Impact of Sign Language Recognition Systems in the Education of Hearing Impaired Students

Ankita Wadhawan
Assistant Professor, Computer Science and Engineering Department
Lovely Professional University, Phagwara, Punjab, India

Abstract: Sign language is an important method of communication among the deaf and hearing impaired people around the world. In India, there are 19% of the disabled persons having hearing disability and it is necessary to educate them so that they can come forward in the society and withstand with the other persons. Education is important for every human that nowadays is explicitly stated in various international documents of many countries. However, the education of deaf children has not received enough importance in India so far. This caused a major lack of infrastructure and support to the cause. Children in villages and remote areas of India that are hearing impaired have very less chance of getting quality education. The use of sign language is very rare and mostly ignored. The times are now changing and Indian Sign Language is slowly getting importance. As Indian education is mostly based on oral skills and it conflicts with the education of children who can't speak and hear, due to which the growth in education sector for hearing impaired children in India has hampered. However, a change in the mentality and attitude is gradually becoming apparent and Indian Sign Language recognition systems appears as a vital resource of hearing impaired education in many parts of the country.

In this paper, an Indian sign language recognition system used for educating students is proposed. The objective of this study is to understand the experiences of hearing impaired students who attended deaf schools and identify with the deaf culture. This paper presents the current status of education of hearing impaired students in India. It also presents the major challenges or hindrances that come forward in the education of hearing impaired and how the proposed system of sign language recognition helps to address these challenges. In the proposed system, the depth data collected using Microsoft Kinect has been used to recognize forty static signs of Indian Sign Language (ISL). All the signs are recorded by using Kinect Studio and Visual Gesture Builder (VGB) has been used for analyzing and tagging of the recorded clips. The recorded clips are analyzed using depth, skeletal and IR data at various angles and positions. The system is trained with 80 samples collected for each of the forty static signs by using AdaBoost machine learning approach. The proposed system achieved an average accuracy of 89% for forty static signs. This study will help the hearing impaired to learn new words used in their daily routine.

Keywords: Sign Language Recognition, Microsoft Kinect, Hearing Impaired, Data Acquisition, Adaboost, Kinect Studio, Visual Gesture Builder

1 Introduction

Sign language is an important method of communication among hearing impaired people and deaf community, which includes friends, interpreters, deaf people and their families. It plays a vital role in eliminating barriers faced by differently abled people while conveying messages to others and contributing to the society. It is a form of visual language using hand and arm movements including facial expressions and lip motion. Sign Language is the language of its own as it has its own grammar, syntax, phonology and syllable structure. It is not the translated version of English. Sign language consists of rules that help and guide the users to communicate correctly [1].

Sign language recognition system will bridge the communications between hearing impaired and those without impairment of hearing. The rapid and continuous development in the sign language research area is due to the advancements in recent technology related to computers. Sign language recognition is a collaborative research area

which involves pattern matching, computer vision, natural language processing, and linguistics. Its objective is to build various methods and algorithms in order to identify already produced signs and to perceive their meaning.

This paper focuses on the current status of education of hearing impaired people in India. It also describes the major challenges faced by them in education and how the proposed sign language recognition system helps to address these challenges.

2 Current State of Education of Hearing Impaired People in India

In India, "hearing handicapped" as defined by the Rehabilitation Council of India Act., is - hearing impairment of 70 dB and above, and total loss of hearing in both ears. This law is suitable for the persons having relentless hearing impairment whose hearing loss is 70 dB and more. A person with hearing levels of 61–70 dB, is automatically excluded from the hearing handicap category [2].
According to India Census 2011, 19% of Indians with disabilities have hearing impairment. 99% of people with hearing disabilities in India are not matriculates [3]. They drop out after Class VI or VII, because they are not able to cope. Hearing impaired people use sign language for communication with one another. Most of these people are raised in such an environment where there is no proper knowledge and resources which lead to unemployment and make it difficult to survive in the society. The main reason for their illiteracy is the use of sign language as a communication medium as it is not understood by all. Also, there is a lack of sign language interpreters in India and most of the schools don't provide learning through sign language. Due to this illiteracy, hearing impaired people are not able to contribute in the development of the country.

3 Major Challenges in Education of Hearing Impaired People

Due to lack of resources and special platforms, hearing impaired people faced many challenges. The major challenges that come forward in the education of hearing impaired people are discussed below.

Classroom Acoustics: Deaf or hard-of-hearing students require full visual access, so it is required to arrange desks in "U" shape for full student participation.
Lighting: Special sound that omits from fluorescent lights interferes with hearing aids, which make it difficult in understanding the lectures.
Language Deficiencies: Remember that some hearing impaired student's first language may not be English. Make sure to implement an appropriate service of interpretation that will effectively deliver the lecture in their basic language.
Inadequate Knowledge and Awareness: If teachers are instructed on how provide knowledge to hearing impaired students, it could be totally different for the next, which results in an academic gap.
Collaboration: Due to hectic schedules and work load during the school, it is often difficult to conduct regular and collaborative meetings with the persons that are demanding components to a hearing impaired student's academic progress.
Social Concerns: Children who are hearing impaired often tend to feel demotivated and awkward in the class when outlining attention to their problem of hearing.
Curriculum and Instruction: Some teachers require all students to take notes during the class. As a suggestion, students should be provided with a digital copy or written of lecture notes in hand before the lecture.
Lack of Resources: Often schools are not capable of providing their hearing impaired students with the proper and latest technology that could significantly enhance the learning development process.

4 How Proposed System of Sign Language Recognition Help to Address these Challenges

In this paper, a sign language recognition system is developed to recognize different Indian signs used in the daily routine of hearing impaired people. The proposed sign language recognition system helps to address the above discussed challenges in the following manner.

A well-established environment with proper lighting conditions has been maintained in a classroom for hearing impaired students so that they can have clear visual access. The proposed system make use of recent technology

like Microsoft Kinect, Kinect studio, Visual Gesture Builder (VGB) for acquisition and recognition of signs which helps in increasing the learning development process. As some student's first language is not English, the proposed system displays picture corresponding to the text at the time of sign recognition. The use of pictures helps them in learning. Instructors are also required to provide hearing impaired people with written information beforehand. With the help of this the hearing impaired students can have quick access, learn and feel comfortable in the classroom.

5 Proposed System Architecture

The proposed architecture for sign language recognition system is presented in Figure 1. The system mainly consists of four phases. First is the data acquisition phase which helps in capturing of the data with the help of Microsoft Kinect. Second phase is tagging of the data, in which the recorded clips are tagged by using Visual Gesture Builder. Next, the system is trained with the AdaBoost classifier which results in building the database model. The last phase is sign recognition, in which the system is tested based on the model trained in the previous phase. The detailed description of each phase is discussed as follows.

5.1 Data Acquisition

Data acquisition is the process of collecting the information from the device and storing them in the database for processing. In the proposed system, Kinect Studio is used for recording clips of each sign. The recorded clips are saved with *.xef* format.

In this phase, 40 Indian Sign Language (ISL) words have been collected from 10 different signers. Each of the ten signers was asked to repeat each sign eight times resulting in a total of 80 repetitions of each sign which corresponds to the vocabulary size of 3200. The data has been collected in different environments, at different tilt angles of the Kinect and at different height positions as body joints are observed differently at different angles and heights. As clothing in India varies across different parts of the country, we have recorded the data from the people wearing the variety of clothing like pants, suits, turban and woolens.

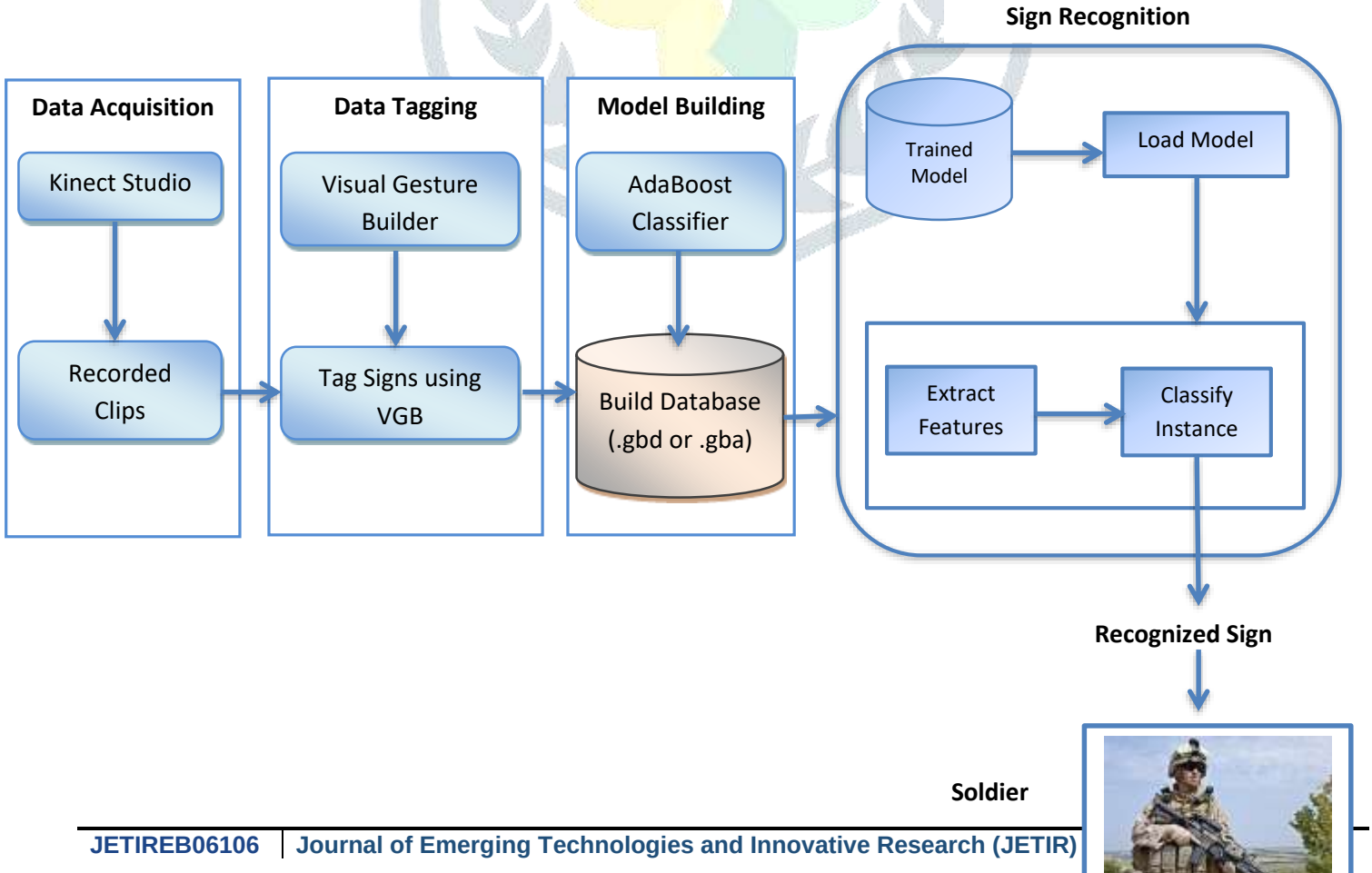

Figure: 1 Proposed System Architecture

5.2 Data Tagging

In this phase, the signing clips recorded using Kinect Studio (*.xef* format) are tagged using VGB tool. The process of data tagging helps in evaluating whether or not a sign has occurred and identifies the confidence of each sign.

Tagging is performed by navigating through the clip and stopping at the starting of the particular sign, group the key frames until a point where a sign is not being performed is reached. The tagging has been performed with utmost care to avoid over-labelling , *i.e.*, only the core portion of a sign is marked which uniquely represents an action and the motions in which a person is getting ready for performing some action are avoided. For example, while tagging a 'Back' sign, the frames in which the person is moving his hand in the backward direction are not tagged; rather the frames after which the user has moved his hand towards the back are tagged.

5.3 Model Building

In the proposed system, the tagged data is trained by using the machine learning algorithm named as AdaBoost classifier. This process creates a sign database file with *.gbd* extension, which is then loaded into any application during runtime. AdaBoost classifier accepts Boolean values as input tags during the time of training. The true Boolean value indicates that the sign is being performed and marked it as a hit. This learning algorithm can adaptively choose best features and combine them into a strong classifier [4] [5] [6].

5.4 Sign Recognition

Once the tagging is complete, VGB created a database using machine learning technique. The signs were tested in different environments and at different distances from the Kinect to signify the position after which the signs can no longer be recognized. In this phase, the users perform some sign and the corresponding picture with text has been displayed on the screen. This helps hearing impaired people to learn different words used in their daily routine.

6 Experimentation and Results

To test and assess the result a number of clips were recorded and the dataset is trained by tagging frames to detect different signs. During training 80 samples for each of the 40 signs were collected. Each of the 40 signs in the system has been tested and the average accuracy of 89% is achieved as given in (1).

$$Accuracy = \frac{Total number of signs - Number of\ false signs}{Total number of signs} \times 100 \quad (1)$$

In order to quickly test and prototype the result, VGB Live Preview tool is used which enables us to view the results of signs in real-time without integrating the already created database into an application. Figure 2 represents the live previews of the sign 'sun'.

Figure: 2 Live Preview of sign 'Sun'

7 Conclusion and Future Scope

Sign language recognition system helps in recognizing different signs and is used by the hearing impaired community to communicate. Although, the number of schools are available for educating hearing impaired students but the literacy rate is still very less. So, the sign language recognition systems are required as these are the Human Computer Interaction based systems that provide facilities to hearing impaired people to get knowledge, education, learn new facts, and help them in making their career. In this paper, an Indian Sign Language recognition system is developed that help hearing impaired people to learn different words used in their daily routine on their own. The proposed system can detect different signs and presents the corresponding text for the same which helps in reducing the communication gap between the normal and the hearing impaired people.

Presently, the proposed system handles limited number of static signs. In future, the system will be tested for more static signs as well as dynamic signs.

References

[1] Dasgupta T., Shukla S., Kumar S., Diwakar S., and Basu A., "A Multilingual Multimedia Indian Sign Language Dictionary Tool", *In Proc. of International Joint Conference on Natural Language Processing*, Hyderabad, India, pp. 57-64, 2008.
[2] The Rehabilitation Council of India Act, 1992, Ministry of Law, Justice and Company Affairs (1992), Available: http://www.rehabcouncil.nic.in/engweb/rciact.pdf. [Accessed: Feb 2016].
[3] Javed Abidi, '99pc of people with hearing disabilities in India are not matriculates', Available https://yourstory.com/2016/12/hearing-disabilities-india/, [Accessed: 3, Dec 2016].
[4] AdaBoost. http://www.nickgillian.com/wiki/pmwiki.php/GRT/AdaBoost (2014). Accessed 17 April 2014.
[5] Freund, Y. and Schapire, R.E., "A decision-theoretic generalization of on-line learning and an application to boosting", *Journal of Computer and System Sciences*, vol. 55, no. 1, pp. 119–139, 1997.
[6] [26] Schapire, R. E. Explaining adaboost., "In Empirical inference", *Springer Berlin Heidelberg*, pp. 37-52, 2013.
[7] Ibañez R.; Soria Á.; Teyseyre A. and Campo M., "Easy gesture recognition for Kinect", *Advances in Engineering Software*, vol. 76, pp. 171-180, 2014.
[8] Lang, S.; Block, M. and Rojas, R., "Sign language recognition using Kinect", *In Artificial intelligence and soft computing*, Springer Berlin/Heidelberg, pp. 394-402, 2012.
[9] Li, H.; Yang, L.; Wu, X.; Xu, S. and Wang, Y., "Static hand gesture recognition based on HOG with Kinect", *IEEE 4th International Conference on Intelligent Human-Machine Systems and Cybernetics (IHMSC)*, no.1, pp. 271-273, 2012.
[10] Tiwari, V.; Anand, V.; Keskar, A. G. and Satpute, V. R., "Sign language recognition through kinect based depth images and neural network", *IEEE International Conference on Advances in Computing*, Communications and Informatics (ICACCI), pp. 194-198, 2015.