Aidable - A Communication System for Hearing Disabled

Harsh Agarwal - 181IT117
Dept. of Information Technology
NITK Surathkal
Mangaluru, India
agrawal.harsh14@gmail.com

Dolly Gupta - 181IT115
Dept. of Information Technology
NITK Surathkal
Mangaluru, India
dolly.mailbox.gupta@gmail.com

Shraddha Gole - 181IT145
Dept. of Information Technology
NITK Surathkal
Mangaluru, India
shraddhagole10sg@gmail.com

***Abstract*—Sign Language is the most natural and expressive way for the hearing impaired. Though the sign language is self-sufficient for conversation between the hearing impaired people, there emerges a problem when normal people try to communicate with differently-abled. This project presents a methodology which recognizes the text and speech of a normal person and using the Indian Sign Language (ISL) translates it into Sign Language. The Sign Language is expressed using 3D animations. The project is developed as a Web and Mobile application in accordance with HCI Principles. The Agile approach is used in the development process and extensive feedback and surveys are taken by the users.**

***Index Terms*—Sign Language, ISL, User Experience, Natural Language Processing, Application Development**

I. Introduction

The deaf are a growing population of every nation. Communication with this group of people is a problem with just one solution, that of sign language. The deaf learn to communicate with the hearing through this dialect, if it may be called so, with a grammar and style of usage of its own. However, the ratio of deaf people to those who can interpret sign language is one of concern, with an average of 93.7:6.3 in India. The goal of this project is to benefit the deaf, who sign language is a prerequisite to communicate with, in the absence of interpreters who can translate to and from sign language and spoken languages. Hence, it greatly benefits the those who wish to communicate with hearing impaired group on day-to-day life, performing activities like face-to-face interaction with a government employee,delivering news to public which consists of deaf viewers too,teaching a group of students who can't hear etc.

This project is specially designed for Indian Sign Language.It is a new version of a speech to sign language translation system with new tools and characteristics for increasing adaptability to a new task or a new semantic domain. It consists of a speech recognizer that converts spoken sentences into utterances and silences, and recognizes it as text- a sequence of words, and a 3D video displaying the sign language interpretation of the spoken sentence. It is an adaptable system capable of reducing significantly the effort and the parallel corpus needed for adapting a speech to sign language translation system to a new domain.

II. Related Work

Deaf Mute Communication Interpreter - A Review [1] : This paper explains the different methods of deaf-mute communication systems. The two broad classification of the communication methodologies used by the deaf –mute people are - Wearable Communication Device and Online Learning System. Under Wearable communication method, there are Glove based system, Keypad method and Handicom Touch-screen.The different wearable devices make use of different sensors, accelerometers, micro-controllers, text to speech converters, etc. The need for an external device to interpret the message between a deaf –mute and non-deaf-mute people can be overcome by the second method i.e online learning system. Technology.

An Efficient Framework for Indian Sign Language Recognition Using Wavelet Transform [2]:The proposed ISLR system is considered as a pattern recognition technique that has two important modules: feature extraction and classification. The joint use of Discrete Wavelet Transform (DWT) based feature extraction and nearest neighbour classifier is used to recognize the sign language. The experimental results show that the proposed hand gesture recognition system achieves maximum 99.23% classification accuracy while using cosine distance classifier.

Hand Gesture Recognition Using PCA in [3]: In this paper authors presented a scheme using a databasedriven hand gesture recognition based upon skin color model approach and thresholding approach along with an effective template matching with can be effectively used for human robotics applications and similar other applications.. Initially, hand

region is segmented by applying skin color model in YCbCr color space. In the next stage thresholding is applied to separate foreground and background. Finally, template based matching technique is developed using Principal Component Analysis (PCA) for recognition.

Hand Gesture Recognition System For Dumb People [4] : Authors presented the static hand gesture recognition system using digital image processing. For hand gesture feature vector SIFT algorithm is used. The SIFT features have been computed at the edges which are invariant to scaling, rotation, addition of noise.

Automated System for Indian Sign Language Recognition in [5]: In this paper a method for automatic recognition of signs on the basis of shape based features is presented. For segmentation of hand region from the images, Otsu's thresholding algorithm is used, that chooses an optimal threshold to minimize the within-class variance of thresholded black and white pixels. Features of segmented hand region are calculated using Hu's invariant moments that are fed to Artificial Neural Network for classification. Performance of the system is evaluated on the basis of Accuracy ,Sensitivity and Specificity.

Hand Gesture Recognition for Sign Language Recognition: A Review in [6]: Authors presented various method of hand gesture and sign language recognition proposed in the past by various researchers. For deaf and dumb people, Sign language is the only way of communication. With the help of sign language, these physical impaired people express their emotions and thoughts to other person.

III. Methodology

In this section, we describe the structure of the proposed solution to convert text or speech into corresponding sign language animation .

The overall framework is a combination of several independent processes. Fig. 1 depicts the overall framework of the system.

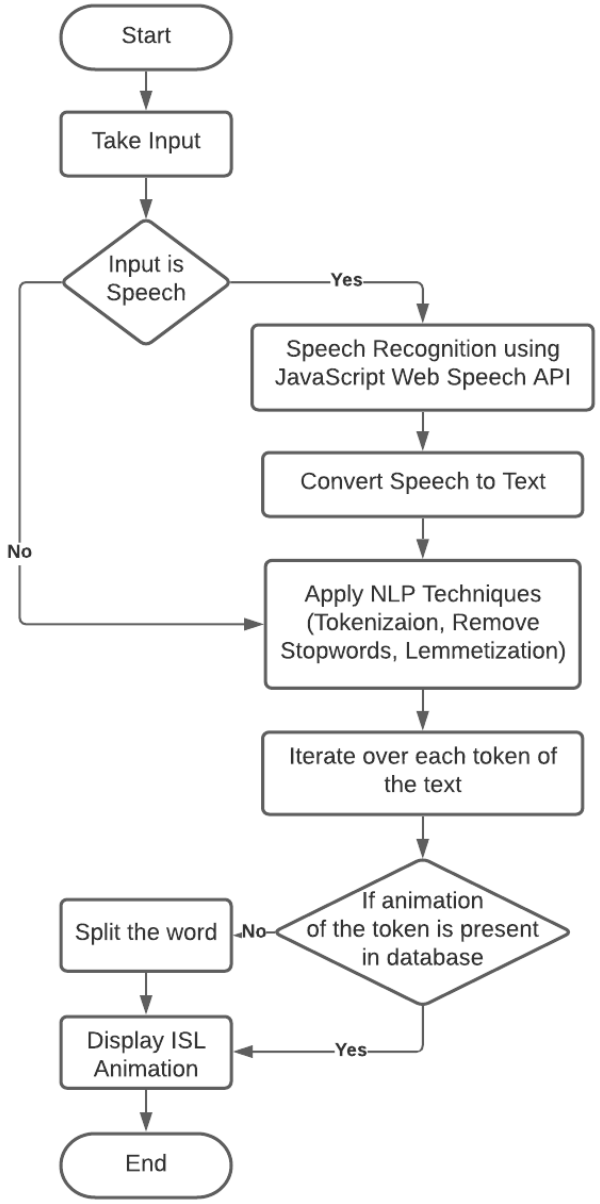

Fig. 1. Overview of the proposed solution.

A. *Getting the Input*

The first process of this framework is to take input from the user. User can either enter the text manually into input box or can record the speech live using the mic button.

B. *Speech Recognition*

If input is an audio speech, it is recognised using JavaScript Web Speech API. After Recognition, the speech is converted into text and then the text is displayed into input box.

C. *Applying NLP Techniques*

Various Natural Language Processing (NLP) techniques are applied to transform the free (unstructured) text into

normalized, structured data. The text sentence is tokenized, stop words are removed and then Lemmatization process is applied to remove inflectional endings only and to return the base or dictionary form of a word.

D. Displaying Indian Sign Language Animations

The tokenized words are processed one by one. For each word the relevant Indian Sign Language animations is displayed from the database. And if for any word, animation is not present in database, the word is spitted first and then animations corresponding to each letter is shown.

IV. Experiments and Results

We designed the User interface keeping in mind the following HCI guidelines:

- Consistency and standards.
- Aesthetic and minimalist design.
- Ask for authentication of any non-trivial critical action.
- Authorize easy reversal of most actions.
- Let the user customize the input (text or audio speech).
- Used standard labels, abbreviations and probable colors.
- Hick's Law is followed to simplify the decision-making process.
- Generate meaningful error messages.
- Used windows (different tabs in navigation bar) to classify different types of information.
- Tutorial is provided to help, diagnosis and recovery from errors.
- Offer Informative feedback.

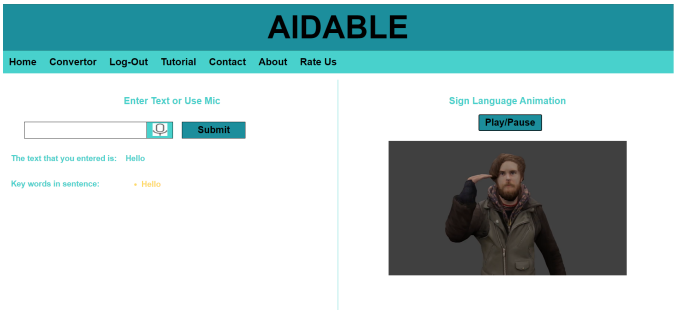

Fig. 2. UI Design

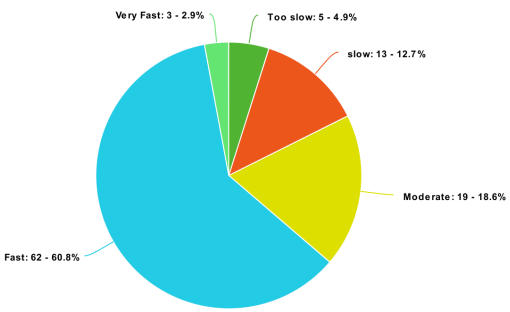

Fig. 3. Results for System and Web Application Speed

Fig 2 shows a snapshot of the animation interface used in Aidable to display the equivalent hand signs in Indian Sign Language. The text input taken as speech is "Hello" as shown on the left side of the interface, which is translated by the 3D avatar on the right side.

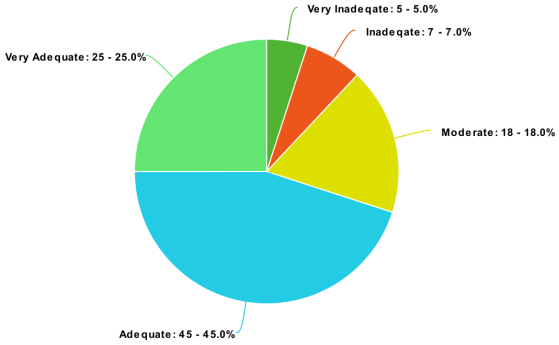

Fig. 4. Results for Adequacy of the Animations corresponding to signs

To check the usability of our product, we preformed Empirical Research Analysis by collecting the quantitative data through a survey from specific number of respondents. The survey contained a set of questions from different sections as follows:

- Screen
- Terminology
- System Information
- Learning
- System capabilities
- Usability and UI
- General Impressions

We used the 5-point Likert Scale for rating in each question. From results, we analysed that it did not take much time for a user to get familiar with the Aidable. It took only around 10 minutes for 53% users in doing so. It can be seen in fig 3. that around 61% users rated the system and Web Application Speed as fast. We tested the adequacy of the animations that were shown corresponding to each sign and found that around 25% rated it as very adequate and 45% as adequate as shown in fig. 4. These were the results of some of the questions from the survey. From the results of the overall survey, we analysed that our product performed quite well in all aspects of HCI.

We also undertook the **Cost and Benefit analysis** of our Project for a period of 8 years considering the product is launched in the market as a scalable and end-to-end tool. We analyzed the Cost Profiles in the sections of Hardware, Software, Telecommunication Equipments, Contracts, Labour, Infrastructure, Training Costs and Other Post implementation costs. The overall cost for 8 years was projected to be **Rs. 12,80,000**. Similarly for the benefits Profile we considered Liquid Revenues, Cost Reductions, Reimbursements form Govt. Agencies, Outsourced funds and Venture Capital Funds. The total benefit came out to be **Rs. 2,18,00,000**.

V. Conclusions and Future Work

As part of this project, we developed Aidable, an app which can translate any spoken language into Indian sign language as a 3D animation.This system would be helpful in schools, hospitals and public meetings, in the place of an interpreter, to convey message to the deaf.

As part of future work, we can focus on improving the real time and continuous speech input more accurately. To make the app more appealing and personalised for a user, multiple 3D avatars can be included.It can also be developed for different regional languages, in India, to solve the problem of communication with the deaf even for small regional language groups.

Acknowledgments

We would like to thank Prof. G Ram Mohan Reddy and Mr. Ranjit Kolkar who helped us shape the idea of our project.

Individual Contributions

Fig. 5. Gantt Chart of the Project

The Individual Contributions of each of the three project members are as follows:
Harsh: Text to Speech Conversion, Django App Development, User Survey, Sign Language Tutorial and Documentation.
Dolly: NLP Techniques, Django App Development, 3D ISL Animations, Sign Language Tutorial and Documentation.
Shraddha: Django App Development, UI Design, User Survey, User Ratings and Tutorial.

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