

Review of Finger Spelling Sign Language Recognition

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Abstract— Sign language is a mean of communication among the deaf people. Indian sign language is used by deaf for communication purpose in India. Here in this paper, we have proposed a system using Euclidean distance as a classification technique for recognition of various Signs of Indian sign Language. The system comprises of four parts: Image Acquisition, Pre Processing, Feature Extraction and Classification. 31 signs including A to Z alphabets & one to five numbers were considered.

Gesture recognition enables humans to communicate with the machine and interact naturally without any mechanical devices. Gesture recognition can be seen as a way for computers to begin to understand human body language, thus building a richer bridge between machines and humans than primitive text user interface or even GUIs (graphical user interfaces), which still limit the majority of input to keyboard and mouse. Gesture recognition pertains to recognizing meaningful expressions of motion by human, involving the hands, arms, face, head, and/or body. Hand gesture is a method of non-verbal communication for human beings for its freer expressions much more other than body parts. Hand gesture recognition has greater importance in designing an efficient human computer interaction system.

Keywords— Principle Component Analysis(PCA), Hidden Markov Model(HMM), Neural Network(NN).

I. INTRODUCTION

Sign language is the medium of communication language generally used by deaf-dump community. It uses gestures instead of sound patterns to convey meaning. Various gestures are composed by movements and orientations of hand, body or facial expressions and lip-patterns for communicating information or emotions. Sign language is not universal and just like spoken language; it has its own regional dialects. American Sign Language (ASL), British Sign Language (BSL), Indian Sign Language (ISL) etc. are some of the common sign languages in the world. Across the world millions of people are deaf. They find it difficult to communicate with the normal people as the hearing or normal people are unaware of sign language. There arises the need for sign language interpreters who can interpret sign language to spoken language and vice versa. But, the availability of such interpreters is limited, expensive and does not work throughout the life period of a deaf person. This resulted in the development of automatic sign language recognition systems which could automatically translate the signs into

corresponding text or voice without the help of sign language interpreters. Such systems can help in the development of deaf community through human computer interaction and the can bridge the gap between deaf people and normal people in society. By deaf community in ISL is expressed by both hand gestures and in ASL is expressed by single hand gesture. It consists of both word level gestures and finger spelling.

Fingerspelling is used to form words with letter by letter coding. Letter by letter signing can be used to express words for which no sign exists, the words for which the signer does not know the gestures or to emphasis or clarify a particular word. So the recognition of the fingerspelling has a key importance in sign language recognition. In recent years computerized hand gesture recognition has received much attention from academia and industry, largely due to the development of human-computer interaction (HCI) technologies. Hand gesture recognition is of great importance for human-computer interaction (HCI), because of its extensive applications in virtual reality, sign language recognition, and computer games [1]. In human's daily life hands play an important role to physically manipulate an object or to communicate with other people. Human Computer Interface is generally accomplished with devices such as mouse and keyboard, which are limited in terms of operational distance and convenience. By contrast, hand gesture recognition provides an alternative to these cumbersome devices, and enables people to communicate with computer more easily and naturally [2]. For handling different hand gesture recognition many tools have been applied including mathematical models like Hidden Markov Model (HMM) [3] and Finite State Machine (FSM)[4], software computing methods such as fuzzy clustering[5], Artificial Neural Network (ANN) [6]. Numerous approaches have been proposed for enabling hand gesture recognition. A common taxonomy is based on whether extra devices are required for raw data collecting. In this way, they are categorized into data glove based hand gesture recognition [7], vision based hand gesture recognition [8], and color glove based hand gesture recognition [9]. For digitizing hand and finger motions into multiparametric data, Data-Glove based methods use sensors. The extra sensors make it easy to collect hand configuration and movement [10]. However, the extra devices are quite expensive and bring much cumbersome experience to the users. In contrast, the Vision Based methods require only a camera, thus realizing a

natural interaction between humans and computers without the use of any extra devices. These systems tend to complement biological vision by describing artificial vision systems that are implemented in software and/or hardware.

II. DIFFERENT APPROACHES FOR SIGN LANGUAGE

Present hand gesture recognition approaches can be classified into various categories.

A. Data glove based approaches:

Data Glove, based approach uses a glove-type device which could detect hand position, movement and finger bending. In this approach user require to wear a glove like device, which uses sensors that can sense the movements of hand(s) and fingers, and pass the information to the computer. These approaches can easily provide exact coordinates of palm and finger's location and orientation, and hand configurations [11,12].The main advantage of these approach are high accuracy and fast reaction speed but this approach can be quite expensive. These methods employs mechanical or optical sensors Attached to a glove that transforms finger flexions into electrical signals to determine the hand posture [13]. Using this method the data is collected by one or more data- glove instruments which have different measures for the joint angles of the hand and degree of freedom (DOF) that contain data position and orientation of the hand used for tracking the hand [14]. However, this method requires the glove must be worn and a wearisome device with a load of cables connected to the computer, which will hampers the naturalness of user-computer interaction [15].

B. Vision based approaches:

In this approach user not require to wear anything. Instead the system requires only camera(s), which are used to capture the images of hands for interaction between human and computers. Vision based approach is simple, natural and convenience [16]. However, there are still several challenges to be addressed, for instance, illumination change, background clutter, partial or full occlusion etc. These techniques based on the how person realize information about the environment. These methods usually done by capturing the input image using camera [17]. In order to create the database for gesture system, the gestures should be selected with their relevant meaning and each gesture may contain multi samples [18] for increasing the accuracy of the system.

C. Color glove based approaches:

Color glove based approaches represent a compromise between data glove based approaches and vision based approaches. Marked gloves or colored markers are gloves that worn by the human hand [19] with some colors to direct the process of tracking the hand and locating the palm and fingers,

which provide the ability to extract geometric features necessary to form hand shape. The disadvantages are similar to data glove based approaches: they are unnatural and not suitable for applications with multiple users due to hygiene issues.



(a)Data-Glove based. (b) Vision based. (c) Colored marker.

Fig. 1 Examples of hand gesture recognition input technologies.

D. Appearance based approaches:

Appearance based approaches also known as View Based Approaches, which model the hand using the intensity of 2D images and define the gestures as a sequence of views. These models don't use a spatial representation of the body anymore, because they derive the parameters directly from the images or videos using a template database. Some are based on the deformable 2D templates of the hands. Appearance based approaches considered easier than 3D model approaches, due to the easier extraction of features in 2D image.

E. 3D Model Based Approaches :

Three dimensional hand model based approaches rely on the 3D kinematic hand model with considerable DOF's, and try to estimate the hand parameters by comparison between the input images and the possible 2D appearance projected by the 3D hand model. Such an approach is ideal for realistic interactions in virtual environments. In contrast, 3D model based approaches can exploit the depth information and are much more computationally expensive but can identify hand gestures more effectively. 3D Model can be classified into volumetric and skeletal models [20]. Volumetric models deal with 3D visual appearance of human hand [21] and usually used in real time applications. The main problem with this modeling technique is that it deals with all the parameters of the hand which are huge dimensionality. Skeletal models overcome volumetric hand parameters problem by limiting the set of parameters to model the hand shape from 3D structure.

III. DIFFERENT METHODS FOR SIGN LANGUAGE RECOGNITION

A. Finger spelling sign language recognition using PCA:

PCA was introduced in 1901 by Karl Pearson [22]. PCA is a statistical technique which is a useful technique to classify and identify patterns in high dimensional data. The advantage of finding these patterns is that PCA reduces the number of dimensions by compressing the data without losing too much information [23]. This reduction of data is called principal component (PC) that will account for most of the variance in the high dimensional data. PCA is very fast and consume low memory as compared to other method. In other word, PCA is a mathematical procedure which is in the definition; an orthogonal transformation is going to be used to convert a set of high dimension data of possible correlated variables into a set of values of reduced data. They are linearly uncorrelated variables which are called PCs. The number of PCs is less than or equal to the number of original variables which the largest possible variance is related to the first PC .

Various author for PCA technique :

Dipali Rojasara and Nehal Chitaliya et.al [24] proposed to use PCA technique. She is used haar transform with Principle component Analysis. She is proposed a system using Euclidean distance as a classification technique for recognition of various Signs of Indian sign Language. She is see that all one handed alphabets images have been identified correctly even though 20% noise is added. Some images are identified correctly after adding noise up to 60 to 70%. Hence, the feature extraction facilitates to reduce the computational time. Shreyashi Narayan Sawant et.al [25] presented design and implementation of real time Sign Language Recognition system from the Indian Sign Language using MATLAB. The signs are captured by using web cam and this signs are preprocessed for feature extraction. The obtained features are compared by using Principle Component Analysis (PCA) algorithm. After comparing features of captured sign with testing database minimum Euclidean distance is calculated for sign recognition. Finally, The proposed method gives output in voice and text form that helps to eliminate the communication barrier between deaf-dumb and normal people. M.Ashraful Amin et.al [26] proposed a system that is able to recognize American Sign Language (ASL) alphabets from hand gesture with average 93.23% accuracy. The classification is performed with fuzzy-c-mean clustering on a lower dimensional data which is acquired from the Principle Component Analysis (PCA) of Gabor representation of hand gesture images.

B. Finger spelling sign language recognition using Hidden Markov Models

Many researches prefer to use Hidden Markov Model (HMM) for the data containing information for dynamic hand gesture recognition. HMM is a doubly stochastic model and is appropriate for dealing with the stochastic properties in

gesture recognition. The first well known application of HMM technology was speech recognition. A Hidden Markov Model is a collection of finite states connected by transitions. Each state is characterized into two sets of probabilities: a transition probability and a discrete or continuous output probability density function which gives the state, defines the condition probability of each output symbol from a finite alphabet or a continuous random vector. HMMs are employed to represent the gestures, and their parameters from the training data. Based on the most likely performance criterion, the gestures can be recognized by evaluating the trained HMMs. Another advantage of HMM is high recognition rates. Hidden Markov models are especially known for their application in temporal pattern recognition such as speech, handwriting, gesture recognition, part of speech tagging, musical score following, partial discharges and bioinformatics.

Various author for HMM technique :

Neelam K. Gilorkar et.al [27] proposed a recent research and development of sign language are reviewed based on manual communication and body language. She is deliberated the static signs of ISL and ASL from images or video sequences that have been recorded under controlled conditions. As sign language recognition is finding its application for nonverbal communication, normal and deaf-dump people, 3d gaming, etc. With increase in applications researchers should emphasis on the development of a well suited segmentation scheme which is capable of extracting the hand and face region from videos/images having any background. More emphasis should also be given for extracting such features which could completely distinguish each sign regardless of hand size, distance from the source, color features and lighting conditions. Lastly the necessities and shortcomings for a perfect sign language recognition system have been deliberated. Nianjun Liu et.al [28] presented that describes a Hidden Markov Model (HMM) based framework for hand gesture detection and recognition. The gesture is modeled as a hidden Markov model. The observation sequence used to characterize the states of the HMM are obtained from the features extracted from the segmented hand image by Vector Quantization. Thus, the HMM-based approach offers a more flexible framework for recognition. Jie Yang et.al [29] proposed a method for developing a gesture-based system using a multi-dimensional Hidden Markov Model. Gestures are converted into sequential symbols. HMM are employed to represent the gesture and their parameter are learned from the training data. Jie Yang developed a prototype system to demonstrate the feasibility of the proposed method. The system achieved 99.78% accuracy for an isolated recognition task with nine gestures. The proposed method is applicable to any gesture represented by a multi-dimensional signal.

C. Finger spelling sign language recognition using Neural Network

Neural networks are flexible in a changing environment and now operate well with modest computer hardware. Performance of neural networks is at least as good as classical

statistical modeling. Neural networks do not require the time programming and debugging or testing. Neural network model is motivated by the biological nervous system, like the brain to process information. There are various neural network algorithms used for gesture recognition such as feed forward and back propagation algorithms. Feed forward algorithm is used to calculate the output for a specific input pattern. Backpropagation algorithm is used for learning of the network. Neural networks are composed of simple elements operating in parallel. These elements are inspired by biological nervous systems. As in nature, the network function is determined largely by the connections between elements. We can train a neural network to perform a particular function by adjusting the values of the connections between elements. Neural networks have been trained to perform complex functions in various fields of application including pattern recognition, identification, classification, speech, vision and control systems. Backpropagation means when doing propagation, the momentum and weight decay are introduced to avoid much oscillation during stochastic gradient descent.

Various author for Neural Network technique :

Sujeet D.Gawande et.al [30] presented a new technique for hand gesture recognition, for the Human-Computer Interaction (HCI) based on shape analysis. The objective of this effort was to explore the utility of a neural network-based approach to the recognition of the hand gestures. A neural network is build for the classification by using back-propagation learning algorithm. The overall model is designed to be a simple gestural interface prototype for various PC applications. The major goal of this research is to develop a system that will aid in the interaction between human and computer through the use of hand gestures as a control commands. Hence, main aim to achieve very good accuracies. V.V.Nabiyen et.al [31] proposed an interactive sign language system that is developed to help the deaf as well as hearing people in learning and education. The main element of a sign language is the manual alphabets, and then we have concentrated on the sign language character recognition. An artificial neural network method is particularly employed to recognize vowel characters of the Turkish sign language. To evaluate the performance of the system, various images are acquired from different people and it achieves accuracy of 96%. Manar Maraqa et.al [32] presented the use of feedforward neural networks and recurrent neural networks along with its different architectures; partially and fully recurrent networks. The objective is to introduce the use of different types of neural networks in human hand gesture recognition for static images as well as for dynamic gestures. This work focuses on the ability of neural networks to assist in Arabic Sign Language (ArSL) hand gesture recognition. Then that tested the proposed system; the results of the experiment have showed that the suggested system with the fully recurrent architecture has had a performance with an accuracy rate 95% for static gesture recognition.

Sign language is the medium of communication language generally used by deaf-dump community. It uses gestures instead of sound patterns to convey meaning. Various gestures are composed by movements and orientations of hand, body or facial expressions and lip-patterns for communicating information or emotions. PCA is very fast and consumes low memory as compared to other methods. The main advantage of PCA is that reduces the number of dimensions by compressing the data without losing too much information. PCA results will come out with respect to standardized variables. Across the world millions of people are deaf. They find it difficult to communicate with the normal people as the hearing or normal people are unaware of sign language. There arises the need for sign language interpreters who can interpret sign language to spoken language and vice versa.

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