# Hand Sign Communication System for Hearing Imparied

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***Abstract:-*** **A sign language is used by hearing impaired people to communicate. This communication is manual instead of using sound to convey meaning (simultaneously combining handshapes, orientation and movements of the hands , facial expressions, arms or body, and to fluidly express a speaker's thoughts). Some of the Sign languages like oral languages organize elementary, meaningless units (phonemes) into meaningful semantic units. Every sign language has fingerspelling as an important component. Fingerspelling is a standardized series of handshapes used to form a word. Different shapes of the hand and fingers forms letters. Each word is then spelt out. It is used mostly for proper nouns. The proposed method aims to convert letters of english to the appropriate American Sign Language (ASL) hand signs which can be comprehended by the deaf. In order to generate the signs the corresponding handshapes are called from a storehouse of pre-made hand shapes and are animated on the screen. Hence the proposed system operates as an translator to communicate with the hearing impaired people.**

***Keywords: ASL, hand signs, Degree of freedom, Graphics transformations.***

## 1. INTRODUCTION

There exists a communication gap between the hearing and the deaf people. To become readers, children should learn the mapping between the spoken language they already know and words printed on a page. For most languages like English, that mapping is based on sound. Once children understand the principles of the mapping print-sound they can recall their knowledge of spoken language to facilitate the reading process. The hearing impaired children do not have access to the phonological code easily. Most of them do not know languages well, let alone the language be captured in print and hence are at a disadvantage. So most deaf people have difficulty in reading the written form of a spoken language.

The Gallaudet Research Institute found that young deaf and hard-of-hearing adults aged 17 and 18 had an average reading score that was the same as that of the average ten-year-old hearing child [1]. Only 15% of white deaf students graduated from high school, and only 5% of African-American and 6% of Hispanic deaf high school graduates, read above the sixth-grade level (Allen, 1994). Indeed, the median reading level of deaf high school graduates is a fourth grade (Allen, 1986). This level barely approaches newspaper literacy. Thus, much meaning from print cannot be got by a majority of deaf children (and deaf adults). This means that deaf people have difficulty conversing with non-signers, watching movies and television, and reading books and the World Wide Web.

This problem is overcome, by developing communication system that converts the English alphabet to appropriate hand signs of ASL-American Sign Language, which is used in communication between hearing and deaf people and also among deaf people.

## 2. LITERATURE REVIEW

### *2.1 American sign Language [ASL]*

American Sign Language (ASL or Ameslan) is the dominant sign language of the deaf community in the United States, in the English- speaking parts of Canada, and in parts of Mexico. It is also predominant in South India. The fourth most commonly used language is American Sign Language in the United States. It is a visual language with its own grammatical rules and semantics.

The sentence structure in ASL primarily is Object-Subject-Verb and Topic-Comment . For example, in the sentence "I want the pen", I is the subject, pen is the object, and want is the verb. The sentence, therefore, would be signed as "PEN, ME WANT". To add a time element, such as "I want the pen tomorrow", first place the time component at the beginning of the sentence, making it look like: "TOMORROW PEN ME WANT".

### *2.2 Human Hand Motion*

The human hand is an organ which is complex and capable of both gross grasp and fine motor skills. In spite of many successful high-level skeletal control techniques, animating realistic hand motion remains tedious and challenging due to the high degrees of freedom [DoF] in hand geometry[2]. The human hand is an object which is highly articulated, and it is also highly constrained. There are dependencies among fingers and joints. The common ones are the constraints of joints within the same finger, the maximum range of finger motions, and constraints of joints between fingers.

The human hand skeleton is composed of 27 bones. These bones can be divided into three groups:

- eight carpals
- five metacarpals
- phalanges

The carpals are found in the wrist, the metacarpals in the palm, and the phalanges are the finger bones. Joints between these bones will vary in the number of degrees-of-freedom they possess. The number of degrees-of-freedom at a joint is the number of axes-of-rotation at that joint. The fig 2.1 illustrates the bones mentioned above, their joints, and the number of degrees-of-freedom (indicated by DoF) at each joint:

It is necessary to introduce at this stage the medical terminology that defines a movement in the hand. Flexion refers to the movement of fingers towards the palm. Extension refers to the movement of the fingers away from the palm.


Fig 2.1: Anatomy of the Human Hand

Abduction refers to movement of the fingers away from the plane that divides the hand between the middle and ring fingers. Abduction refers to the movement of fingers towards this plane. The same terminology is used in relation to the thumb. All the fingers have the same essential structure[2].

The MC joint exhibits 1 DoF, the PP exhibits 2, the MP exhibits 1, and the DP exhibits 1. Each of these joints exhibits flexion and extension. However, only the PP joint of the fingers exhibits abduction and adduction. Note that all of this motion is being generated at the metacarpals and phalanges. There is a certain degree of motion generated in the carpals (wrist bones). The thumb has a more complex structure. The MC joint exhibits 3 degrees-of-freedom, the PP exhibits 2, and the DP exhibits 1. The MC joint exhibits flexion/extension, abduction/adduction, and also rotation about the axis of the metacarpal. The PP joint is similar to the PP joint of the fingers in that it exhibits flexion/extension and abduction/adduction. The DP joint exhibits flexion/extension. In total, the hand model has 26 degrees-of-freedom [2]. One of the way to analyze the hand motions is the appearance-based approach, which provides analysis of hand shapes in images[3]. A statistical system was developed from translating speech to sign language for deaf people based on Automatic Speech Recognition (ASR) system [4]. A tree-based approach is used in which an efficient greedy random algorithm is discussed to obtain a good approximation of prototype for generating hand-drawn patterns [5]. American finger-spelling recognition system by using a vote method is discussed [6]

Sign synthesis is a textual representation that is converted into fluid signing. The elements of a sign are Handshape, Orientation (or Palm Orientation), Location, Movement and Facial Expression, summarized in the acronym HOLME. This resulted as a potential solution to communication problem. If deaf people can understand sign, the assumption is that all that is necessary is to convert speech or writing into sign, and the communication problem is solved.

- The most common way of recording spoken languages is to write them, but sign languages are almost never written.
- Video clip technology: The video clip technology uses digital recordings of actual signers to produce realistic images and motion of finger spelling and sign phrases.
- Computer generated animation.

There have been several attempts to create writing systems for sign languages, but any deaf community has adopted none for widespread use. This failure to record and represent sign languages has resulted in the recording problem.

One often-advocated solution to the recording problem is video clip technology, but that brings up two other problems, the storage problem, and the bandwidth problem. As the video takes up more storage space, it takes proportionally longer to transmit from one place to another (the bandwidth problem). Also in the video method, recordings of various handshapes are concatenated together to produce hand signs. However, such an approach is doomed to failure because it is disruptively unnatural when letters are simply strung together in a concatenation scheme to form a word. So sign synthesis must appear as humanoid as possible .

## 3. PROPOSED COMMUNICATION METHOD

The aim of the method proposed is to integrate hearing impaired individuals in society using sign language communication, for example to make public services easily accessible, active participation in e-learning. Large number of organizations which offer diverse services will have to address the issue of communication with sensory impaired people. At present, such communication relies heavily upon human sign language interpreters, but there can never be enough of these skilled individuals to be present at every face-to-face interaction or even to sign a large proportion of broadcast television. This method can be suitably extended to widen its scope and then used in the following below mentioned areas:

- Television & Broadcast Transmission

Deployment of virtual human synthetic signing in broadcast television. Such signing will supplement existing human sign transmission to enable a far greater percentage of programmes to be signed.

- Multimedia and WWW Applications

Generation of on the fly handsigns for various multimedia and WWW applications, thereby letting the deaf harness the power of the Web and as a result enabling them.

- Face-to-Face Transactions

Developing applications that will enable face-to-face transactions in public places such as post offices, health centres and hospitals, advice services, and shops.

### *3.1 Architecture*

The proposed work is divided into three main modules

• HandShape (HandshapeLeft and HandShapeRight). HandShapeLeft and HandShapeRight are used to get the basic structure of the left hand and right hand respectively. Both are nearly the same except a few orientation values being changed.

• HandSimulationLeft and HandSimulationRight are using the above modules to define the motion of the left hand and right hand respectively. Both are nearly the same except a few orientation values being changed.

• HandSimulationApp generates and displays applet.

The fig 3.1 decipts the block diagram of the proposed method. The input is given through the keyboard. The initial and the target values of handshape are passed by HandSimulationApp to HandSimulation. Then the module HandSimulation calls getHand() and the module HandShape returns the generated hand. The module HandSimulationApp calls move() to set the orientation of the finger or the hand. Finally the HandSimulation module displays the final transformed handshape on the output screen.

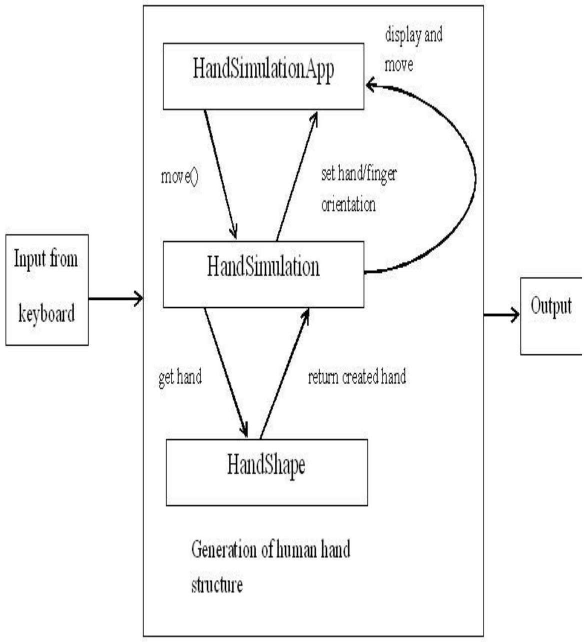


Fig 3.1: The System Architecture

This proposed method can overcome the storage problem and bandwidth problem by animating the entire process of sign synthesis. This application store signs as parametric data, allowing run-time generation of sign movement through interpolation and display of computer graphics primitives.

### *3.2 Methodology*

The elements of a sign are Handshape, Orientation (or Palm Orientation), Location, Movement and Facial Expression, summarized in the acronym HOLME.

For the 3D modeling of the human hand Java3D, an interactive 3D graphics Application Programming Interface(API) library is used. It in turn uses the lower level OpenGL specification API's. Finally, the generated handshape with the motion translates the input letter into the form understood by the deaf.

A set of keyframed poses are generated through animation. Joint angles are interpolated by the system , the system also calculates modelled joint positions using robot kinematics, and 3D human model is rendered in real-time. This technique allows smooth animation between and within stored signs, as well as more flexible control of the 3D model display. Geometrical parameters used for animation are: Finger orientation: rx, ry, Finger geometry:

rr (bending), Translation and rotation parameters of wrist (six degrees of freedom).

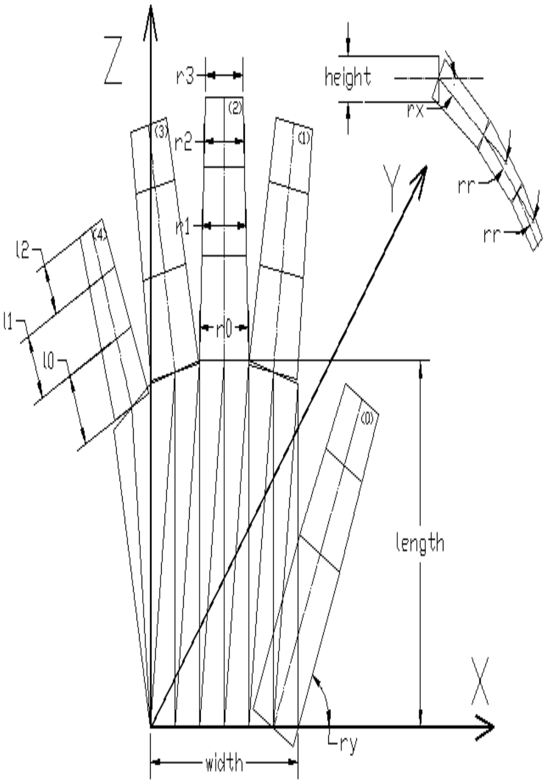


Fig 3.2 Hand Shape Properties

The hand properties shown in fig 3.2 are as follows: l0, l1, l2 represent the length of the three parts of each finger. r0, r1, r2, r3 represent the radius of each part of the finger. **rx** is the rotation angle of fingers along x-axis. **ry** is the rotation angle of fingers along y-axis. **rr** is the bend angle of fingers.

Then the transformation matrixes for all the fingers are generated. First the transformation of the hand is calculated by using the rotation angles for the hand. The translation of each of the fingers is calculated using the radius of the fingers. By using the translation of the fingers and the hand transformation matrices the finger transformation matrices are generated.

Using the length of palm, the radius of the fingers and the wrist transformations the co-ordinates of the palm are generated. The palm is divided into the front and the back faces. The co-ordinates of the front face is generated first. Then the co-ordinates of the back face are nothing but the reflection along the y-axis.

## 4. EXPERIMENTAL RESULTS AND COMPARISONS

The generated signs for each alphabet of the proposed method are compared with the hand signs which are a part of standardized ASL.

The evaluation of the output showed a high degree of resemblance to the standard ASL hand signs. As a result there was a good percentage of successful recognition of the hand signs.

The fig 4.1(a) shows the hand sign for the alphabet L generated by the proposed method and fig 4.1(b) shows the hand sign for the alphabet L by ASL. The fig 4.2 shows the hand sign for the alphabet B. The fig 4.3 shows the hand sign for the alphabet R. The fig 4.4 shows the hand sign for the alphabet V.

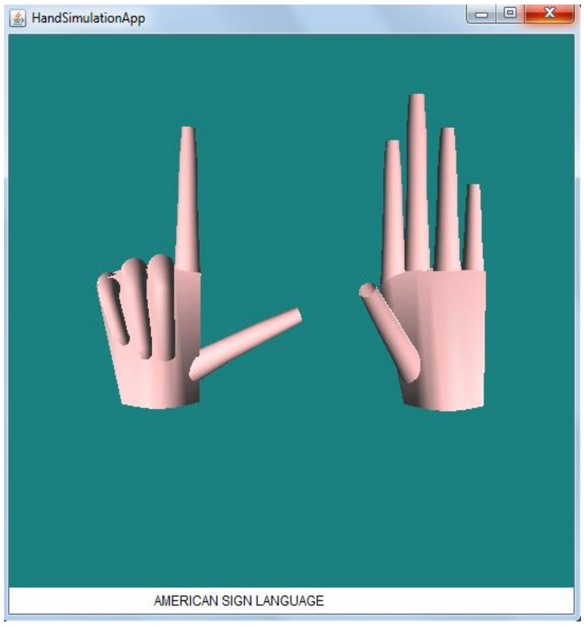


Fig 4.1 (a) Output of the Proposed Method for the alphabet L

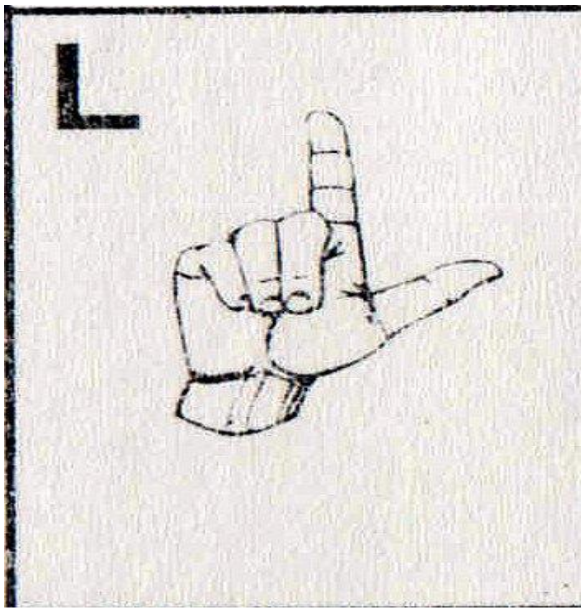


Fig 4.1 (b) Handsign for the alphabet L by ASL

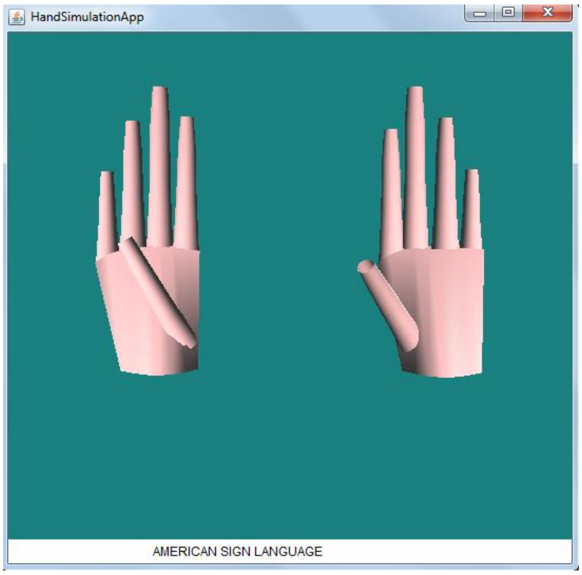


Fig 4.2 (a) Output of the Proposed Method for the alphabet B

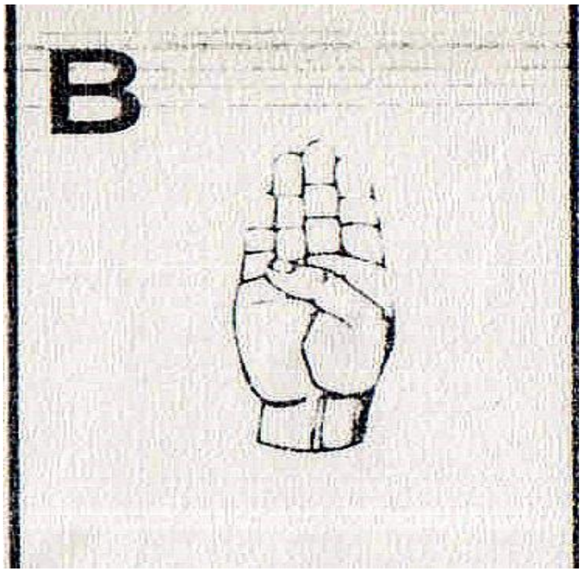


Fig 4.2 (b) Handsign for the alphabet B by ASL

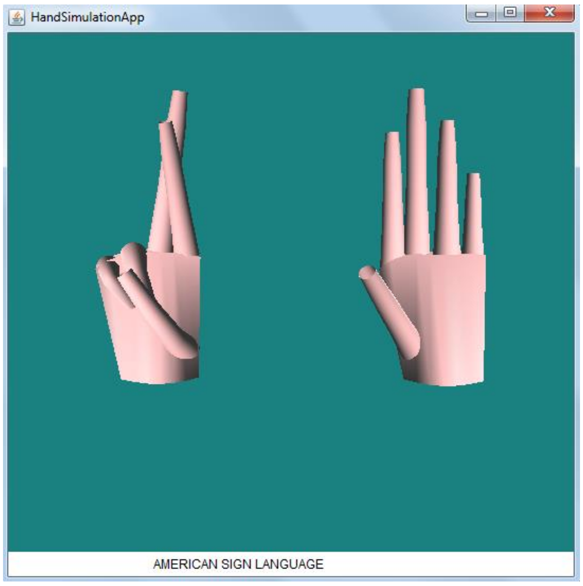


Fig 4.3 (a) Output of the Proposed Method for the alphabet R

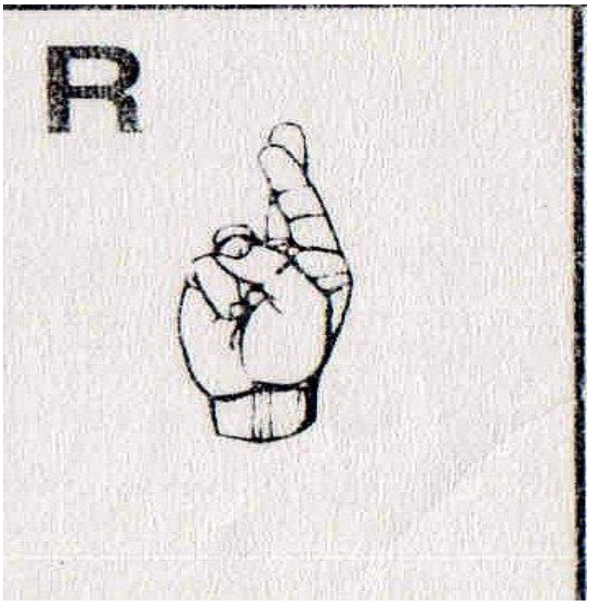


Fig 4.3 (b) Handsign for the alphabet R by ASL

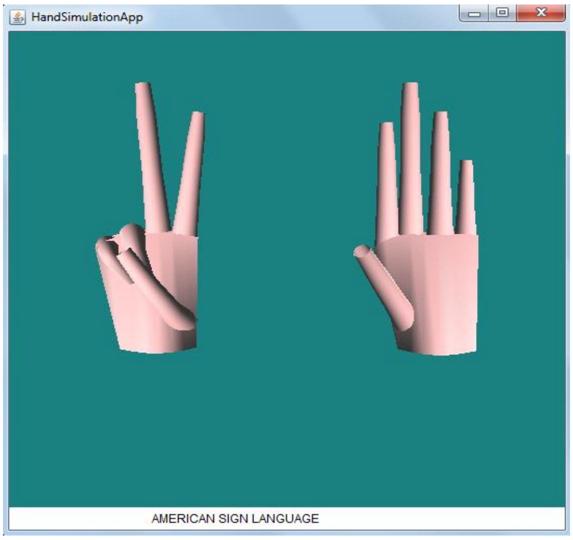


Fig 4.4 (a) Output of the Proposed Method for the alphabet V

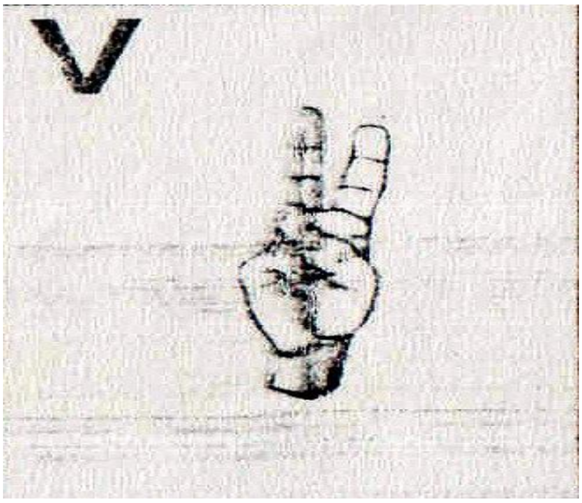


Fig 4.4 (b) Handsign for the alphabet V by ASL

## 5. CONCLUSION AND FUTURE ENHANCEMENT

### 5.1 Conclusion

The proposed method provides the means by which children at schools will be benefited by using it as an educational tool, eliminating the need for a translator or a human tutor. Thus, enriching the educational experience by providing playback facilities for easier retention.

It encourages students to learn structured sign language which will be grammatically correct and hence aid them to communicate officially. Reading the English Alphabet is extremely difficult for the hearing impaired, this method will help in conversion of academic textbooks, on various subjects of teaching, to sign language for easier comprehension. Thus making the traditional knowledge base available to the deaf.

This proposed method can be packaged with an internet browser and in real time can convert streaming text into sign language, thus opening up the world of the internet to the deaf and dumb. This is the ultimate goal, which can be achieved by future efforts.

The total memory used is approximately 500MB. The CPU usage for the execution of this application is about 40%. The time limit for the data transfer does not take more than 20s. An estimated response time to generate the output is 2s.

### *5.2 Future work*

The idea behind creating a sign synthesis system such as this was to extend it suitably and create applications in diverse fields. Through this proposed work a start for the same has been made. In future the proposed work can be enhanced in the following ways:

- To increase the database of the preconfigured handshapes to enable signing of more words and ideas too.
- To increase the interaction with the user. This would involve taking input such as letters or words from the user. On the output side the text or the words and letters being animated through the hand can be displayed.
- Real time reading and hand signing of entire WWW documents, so that the deaf are not left behind in this age of the Internet.
- The ultimate goal would be to take in a complete English sentence and handsign it back to the user. This would involve incorporating Natural Language Processing [NLP], an active research field into this project.

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