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Research Article

An Indian Sign Language to American Sign Language Translator

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Abstract

Currently there is a lot of research going on in the domain of sign language interpreters, many sign-to-text, text-to-sign, speech-to-sign, automatic conversion systems are being developed to improve the conversation between hearing-impaired people. Different countries use different sign languages, even if two countries speak same language, their sign languages are completely different. Thus, there is need for system which will translate a sign language to another sign language. The Hamburg Sign Language notation system (HamNoSys) is a type of alphabetic system for describing signs of sign language. The HamNoSys is independent of the differing regional conventions, thus enabling us to apply on virtually any sign language. By studying the similarities between different sign languages, their HamNoSys, a sign-to-sign translator can be designed which would help in strengthening then communication between different sign language users.

Keywords: *Sign language conversion, sign-to-sign language translation, HamNoSys, sign writing*

Introduction

Sign language is a visual language that is used by deaf and dumb people. Sign language uses body language and manual communication to convey the thoughts of a person. It consists of synchronized combination of hand shapes, positioning and movements of the hands, arms or body, and facial expressions. Non-Manual components of the signs in terms of the position of head, orientation of head, body posture associated with sign, the movement of eyes associated and the shape of lips also play significant role in the meaning of the signed gesture. The Facial features used in sign language are significant in expressing emotions and also in distinguishing among the sign being a question, affirmation or negation. A few signs are depicted by the use of both hands whereas others may be by the use of single hand only. The right hand is terms as the dominant hand and most of the signs are conveyed by the use of right hand only. It is difficult for deaf people to access the information available in any form other than gestures because of their language problem and hence this hinders their normal social life. Like there are different spoken languages in the world, there are different sign languages in different countries. They are developed independent of the spoken language in a particular region. For example, British Sign Language (BSL) and American Sign Language (ASL) are different, even though the spoken language used by hearing people of Britain and America is same. There is a lack of universal sign language. Different countries and regions use different sign languages. Americans who know ASL may not understand BSL. Some countries implement the features of ASL in their sign languages. American Sign Language is a language completely separate and discrete from English. It has all the essential structures of a language, with its own rules for pronunciation, word formation, and word order. Sign languages differ in how signaling different functions is done, like asking a question rather than making a statement. For example, English speakers may ask a question by raising the pitch of their voices and by adjusting word order; ASL users ask a question by raising their eyebrows, widening their eyes, and tilting their bodies forward. [13]

The Hamburg Notation System for Sign Languages (HamNoSys) is an alphabetic system describing signs on a mostly phonetic level. In HamNoSys notation of a single sign, description of the initial posture describing non-manual features is given which consist of, hand shape, hand orientation and location and the movements. For two-handed signs, the initial posture notation is preceded by a symmetry operator that defines how the description of the dominant hand copies to the non-dominant hand unless otherwise specified. [8] Specifying non-manual features and actions is optional. If the location specification is missing, a default location is set. HamNoSys notation can be generated for virtually all sign languages in the world, and the notation does not rely on conventions differing from country to country. This feature of HamNoSys enables to explore the application of inter country sign language translation.

Literature Survey

Raheja, J.L., Mishra, A. & Chaudhary, [1] A proposed a dynamic hand gesture recognition technique in real-time which would benefit the teaching and communication with hearing-impaired people. The system used a real-time video captured in 30fps, by applying skin filtering hand region was extracted. The segmentation was done based on skin pixels from extracted image in HSV colour space. Features like Hu-moments and hand motion path were extracted from image frame. Authors also used depth information in parallel for more accurate results. SVM was used for classification of gestures. The proposed system gave 97.5% recognition rate for selected 4 signs of Sign Language. Out of 80 signs 78 are correctly classified. Kumar, P., Saini, R., Roy, P.P. et al. [2] presented a position invariant sign language recognition (SLR) framework which could recognize occluded sign gestures. Most of the sign language recognition systems require the signer in front of capturing device and fail when position is varied. The skeleton information which is captured through Kinect sensor is processed through affine transformation. Hand segmentation is done after transformation which gave 3 features- angular features, velocity features and curvature features. Hidden Markov model was used for gesture recognition. The system recorded an accuracy of 81.29% for single handed gestures, 84.81% for double handed gestures and 83.77% for combined gestures. Hisham, B. & Hamouda [3] introduced a dynamic Arabic Sign Language recognition system in which a Microsoft Kinect sensor was used. It was found that the system would help in reducing the barriers faced by deaf sign language users in terms of health education. 42 different gestures related to medical field were recorded using the sensor from two volunteers at different position. The system used Kinect SDK which detects the body joint positions. It was observed that only 10 joints out of 25 were used for performing signs. Joint position normalization was performed and angle between joints was calculated. Classification was done using decision tree and Bayesian network with accuracy 91.18% and 92.5% respectively. Molina, J., Pajuelo, J.A. & Martínez [4] have proposed a realtime dynamic hand gesture recognition technique for providing natural and good interaction with computer applications. 495 videos were recorded using TOF camera, 11 users were asked to execute 5 repetitions of 9 gestures. Arm model based on human anatomy was proposed wherein the trajectory of hand motion is captured. Dynamic Time Warping (DTW) is used for comparing hand trajectories at different speeds. Results showed that the computational cost of this technique is much less that improved real-time HCI. Accuracy of 95.1% and 78% was recorded in 2 different testing scenarios. Hasler, B.S., Salomon, O., Tuchman, P. et al. [5] A real-time culture specific gesture translator using body tracking and gesture recognition was proposed, for bridging the gap between different cultures and enhance mutual understanding. The authors captured the video using MS Kinect sensor, the 11 joints' orientation data was used as input features for Hidden Markov Model (HMM). The weighted average of the output generated by HMM was compared with threshold for translation of that gesture. Authors used only 2 greeting gestures and some random movements for testing, the system was not evaluated for accuracy. J. Joy, K. Balakrishnan, Sreeraj M [6] proposed SignQuiz, a costeffective web-based application for learning finger spelled signs of Indian sign language. The application captured images of signs made by users and sent them to a server where recognition of sign was done. Alphabet learning algorithm is proposed for learning new alphabets in sign language. Two pre-trained neural network models Nasnet and InceptionV3 were used for sign language recognition which produced 97% and 99% accuracy respectively. A. S. C. S. Sastry, P. V. V. Kishore, D. Anil Kumar, E. Kiran Kumar [7] proposed a sign-to-sign language translator, for conversion of sign languages of different countries. Similarity between different sign languages was found using histogram of oriented gradients (HOG) and support vector machine (SVM) from a database of finger spelled sign language from 30 different countries' sign languages. The multi class classification rate using SVM and HOG features was 95%. K. Kaur and P. Kumar, [9] presented a system for animating English words in Indian Sign Language, using HamNoSys. The authors generated HamNoSys notation for 250 words used in dayto-day communication such as names of birds and animals, body parts, colors and shapes, dishes and spices and also the words used in school items and in basic behavior norms. The generated HamNoSys is then converted into SigML and then animated using tool JA SigML Player. Automation of "Thirsty crow" story for the purpose of learning for deaf children is done using the system. A. S. Dhanjal and W. Singh, [10] presented a comparative survey of various sign language notation systems, which can be used for the purpose of representing the Indian Sign Language in terms of symbols. The authors compared 3 sign notation systems, Stokoe cPGCON 2020 (Post Graduate Conference for Computer Engineering) notation system, SignWriting notation system, Hamburg notation system. The authors found that using Hamburg notation system for the Indian Sign Language (ISL) is more suitable than others. M. G. Grif and A. L. Prikhodko, [11] proposed a sign language recognition system for Russian sign language based on Hamburg sign language notation system (HamNoSys) analysis. The hand gestures are extracted using the OpenPose library which provides skeletal tracking of human body using deep learning. The authors propose classification of gestures based on 5 features, i.e. handshape, axis, orientation, rotation, trajectory. Sugandhi, Kumar P, Kaur S., [12] proposed an avatar-based dictionary for translation of text to Indian sign language. Their system used HamNoSys and SigML for conversion of

text to animation of ISL. The dictionary has 2000 English words, 3286 Hindi Words, 110 sentences. The system can be used for learning ISL words, sentences.

Proposed Methodology

A. *System Overview:*

The following section describes the system overview, the phases of translation system.

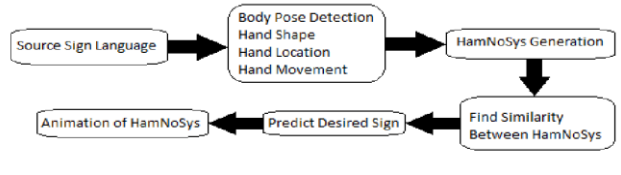

Figure 1: System Overview

B. *Translation Algorithm*

The proposed sign-to-sign translation algorithm is given:

Step 1. Obtained source sign language in the form of videos/images.
Step 2. Pre-processing of frames as needed Brightness, Contrast Modification.
- Scaling, Cropping.
- Smoothening, Sharpening.

Step 3. Body Pose Estimation
- Produce key points *Step 4.* Hand Trajectory analysis Hand Location.
- Hand Shape.
- Hand movement.

Step 5. HamNoSys generation will be performed.
Step 6. Comparison of HamNoSys using similarity measures
Step 7. The terms with most similarity will be selected, and the word from desired sign language will be predicted.
Step 8. The most similar HamNoSys will then be converted into SigML and animated using SigML Player tool.

Result and Future Work

The database of words from Indian Sign Language and American Sign Language will be created, which has words and their corresponding HamNoSys symbols. The videos related to both the sign languages will be stored on the local file system. The Body Pose estimation phase will produce following output:

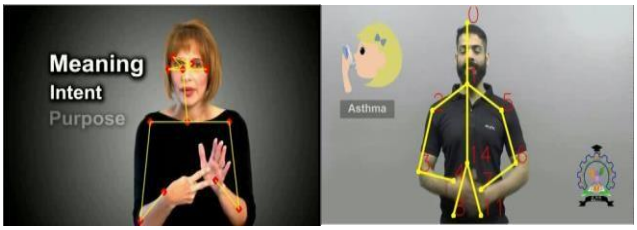

Figure 3: Human Body Key points

HamNoSys generation step requires the features such as Hand Shape & Orientation, Hand location and Hand movement.
Example of HamNoSys is: Indian sign language term for Diarrhea

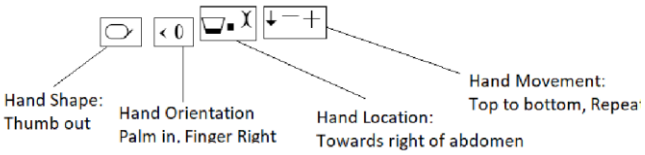

Figure 4. HamNoSys of ISL Diarrhea

After the HamNoSys generation, the HamNoSys of the desired sign language can be animated using the SigML tool. The SigML takes SigML as input. The HamNoSys to SigML conversion tools such as the e-Sign Editor are available. Figure 4 shows the sample SigML file generated from tool eSignEditrot[14]

```
<sigml>

    <hns_sign gloss="$PROD:">
        <hamnosys_nonmanual>
        </hamnosys_nonmanual>
        <hamnosys_manual>
            <hamfist/>
            <hamthumboutmod/>
            <hamextfingerl/>
            <hampalml/>
            <hamstomach/>
            <hamlrat/>
            <hamtouch/>
            <hammoved/>
            <hamslow/>
            <hamrepeatfromstart/>
        </hamnosys_manual>
    </hns_sign>

</sigml>
```

Figure 5. Sample SigML File for ISL Diarrhea

This SigML is then animated using the SigML Player[14] The final output can be seen via the SigML Tool in Figure 5. Further work can be done for:
- Recognition of gestures from multiple persons.
- Recognize continuous sentences.
- Detecting more complex gestures.
- Detecting gestures involving finger movements

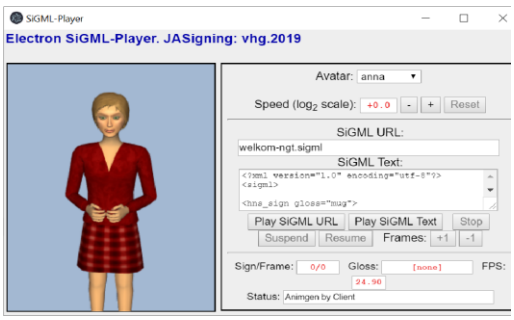

Figure 2: SigML Tool

Conclusions

This work proposes a sign-to-sign translator, for minimizing the gap between the hearing and speech impaired people from different countries, which use different sign languages. Here we observe that deep learning provides the key point extraction which can be used to recognize hand shape, orientation, location, movement. The HamNoSys notation is a language independent notation system, which acts as an intermediate language for translator. Using similarity measures the similarity between HamNoSys of different words from different sign languages can be found and translation will be done.

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