An Android Communication Platform between Hearing Impaired and General People

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ABSTRACT

An enormous number of deaf and mute people in society use sign language to communicate. Besides, the general people also use both verbal and nonverbal language to establish a perfect communication system. Although the general people use several signs in everyday life there is a large gap between the general and the deaf and mute people in terms of communication as there are many special signs that are only used by the heard impaired people. Again, some signs are common all over the world but most of the signs used by the hearing impaired people are differed by place to place. Smartphones can be a preferable technology to develop a mechanism that will help these two communities to make effective communication among them, as the use of smartphones is now at peak. In this work, an android-based application has been established which helps to build a connection between general and hearing-impaired people who speak Bangla as smartphone is now very popular among the users and it is easy to use. The system implies a Bangla voice recognition system for general people through which they can input their voice in their application. There are more than 200 Bangla words available in the application. Whenever voice is detected, the words are separated and translated into sign language animation and played sequentially. On the contrary, there is a keyboard for deaf/mute users who can use this to express their language readable to general users. The project has been tested in real life scenarios to evaluate the project for real-life purposes. The test results shows that the developed sign language convert module gives accuracy of 88% and the keyboard module gives satisfactory results as well.

General Terms:

Natural Language Processing, Android Application

Keywords

Sign language, Voice recognition, Bangla keyboard, Animation

1. INTRODUCTION

Communication is one of the major needs of humans. Sign language is a visual form of language which uses movements of body parts as a method of communication. In day to day life, the general people frequently use some signs to communicate with others along with verbal language. In a nutshell, it can be said that to express feelings or to explain what a person wants to say to others; sign language, facial expressions, and verbal language are used by general people. But deaf and mute people have only one medium to express them via sign language. On the other hand, not every people know every sign used by them. Again there is a lack of Bangla medium system which can provide an easier solution to ensure two-way communication between deaf and mute and general people. Thus, a necessity is being risen to have an effective system among people as human translators are not always available nearby and the number of them are not sufficient and efficient.

Sign language is most often used for visual communication directly for the cases of interpersonal communication or video broadcast and is different in grammar unlike their counterparts of the same natural language.

Many deaf people may not know natural language while many general people may not have knowledge about sign language. This work develops a platform for a deaf/mute child where they can be acculturated with both deaf and hearing worlds. Also, the people who do not know anything about the sign language used by them can communicate with them easily.

2. RELATED WORK

There have been some notable work performed based on identifying sign language image or body movement to develop a medium for deaf people. Sarkar et al., developed a translator for Bangla text to sign language [1] . In this process, a dictionary containing about 1000 words is maintained against unique id, grammar id, path, and filename. In the sentence mode enabled, the corresponding Bangla word is fetched according to corresponding matched id and individual video clips are concatenated one after another in the correct sequence to generate a video clip that represents the sign language output corresponding to the input text.

A similar type of work is presented in another research by Marshall et al., [2] where input text is broken and analyzed into syntactic level. Discourse Representation Structure (DRS) is generated from this level to identify specific semantic content and move to sign language oriented DRS. Afterwards, HPSG semantic structure starts sign language generation.

Arefin et al., shows an empirical framework for tokenizing and parsing Bangla three types of sentences: assertive, interrogative and imperative [3]. The input sequence is taken at first. Then the program breaks the string into individual words called tokens. A lexicon is maintained containing parts of speech of each word. Some Context-Sensitive Grammar (CSG) rules are used for processing tokens of the input sequence to generate parse tree or structural representation according to CSG rules.

Two-Way communication is established by Shahriar et al., in mobile platforms between a deaf/dumb person and a normal person [4]. In the process, an open-source speech recognition software called CMU Sphinx is used to convert Bangla speech to Bangla sign language. The Sphinx defines Bangla phonetics, words and grammar and recognizes speech input and converts it to phonetic text. Scope of words are stored in a dictionary, hence sentences are built and stored as Bangla language model file. Audio files are stored as Bangla acoustic model file as well and therefore using those required files, the training process is begun which breaks recorded speech into phonetics text. By converting texts to Bangla words, these are matched against the database. If a match is found, corresponding images are shown on screen fetched from the database. On the other end, impaired persons have to write Bangla text which would be converted to speech by utilizing Google Translation Server. This is lacking since im-

paired persons may not know the Bangla language which re-quires designing a new keyboard for them.

Essential keyboard design is introduced by Gayyer et al., for deaf people [6] and Bangla layout is described by Islam et al., [5]. The swipe and press layout and sign keyboard both can be combined for the sake of deaf people to communicate with normal people. The swipe and press keyboard layout would require less space on the screen. Both can be applied for the android platform. The sign language keyboard also supports speech to text and text to speech where the text to speech allows the use of an algorithm and standard output uses a morphological analyzer module to determine the stem and part of speech of each word. After the pre-processing, a search is begun to find an exact match of the word using the hash value. If not found, Levenshtein distance between those stems and the stem of the word under search is calculated and the minimum value of distance less than two is selected from the database. If that word is not found also, the word is broken into letters and signs are retrieved for letters.

Allison et al., developed an android app in different platforms that can be communicated through specific methods [7]. The inter-app communication can be established using predefined 'intent', built into the Java package.

Jemni et al., developed an animation-based teaching assistant that is presented with the help of 'WebSign'; which is based on the technology of avatar (animation in the virtual world). It translates transcriptions of natural hearing languages to a real-time animation in sign language. [8] Actual sign is played for each word from the dictionary.

3. METHODOLOGY

3.1 Overview of the Proposed System

The main concern is to set up a communication medium between the deaf-mute and general people. Figure 1 shows the android app is provided with a choice of option for users. The people who can speak are provided a simple list of Bangla words. In accordance with the list, users have certain speech recognition systems inbuilt with the application. If the speech is matched with the list of words, the sign is played sequentially through a media player.

For deaf people, there is another choice for selecting a keyboard that they can understand by previewed signs of available Bangla characters. The typed text is displayed in the output box for the general people to understand easily. Each keystroke is combined to form Bangla readable text.
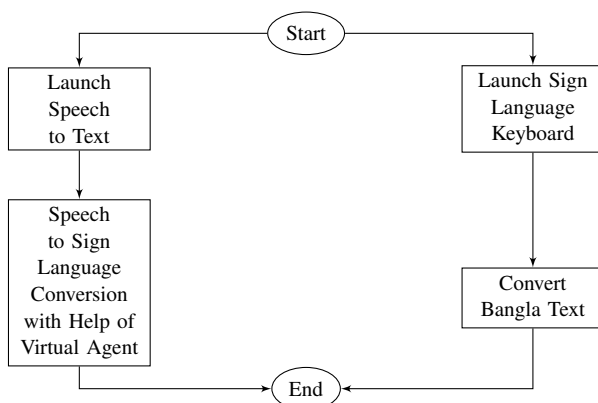

Fig. 1: Overview of the proposed system

3.2 Drawing Puppet in Adobe Photoshop

In order to design animation for sign language, a puppet needs to be designed. To design, Photoshop offers plenty of exclusive features. The steps of flow are described below:

—First a new Photoshop file is opened and saved as .psd select-ing a perfect resolution.

—Background is selected of color black.

—Using the ellipse tool, the head, eye, pupils are drawn.

—By using the rounded rectangle tool, ellipse tool, polygon tool, line tool, and custom shape tool, the remaining shapes of body parts are drawn.

—Optimal strokes are selected for these tools.

—By using the brush tool, particular body parts are colored ac-cordingly.

—These drawn parts are sequenced in perfect layer (Layers on top of other layers are visible).

—The parts movable is under the same group so that they can move together.

—The movable layers are assigned '+' sign in front of them to indicate them as an independent entity.

—These Photoshop files are further analyzed in Adobe Character Animator.

3.3 Generate Animated files in Adobe Character Animator

To generate the animated video files, the designed Photoshop puppet needs to be imported from Adobe Character Animator. The layers marked as a crown on the left side of the panel are the independent layers that are imported from Photoshop. The puppet is available in two types of mode: Rig mode and Scene mode. In Rig mode, the puppet can be edited for movement of particular parts. In Scene mode, the corresponding video can be taken frame by frame. The video taken can be further analyzed and exported for rendering. The followings are maintained for puppets:

—The Photoshop puppet is imported into the Character Anima-tor.

—Making those layers crown which is to be made independent and organizing other layers that are to be moved with those layers.

—Handle tools are added for the parts to be fixed during the taking of animation.

—Stick tools are added for the arm which is not to be dangled.

—Dragger tools are added for the palm group which is movable with the movement of the mouse.

—Triggers are added for multiple parts to switch by triggering the keyboard input.

—Frame duration is set to 3 to 4 seconds.

—Frame rate of 3 fps performs just fine.

—Pressing record button, the scene is recorded.

—During record, the movements are either triggered or dragged via mouse.

—For some animation, behaviors need to be set.

—Multiple frames can be taken via the press of recording button again and again.

—The record can be previewed through the play button.

—If necessary, eye gaze can be taken using laptop webcam from taking the expression of operator's face.

—Finally, the recorded animation can be exported for rendering to particular software via render option.

3.4 Render using Adobe Media Encoder

The recorded animated files are opened in the Adobe Media Encoder as the source. The following procedures are followed:

—Character Animator file is opened.

—System preset is set to .mp4 file.

—Start button is pressed.

3.5 Convert Speech to Text

Android is supplied with a built-in speech recognition engine from Google. A speech recognizer is initiated by passing language data to a very special RecognizerIntent class through sendOrderedBroadcast().

3.6 Show Signs

Animated sign videos generated from Media Encoder are stored in the Android Studio raw folder shown in Figure 2. Each word in the Bangla text is checked against the root word. If a match is found, MediaPlayer() plays the video file for more than 200 Bengali words.
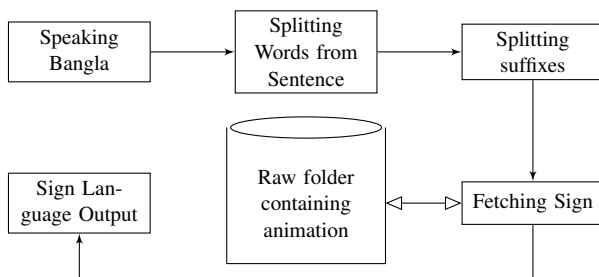

Fig. 2: Layout for showing the signs on the mobile screen

3.7 Keyboard

Android keyboard service is implemented by inheriting a class InputMethodService and overriding its methods. The xml folder in Android Studio contains keyboard layout files for each layout changes visible after pressing certain keys of the keyboard. Each row is designed separately. In a separate xml file, keyboard background is designed while keyPreviewLayout is designed in another separate file. When the button is pressed, the corresponding value is committed into the output field. Hence the keyboard works in a predefined way shown in Figure 3.
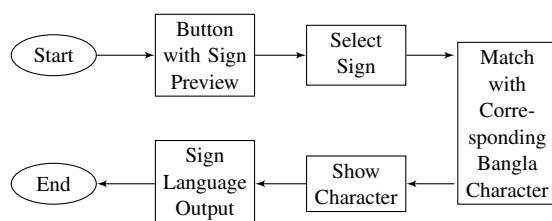

Fig. 3: Layout for the keyboard of the proposed system

4. IMPLEMENTATION

The implementation of this system requires designing and development of a smartphone-based software that has a Graphical User Interface (GUI) with communication medium working in between people.

4.1 Implementation of Speech to Sign Conversion

At first, the application has to be launched by clicking the launcher icon of the application. When the application is launched the home-screen appears.

The home screen contains two buttons, one to convert speech to sign language and others to launch the keyboard. Two specific types of users select the buttons according to their needs. For deaf/mute people launch keyboard button is used and for normal people convert speech to sign language button is used.

After pressing the first button on the home screen like Figure 4a, a new screen will popup. This screen comes with a list of words showing from the left side as a listview shown in Figure 4b. The list can be scrolled down to see the available words. There are more than 200 Bangla words available on the list. If suffixes are added during speech, it is handled by recursive functions. Upon pressing the microphone button, Google's speech recognition is initiated. The user has to provide his/her voice as soon as they hit the microphone button. The voice is sent to Google for Bangla audio recognition as shown in Figure 4c. Following scenario shown in Figure 4d is occurred. Another button is for showing the Bangla Sign Language (BSL) output using MediaPlayer of android which is shown in Figure 4e. Figure 4 describes the overall operations performed by general users.

4.2 Implementation of the Keyboard

For the people having hearing impairment will have to choose the launch keyboard option.Figure 5 describes the process.

From the screen shown in 5a, the keyboard must be enabled and selected. The keyboard looks like Figure 5b. Typed text is shown in output section shown in Figure 5c. Hence the text can be understandable by normal people.

5. RESULTS

The system was tested with extensive experiments. In this section, It is first introduced how data are collected. Then the performance of the system is presented.

For this purpose, a school named "Mute and deaf school, Muradpur, Chittagong" has been visited before building the app for real-life scenarios. Hearing impaired and mute children were communicated for this purpose. People have been asked about their expectations by which they can help to eradicate the communication gap. Various people age varying from 20 years to 60 years were taken as respondents. The people included were:

—Principal of the deaf and mute school.

—Guardians of the students of the school.

—The students.

5.1 Experimental Design and Procedure

The honorable principal named "Md. Habibur Rahman" was very helpful to gather the necessary data from them. 6 deaf and mute students (age= 8 years to 14 years) were taken for the responses. 02 teachers, 02 guardians, and one commoner were selected as well to evaluate the system. Figure 6 provides a closer look of the situation.

5.2 Experimental Result

Table 1 demonstrates the success rate of the voice to the animation module. The system shows the accuracy of 88.0%. The main realization was that this accuracy could be higher if the internet connection had been fair enough. Again, the pronunciation of different people is varied and some people have regional accent. Again, all of the signs were not understood by the students of the school. The converted signs that were understood by the students are given in table 2 having an accuracy of 91.67%. The experi-
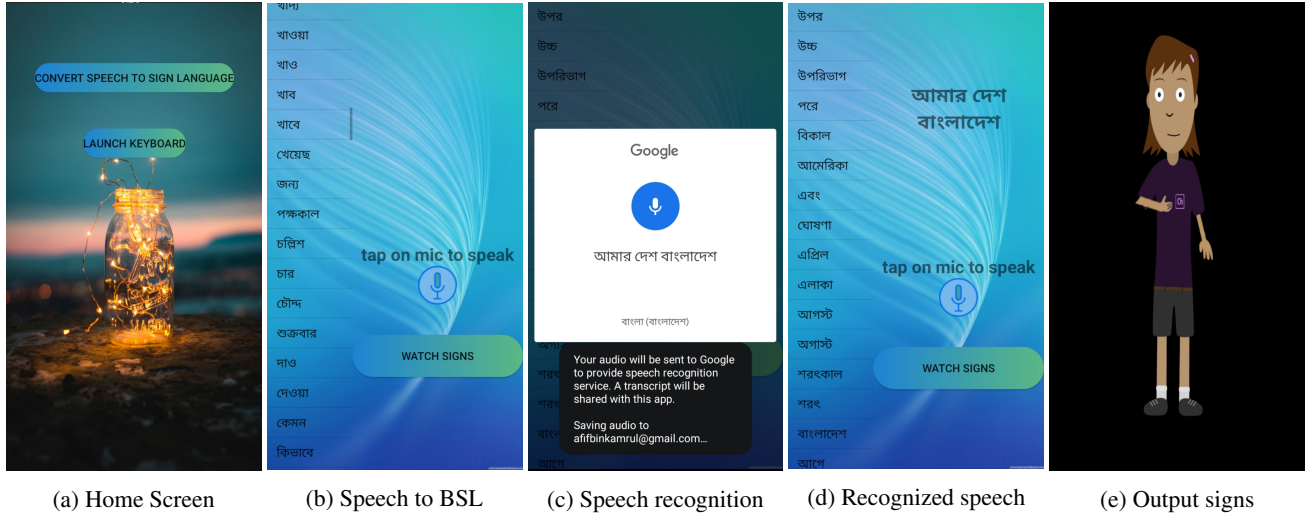
(a) Home Screen   (b) Speech to BSL   (c) Speech recognition   (d) Recognized speech   (e) Output signs

Fig. 4: Speech to sign language conversion

(a) Keyboard Setup   (b) Typing   (c) Typed Text

Fig. 5: Sign language keyboard

(a) Teacher's explaining sign to student to type on keyboard

(b) Student's verifying animated signs to teacher

Fig. 6: Experimental setup

ence was that the deaf students found difficulties to recognize on some words which have 3D motions.

The testing of the keyboard had to be done in a different way. The honorable principal of the school helped very much in this case. While testing he had shown specific signs towards the chosen students and the students had to type what they understood. The results are mentioned in table 3.

$$Mean = \frac{Sum\ of\ the\ terms}{Number\ of\ terms} \tag{1}$$

$$Standard\ Deviation\ (SD) = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \overline{x})^2}{N-1}} \tag{2}$$

5.3   Subjective Evaluation

After finishing this session, the principal was requested to ask the deaf/mute students for scoring the following questions:

(1) (Q1) Are the animated signs understandable?
(2) (Q2) Is the application boring?

Table 1. : No of times while application was able to convert voice to signs

Deaf/mute People	Teachers and general people (each having 5 trials for each student)				
	1	*2*	*3*	*4*	*5*
1	5	5	2	4	5
2	5	3	4	5	5
3	4	3	5	5	4
4	5	4	5	4	4
5	4	5	4	4	5
6	5	4	5	5	5
Mean	4.666667	4	4.166667	4.5	4.666667
SD	0.516398	0.894427	1.169045	0.547723	0.516398
Success rate	*132/150=88.0%*				

Table 2. : No of times while students actually recognized the signs

Deaf/mute People	Teachers and general people (each having 5 trials for each student)					*Mean*	*SD*
	1	*2*	*3*	*4*	*5*		
1	5	4	3	4	5	4.2	0.836660
2	5	4	3	5	4	4.2	0.836660
3	4	5	4	3	4	4	0.707106
4	5	4	4	4	4	4.2	0.447213
5	4	5	3	4	4	4	0.707106
6	4	4	3	4	3	3.6	0.547722
Success rate						*121/132=91.67%*	

Table 3. : No of times the students typed the words using keyboard

Participants	Perfectly typed words
1	5
2	3
3	5
4	4
5	4
6	3

(3) (Q3) Is the keyboard flexible to type?

The general people and teachers along with the principal were asked as well to score the following questions:

(4) (Q4) Are you facing any problem while using the application?

(5) (Q5) Do you find this application easy to use?

(6) (Q6) How interactive the application is?

People answered each question on a 1-to-5 Likert scale, where 1 is the lowest evaluation and 5 is the highest.

6. CONCLUSIONS

The proposed application can be used not only to establish a communication channel but also to educate the deaf or mute people and allow them to participate with the rest of the people in society so that they can become self-dependent. Although there are more spaces to update it forward, it can work as a framework for the development. The application can remove the hidden barrier in between the hearing impaired and normal people. For the future work of this project, many recommendations are found while taking the survey. People from all aspects of life gave suggestions to make this project a complete package. As fulfilling the user's need is the utmost motive and goal, the following areas can be considered for future improvements:

—Log-in system can be introduced for the users.

Table 4. : Q1, Q2, Q3 answered by deaf/mute people

Questions	Participants (Deaf and mute users)					
	1	*2*	*3*	*4*	*5*	*6*
Q1	4	5	5	4	3	5
Q2	2	1	2	2	1	2
Q3	5	4	4	4	5	4

Table 5. : Q4, Q5, Q6 answered by teachers and general people

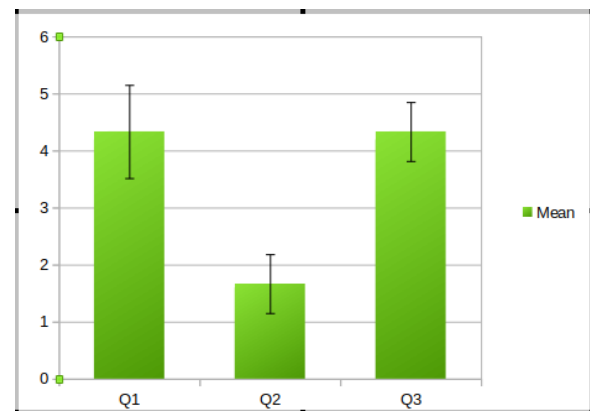| Questions	Participants (General user and teachers)				
	1	*2*	*3*	*4*	*5*
Q4	3	4	2	2	3
Q5	4	4	3	5	5
Q6	4	5	1	4	3

Fig. 7: Column chart showing subjective evaluation of answering Q1, Q2, Q3

—Word list can be increased more to support a broad range of Bangla words.

—Messaging option can be introduced.

—The keyboard layer might be modified for improvement.

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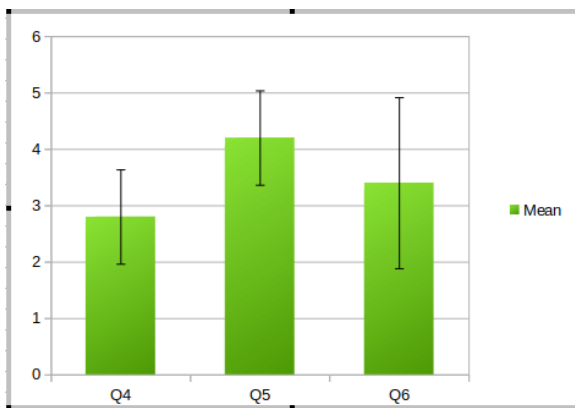
Fig. 8: Column chart showing subjective evaluation of answering Q4, Q5, Q6

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