implemented majorly on rule based algorithms using parts of speech tags. The future scope involves using encoder decoder models like English to American Sign Language on further collection of dataset and development of language as overall.

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8. REFERENCES

1. *Gouri Sankar Mishra, Parma Nand, Pooja. International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8, Issue-10S, August 2019 , 460-467*
2. *Zeshan, U., —"Indo-Pakistani Sign Language Grammar: A Typological Outline", Sign Language Studies, 2003, vol.3, no. 2, pp. 157-212*
3. *Luetke-Stahlman, B. (1991). "Following the Rules:Consistency in Sign."Journal of Speech and Hearing Research. 34:(1293-1298)*
4. *Jipeng Qiang, Yun Li, Yi Zhu, Yunhao Yuan, Xindong Wu. Lexical Simplification with Pretrained Encoders*
5. *Goyal, L., & Goyal, V. (n.d.). Automatic Translation of English Text to Indian Sign Language*
6. *Ilya Sutskever, Oriol Vinyals, Quoc V. Le. Sequence to Sequence Learning with Neural Network*