



A Process to Develop Sign Language Corpus using Crowdsourcing

Uzma Farooq, Mohd Shafry Mohd Rahim, Adnan Abid, Nabeel Sabir Khan

Abstract: Humans use language in order to communicate between one another. There exist a number of languages which are either spoken or written. Among these languages, there exists a special type of language called Sign Language (SL). Sign language is a general term which includes any kind of gestural language that makes use of signs and gestures to convey message. Although the deaf community feels comfortable while using Sign Language as their mode of communication, but they face a lot of problems as well. Therefore, in order to help and assist the deaf community a repository of different sign languages are essential for each sign language. This work presents a process to develop a repository by collecting and validating sign language gestures of any language by involving the deaf community and language experts. A small data collection based on a proof-of-concept application has also been presented in this work. Lastly, it highlights the benefits of such corpus by discussing possible applications that can be built to serve the deaf community of the world at large.

Keywords: crowdsourcing, sign language, sign language corpus, sign language standardization.

I. INTRODUCTION

Sign languages comprise of gestures corresponding to scriptive language words. The deaf and dumb community of the world uses sign languages to communicate with one another. Like natural languages comprise of different set of words, every sign language possesses a different set of gestures. There are hundreds of sign languages, and every country has different sign language. Furthermore, there exist different dialects of sign languages within the countries, especially in the big countries. Researchers have been working on building theories, tools, services, and applications to facilitate the deaf community in learning, understanding, and most of all communicating with other people. American Sign Language (ASL) [1] is the most developed sign language of the world. Whereas, significant research work has been done in British Sign Language (BSL) [2], Spanish Sign Language [3], South African Sign Language [4], and German Sign Language [5]. While, there is a rising trend in the countries of the developing world, particularly in

South and South East Asia, to facilitate their deaf community, as the literature reveals a considerable number of research articles are being published for the development of Indian [6], Vietnamese sign language [7], Bangladeshi [8], Pakistani [9], Thai [10], Arabic [11], and Malaysian [12] sign languages. Motivation: A significant research work on translation of Pakistan Sign Language (PSL) has been conducted in [13]. Whereby, a high level architecture for the translation system has been developed that translated natural language into Pakistan Sign Language and vice versa. This requires gestures repository for PSL, preferably in machine readable form, so that automatic avatar can be generated. A translation component that translates natural to sign language and vice versa. The authors in [14] claim to have built a grammar based translation system from natural language to PSL. There exist repositories of several sign languages of the world. These repositories include gestures of a sign language for a natural language word.

This focus of this article is to devise a process to generate a parallel corpus of sign language by employing crowdsourcing. Though some efforts for collection of sign repository for Swedish sign language has been started, but it involves social media applications. Similarly, To this end, basics of sign languages have been presented in Section II. Whereas, the process to develop a sign language repository using crowdsourcing has been discussed in Section III. The advantages of such corpus have been discussed in Section IV. The data collection and results have been presented in Section V. Whereas, the article has been concluded and future research directions have been presented in Section VI.

II. FUNDAMENTALS OF SIGN LANGUAGES

A. Global Sign Languages

Sign language is a general term which includes any kind of gestural language that makes use of signs and gestures to convey message. Sign language is known as 'language of gestures' as well. It is a visual-motion language utilized by hard of hearing, people with hearing disabilities and deaf individuals as their mode of communication. Sign language which is a gestural dialect is influenced by spoken languages. Sign Language is nearly an only mode of communication among people suffering from hearing impairment. When a hearing impaired individual wants to say something, he/she performs some gestures to communicate. Each particular sign means a distinct letter, word or expression. Combination of signs makes a sentence just like words in spoken languages make sentences which are understood by normal and deaf people. Sign Language itself is a complete natural Language with its own syntax and grammar.

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Sign Language varies from country to country or region to region like other spoken languages. There exist different sign languages like American Sign Language (ASL), British Sign Language (BSL), Indian Sign Language (ISL), Japanese Sign Language (JSL) and Pakistan Sign Language (PSL) etc.

Although Sign Language is a type of language but it is dissimilar with spoken natural languages in many ways like: It is a language of hearing impaired people, It is a language of signs and gestures, Words are produced using hands movement, head nodding, shoulder's movements and facial expressions to convey meaning, Sign Language doesn't have well-defined word order, grammatical rules and sentence structure, It is used for communication between deaf-deaf or deaf-normal individuals, It does not have pre-defined standards of writing.

As there is no universal Sign Language so they differ with each other in many terms like syntax, semantics, grammar, morphology, and phonology. Syntax refers to the rules in which signs of a Sign Language are arranged to form a sentence. Semantics are the building blocks of a language which are used to validate the meaning of a sentence. Grammar defines the overall structure of the language. There exist different gestures of same words in Sign Languages as shown in Fig. 1.



Fig. 1. Different Gestures of Same Word in Different Sign Languages

B. Components of a Sign Gesture

Sign Language is basically composed of two basic components or features: Manual and non-manual. The manual components of Sign Languages often include movement of hands which further includes Hand shape, Hand orientation, Location and Movement as shown in Fig. 3.

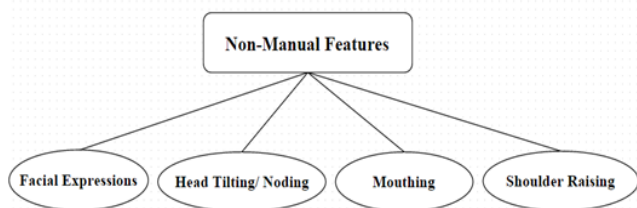


Fig. 2. Details of Non-Manual Features

Non-manual features are shown in Fig. 2, and they include different facial expressions, head tilting / nodding, shoulder raising, mouthing, and related actions which adds meaning to our performed gesture/sign. Mostly non-manual markers are used along with manual markers.

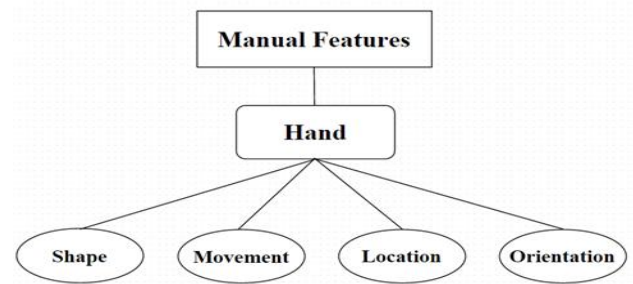


Fig. 3. Some detail of manual features

Some non-manual features used in PSL have been presented in Fig. 4, where we can see a lady performing a gesture for the word “afraid” by raising her eye brows, which is a non-manual gesture. Similarly, in another gesture for “smile”, the lady is expressing the smile with lips movements.

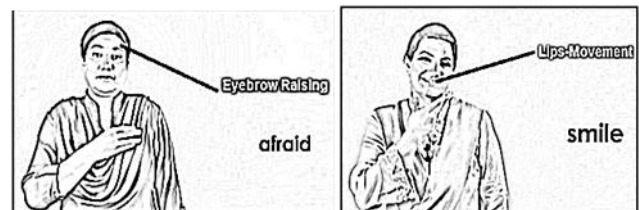


Fig. 4. Some non-manual features in PSL

C. Sign Writing Notations

Like spoken languages, Sign Languages can also be written down with the help of Sign Writing Notation Systems. Different notation systems are present for the representation of signs in Sign Language, but there is not any standard notation available. Notation systems are an important component of Sign Languages in order to render signs and gestures from Avatars. Up-till now there are four Sign Writing Notation Systems proposed, named as Stokoe, Gloss, SignWriting, and HamNoSys [15].

STOKE: The Stoke Writing Notation System was the very first sign writing notation system introduced and developed by William Stokoe. As it was the base line defined for Sign Writing Notation Systems, so many other notations are based on Stokoe's Notation [16]. The constructs of Stoke notation have been presented in Fig. 5.

Stokoe defined signs by introducing following three main parameters which he called ‘aspects’ [15]

Hand configuration: Stokoe identified nineteen different values of hand-shapes or hand configuration, which included: open palm, closed fist, or partially closed fist with the index finger pointing.

Place of articulation: It has twelve values which deals with the signs made at the upper arm, upper brow, or the cheek

Movement: It included twenty-four values which determine whether hands are moving upward, downward, sideways, toward or away from the signer, in rotary fashion, and so on.

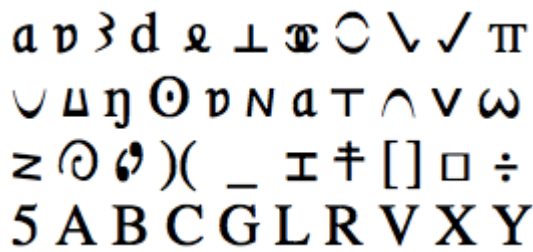


Fig. 5. Stoke Notation

GLOSS: In this notation system, signs are represented using words from English Language or some other language. The translation of Signs in GLOSS requires a dictionary based approach [15]. A sample sentence in Gloss notation has been presented in Fig. 6.

_____ t shake-head	FINISH
GO-TO MOVIE I DONT-WANT	PAH
	K-N-E-E
CL:3[swerve and flip-over]	#JOB
IX:Alice VISIT-ME++	QM-W

Fig. 6. Gloss Notation

SIGN WRITING NOTATION SYSTEM: SignWriting Notation System was introduced by Valerie Sutton who was a dancer. It was initially developed for communication between deaf people. Among all Sign Writing Notation Systems, SignWriting is considered as practical one to be implemented. Fig. 7 shows notations involved in writing signs using sign writing notation system.

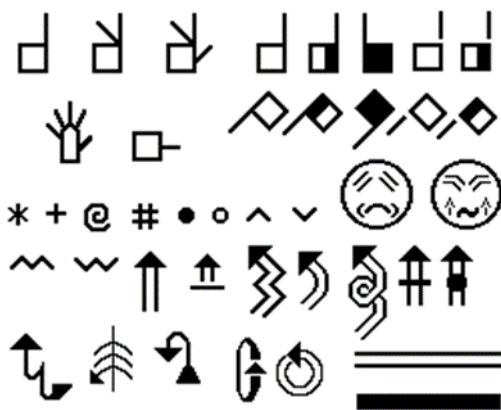


Fig. 7. Sign Writing Notation

HAMNOSYS: It is basically a Hamburg Sign Language notation system introduced by the University of Hamburg in Germany in 1985 [17]. It has its own pre defined notations and phonetic transcriptions for the definition of signs and gestures. It provides us a way to write signs in a computer understandable manner which is easy to interpret and process.

The origin of HamNoSys was basically Stokoe writing notation system and it gives us an alphabetic system to define different sign language parameters like hand-shape, hand-movement, hand-location and hand-orientation [18].

Fig. 8 shows the constructs involved in writing a gesture using HamNoSys notation.



Fig. 8: HamNoSys Notation

D. Advantages of Sign Writing Notations

Giving Hearing impaired individuals the facility to write their language can bring a positive and rapid change in their social educational and personal lives as follow:

- Learners of Sign Language would have the capacity to see composition and context of sentences, word order and grammatical structure for writing up sentences, semantic and syntactic nature of the sentences and much more.
- Young hard of hearing kids, who take in a communication through signing as their first source of communication, will have the capacity to figure out how to peruse by means of a language that is completely open to them. It is completely different to the educational system in which the hearing impaired child learns to read a spoken language.
- A new written style of the language would come in to existence for hard of hearing individuals that will help them to promote and standardize their educational system.
- For Sign Language specialists, Sign Writing Notation System permits the documentation of enough detail to research straight forwardly on the writings of the dialect in proper and suitable manner.

III. A PROCESS TO DEVELOP SIGN LANGUAGE CORPUS USING CROWDSOURCING

There are four major provinces of Pakistan and every province has its own gestures of PSL words. Some government organizations including National Institute of Special Education have been working on developing gestures for Pakistan Sign Language, and they have developed booklets and some digital resources of few hundred words of PSL. Similarly, among the private sector, Hamza Foundation, and Family Educational Service Foundation have developed separated repositories for learning and promoting PSL. However, these corpuses comprise of videos, images, and books. Such representation challenges the general and flexible usage of these resources in advanced applications that involve automatic translation from natural to sign language and vice versa.

In order to build a parallel corpus of Pakistan Sign Language, which preferably involves gesture representations of different words of PSL in different local dialects, this research aims to use the following mechanism to develop a parallel corpus for PSL.

- Define a process to develop parallel corpus.
- Collect video gestures for most frequent 500 words in different dialects of PSL using public while involving PSL experts as reviewers and editors for this data collection.
- Write HamNoSys representation of these words.
- Generate animating avatar using written sign language representation.
- Expose the finalized gestures in a useful way to public.

The process to collect video gestures for different dialects of PSL has been presented in Fig. 9. It shows that the corpus involves general public to contribute for local gestures for any word in PSL.

These gestures will be submitted to the online system in the form of recorded video. Each video will be initially processed by editorial office for a preliminary review. On clearance it will be passed on to any editor of respective dialect expert editor. The editor will assign the submitted gesture to one or more reviewers to evaluate the gesture for its correctness in terms of manual and non-manual features in any gesture. Subsequently, the reviewer may accept the gesture or may ask the contributor to revise and improve the video by using the provided comments in the review process. Upon acceptance the gesture is stored in a central repository.

The rubric to facilitate the reviewer has been presented in Fig. 10. In order to make the review more objective and clear we have provided a well-defined criteria for the evaluation of the provided rubric. Whereby, each reviewer has to rate the submitted gesture based on its non-manual features that include shape, location, orientation, and movement involved in a gesture. Furthermore, non-manual features are also rated by the reviewer. It is pertinent to mention that not all the gestures involve movements, and similarly, there exist gestures which do not involve any non-manual features. Therefore, the default setting for these two rubrics is always maximum, so that they may not result in rejection of any gesture where they are absent. Apart from this, the reviewer can also provide comments in the text box below. This will help the reviewer explain the required improvements in the gesture, and will facilitate the contributor understand the short comings in the submitted video. Thus, to improve and resubmit the improved video of that gesture.

IV. BENEFITS OF CROWDSOURCING BASED SIGN LANGUAGE CORPUS

The development of such corpus by involving crowd as general public provides the following benefits:

- We can build a huge repository of gestures in quick time.
- All the gestures in the repository will be verified and validated by experts, so the credibility of these gestures cannot be challenged.
- It is easy to incorporate different dialects present in sign

languages.

- The gestures can be converted into machine readable formats.
- The machine readable formats can be stored in significantly less space.
- The machine readable gestures can be converted into an avatar, which in turn, is helpful in creating several useful applications for the deaf community.
- We can extend the scope of this work to build a regional or global sign language repository.
- The translation systems can use this gestures' repository to translate from any natural language to any target sign language.
- The crowd based data collection may help getting videos and images of a single gesture from many people, thus resulting into a huge corpus. Such big sized corpora can be used to apply machine learning and deep learning algorithms.

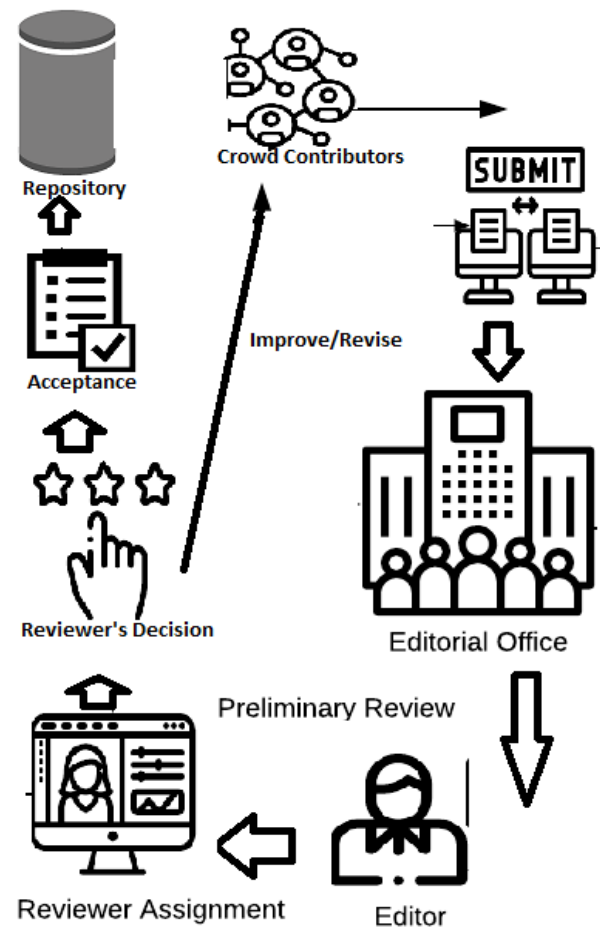


Fig. 9. Process to Generate, Evaluate, and Add a Gesture in the Repository

SMS Phone Banking

Submitted by Ali Khan



Evaluation

Rubric	5	4	3	2	1
Shape	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Location	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Orientation	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Movement	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Non manual Features	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Comment:

Overall Decision

☒ Accept ☐ Need Revision ☐ Reject

Submit

Fig. 10. Rubric for a Reviewer to Evaluate a Gesture

V. DATA COLLECTION AND RESULTS

A prototype application that employs the aforementioned process for the data collection of different dialects of PSL has been developed. Nearly 10 language experts and 40 contributors have been involved in the data collection process for a list of 100 words. The contributors were asked to submit a gesture of a word in their dialect, whereby each submitted gesture was given to the concerned editor and reviewers for evaluation. After the review process that involved revision of many gestures and rejection of few gestures, different variants of a gesture based on different dialects were added to the gesture repository. We are also generating the HamNoSys of each accepted gesture so that the repository can seamlessly be used for other purposes such as gesture rendering or machine translation.

It is pertinent to mention that all the stakeholders including the data contributors, editors, and reviewers were very pleased with the process of data collection. They also suggested certain improvements for the improvement of the UI and UX of the developed system. Furthermore, they have also suggested to include more linguistic annotations with each gesture that would not only enrich the repository but will also help in many different ways in complex language processing activities.

As a result an average of 10 videos for 100 different daily used words has been compiled with the help of deaf community and sign language experts. The data is further converted into HamNoSys so that it should be stored in a machine readable format to use it for different purposes.

VI. CONCLUSION AND FUTURE DIRECTIONS

This article presents fundamentals of a sign language, and highlights the major constructs of a sign language gesture.

Secondly, it provides brief description of different sign language writing notations, and highlights the benefits of writing gestures in machine readable format. Subsequently, the importance of parallel corpus that includes machine readable format of sign language gestures has been highlighted. While, a process to build a parallel corpus for any sign language using crowdsourcing has been presented.

In future, we intend to scale up the deployment of this process to collect sign language gestures while involving general public and domain experts of Pakistan Sign Language. We strongly believe that this will not only help raising the standard of PSL, but will also be used as a platform to design and develop numerous useful applications for the deaf community of the country.

We strongly believe that this idea of developing a sign language repository using crowdsourcing is generic and can be used to develop an international sign language repository.

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