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A Review on Image based Indian Sign Language Recognition

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ABSTRACT: Sign Language is the medium of communication among physically impaired individuals who cannot speak or hear by expressing signs using hand shapes, orientation and movement of hands. Automatic Sign Language Recognition is a significant research area in the field of human computer interaction. Automatic Sign Language systems need fast and accurate techniques to identify signs with correct meaning. Many techniques have been developed with the development of image processing and artificial intelligence techniques. Most of signs Indian Sign Language(ISL) are double handed. It is more difficult to recognize compared to single handed signs like American Sign Language (ASL), French Sign Language (French: langue des signesfrançaise, LSF). In the process of sign language recognition three main steps involved – pre-processing, feature extraction and classification. Most used classification techniques are Artificial Neural Network (ANN), Hidden Markov Models (HMM), K-Nearest Neighbor (KNN), Support Vector Machine (SVM) etc.

KEYWORDS: Indian Sign Language, Sign language recognition, ANN, HMM, KNN, SVM

I. INTRODUCTION

Sign language is a natural language used by hearing and/or speech impaired people to communicate. It uses hand gestures instead of sound to convey meaning. Sign language is spread and used all over the world, it is not universal. It is different in every country to country.Sign language can vary from region to region, even in one country, like spoken languages. Some of common language's linguistics characteristics are given in table 1. More than 2 million people in India are deaf. They find it difficult to communicate with the normal people because normal people cannot understand sign languages. There arises a need for sign language translators who can translate sign language to spoken language and vice versa. However, the availability of such translators is limited, costly and does not work for a deaf person's entire life. This led to development of sign language recognition system which can automatically translate signs into text or voice.

Table 1 : International Sign Languages

Sr. No.	Country	Sign Language	Abbreviation
1	United States of America	American Sign Language	ASL
2	France	French Sign Language	LSF
3	United Kingdom	British Sign Language	BSL
4	China	Chinese Sign Language	CSL
5	**India**	**Indian Sign Language**	**ISL**
6	Japan	Japanese Sign Language	JSL
7	Ukraine	Ukrainian Sign Language	UKL
8	Sri Lanka	Sri Lankan Sign Language	SLTSL
9	Brazil	Brazilian Sign Language	Libras

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Sign language recognition is vast research area because of lots of challenges involved in developing of an automatic recognition system. Most of the research done on the recognition of American Sign Language (ASL), as most of the signs in it are single-handed and thus, complexity is less. Indian Sign Language (ISL) involves both static and dynamic gestures, single as well as double handed gestures, and the hands involved in gesturing can also have complex movements.Another interesting feature is that ASL already has a standard database. So, compared with ASL, ISL recognition systems is more complex.Figure 1 shows double handed Indian Sign Language (ISL) for alphabets. The research work done by the researchers in the recognition of ISL is very less. Recently, more researchers have started doing research in ISL recognition.This paper focuses on a study of ISL recognition system with reference to image recognition.

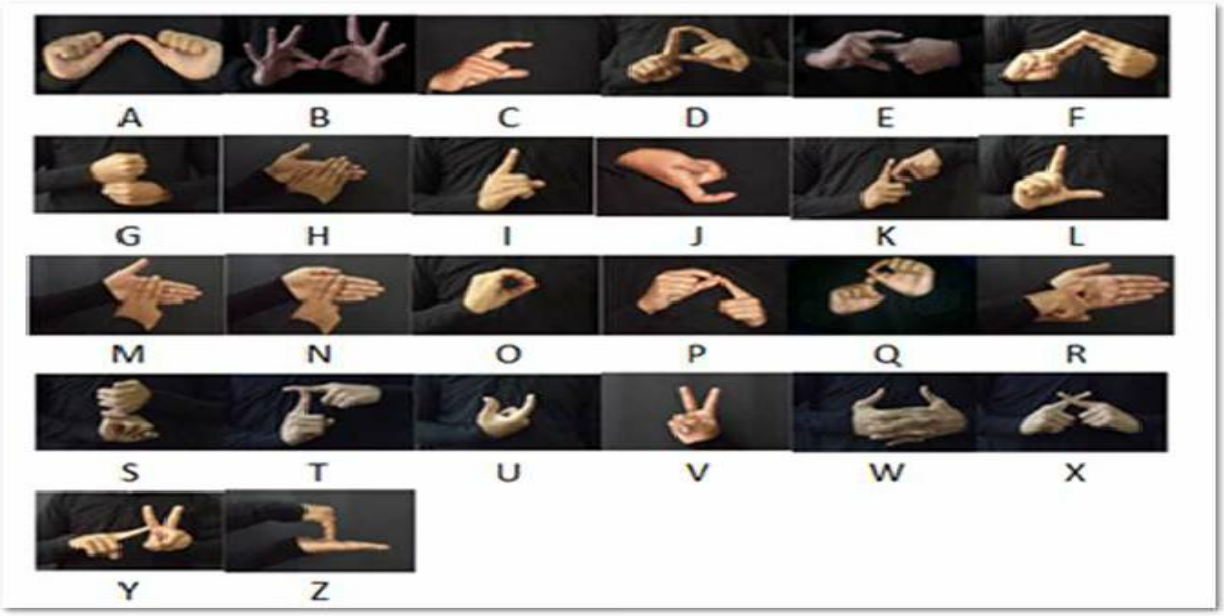

Figure 1 : Double Handed Indian Sign Language for Alphabets

II. LITERATURE REVIEW

Sign language recognition is an important application of gesture recognition and classification. There are mainly two different approaches widely used in sign language recognition – Data Glove Based approach and Vision Based approach. Image based system is moresuitable than traditional data glove based system, as sensors are attached to the data glove and data suit where, user has to wear these cumbersome devices [1]. Vision based approach uses image processing algorithms to detect and track hand signs movement. This approach is easier for the signer, because no additional hardware is needed. However, there are problems with the accuracy of image processing algorithms.

1. Data Glove Based Approach:
This approach uses different sensor to detect hand gesture signal. Hand gesture signal is in the form of analog. ADC is used to convert analog signal into digital form. It consists of flex sensor and accelerometer. Flex sensor is used to detect bend signal [2].

2. Vision/Image Based Approach:
In this approach, web camera used to capture video or images. Vision or Image based sign recognition process can be divided into two phases – training and testing. The classifier must be trained in the training phase with the training

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dataset. Creation of dataset, preprocessing, feature extraction and training the classifier are main steps involved in training phase. The testing phase includes video/image acquisition, preprocessing, feature extraction and classification. Generalizedsystem architecture of a sign language recognition system is shown in Figure 2. Preprocessing techniques applied to image or video captured by camera. In next step, feature extraction method used to get feature vector from preprocessed image. Various classifiers are available to recognize objects/signs from feature vector generated by previous step. Recognized signs are represented to user in either text or audio format.

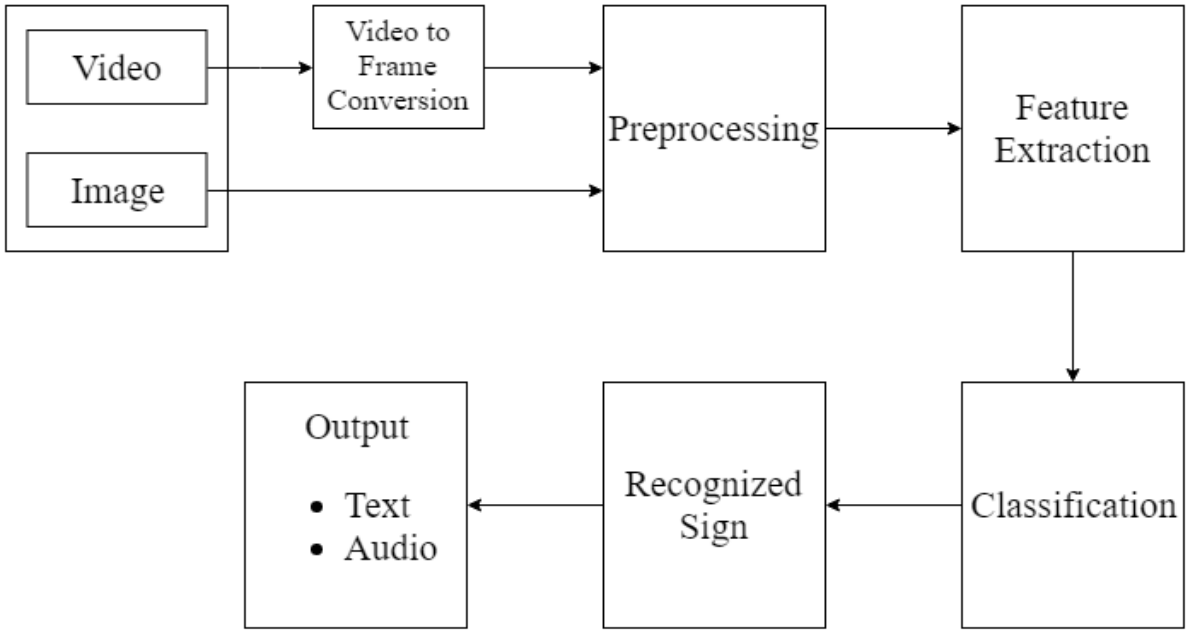

Figure 2 : Block Diagram of Sign Language Recognition System

III. VISION/IMAGE BASED SIGN LANGUAGE RECOGNITION

1. Image/Video Acquisition

The image acquisition of signer can be obtained by external web camera, digital camera, laptop or smartphone camera. In case of video acquisition, it must convert in frames. Those images and frames used in preprocessing step.

2. Preprocessing

As images are not captured in a controlled environment and they have different resolutions and sizes, so preprocessing on image is required. It is a method to digitalize images and extract some useful information called region of interest (ROI) from image. Region of interest can be only one hand or both hands, facial expressions are also included if need. Preprocessing includes filtering, image enhancement, image resizing, segmentation and morphological filtering. For filtering and image enhancement, any known method used. But for segmentation, the algorithm differs as input images/video. Background subtraction [2], skin color based segmentation [3], Otsu's thresholding [4] and motion based segmentation [5]is widely used segmentation techniques. In both training and testing phase, images/videos preprocessed to extract the region of interest.

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3. Feature Extraction

Feature extraction is one of the most important step in sign language recognition, because it gives feature vector as output which is used by classifier as an input. Feature extraction techniques used to find objects and shapes must be reliable and robust without depending on orientation, illumination level, position and size of object in image. The features can be obtained using different techniques like texture features [6], orientation histogram [7], wavelet decomposition [8], Haar wavelets [9], Fourier descriptor, etc. In some cases, the Principal ComponentAnalysis (PCA) is used to reduce dimensionality to get feature vector from ROI [10]. However, PCA is very sensitive to the scaling, rotation and translation of the image and hence the image needs to be normalized before applying PCA [10]. The feature vector obtained using anyone of these techniquesis used for training classifier.

4. Classification

Classifier classify input image sign into its related classes. The feature vector is used to train classifier during training phase. During testing phase, trained identified class corresponding to signs and give output in text or audio format. The performance of classifier measured in term of accuracy or recognition rate. Some of the common used classifiers are Artificial Neural Network (ANN), Hidden Markov Models (HMM), K-Nearest Neighbor (KNN), Support Vector Machine (SVM), Fuzzy System, Finite State Machine (FSM), etc.

4.1 Artificial Neural Network (ANN)

An artificial neural network [11] involves artificial neurons that show complex behaviour determined by connections between elements and its parameters. ANN is used to infer a function from given inputs and observations. Structure of ANN changes based on information that flows through its network during training phase. There are many neural network algorithms used to recognize signs. One of basic network belongs to unsupervised learning is Kohonen-Self Organizing Map (Kohonen-SOM). Kohonen-SOM was used [12] to classify ISL gestures of the alphabets. Two most used networks of supervise leaning are Feed Forward Back Propagation Network (BPN), and Radial Basis Function Neural Network (RBFNN). RBFNN was used in [13] for static gesture recognition of American Sign Language (ASL). Feed Forward BPN was used in [14] for classification of gesture of ASL alphabets with 92.78% accuracy.

4.2 Hidden Markov Models (HMM)

In late 90s the HMM were primary choice of gesture recognition techniques. The successful application of Hidden Markov modelling techniques to speech recognition problems motivates the HMM approach to gesture recognition.A Hidden Markov model is a collection of finite states connected by transitions. Each state is characterized by two sets of probabilities: a transition probability and either a discrete probability density function which, given the state, defines the condition probability of each output symbol from a finite alphabet or a continuous random vector [15].HMM was used in [16] to recognize of 60 different dynamic gestures. Recognition was performed using the Viterbi algorithm to estimate maximum likelihood state sequences.

4.3 K-Nearest Neighbor (KNN)

K-nearest neighbour (KNN) classifier classifies objects based on feature space using supervised learning algorithm. Nearest neighbor algorithm is most popular classification technique proposed by Fix and Hodges. An object is classified to the class which is most common among its K nearest neighbors. K nearest neighbors is a simple algorithm that stores all available cases and classifies new cases based on a similarity measure [17].

4.4 Support Vector Machine (SVM)

The SVM is widely known pattern recognition supervised learning technique. Originally, Vapnik and colleagues developed SVM at bell laboratories for solving binary decision problem. The basic SVM takes input data and predict that which two possible classes generate output. So, it is also known as a non-probabilistic binary linear classifier. Multi-class problems are divided into many two-class problems that can be addressed using several SVMs. One against all, one against one, decision directed graphic approach, etc. are some methods to solve multi-class problem using SVMs [18].

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IV. COMPARISON OF INDIAN SIGN LANGUAGE RECOGNITION SYSTEM

Table 2 shows comparison of some Indian Sign Language (ISL) recognition systems including preprocessing, feature extraction and classification techniques.
In [19], P.V.V. Kishore and P.Rajesh Kumar proposed system to recognize gesture from real time video of the signer. Image frame is preprocessed by achieving active contours from object color, prior shape information and boundary edge map. Artificial Neural Network (ANN) classified signs with 93% accuracy using back propagation algorithm on MATLAB platform.
Anup Nandy and team proposed framework for ISL sign based human robot interaction [20]. ISL video used to train robot with 20 different gestures in real time. K-Nearest Neighbor (KNN) and Euclidean distance classified gestures from Orientation Histogram features with 90% recognition rate.
In [21], authors suggested sign recognition technique on OpenCV platform. Images of ISL signs are used as an input to Support Vector Machine (SVM) to identify sign using boundary tracing technique and new B-spline approximation approach with 91.83% accuracy.
Himanshu Lilha and DevashishShivmurthy used their double handed ISL sign dataset. Features were extracted using 2 different approaches - Histogram of Orientation Gradient (HOG) and Histogram of Edge Frequency (HOEF). They classified both features using Support Vector Machine (SVM) and proved that HOEF approach is better than HOG with 98.1% recognition rate.
In [22], [11] and [23], P.V.V. Kishore and P.Rajesh Kumar used fuzzy classification technique to recognize gesture with better accuracy using different preprocessing and feature extraction techniques from video of ISL on MATLAB.

Table 2 : Comparison of Various Indian Sign Language Recognition Systems

Ref. No.	Author	Input	Segmentation (Preprocessing)	Feature Extraction	Classification	Accuracy	Platform
[19]	P.V.V. Kishore, P.Rajesh Kumar	Video	Active contours	Texture features	ANN- error back propagation algorithm	93%	MATLAB
[20]	Anup Nandy, Soumik Mondal	Video	-	Orientation Histogram	KNN and Euclidean distance	90%	-
[21]	Geetha M., Manjusha U C	Images	Boundary tracing	A novel method based on B-spline approximation	Support vector machine	91.83%	OpenCV
[18]	Himanshu Lilha, DevashishShiv murthy	Images	-	Histogram of Edge Frequency (HOEF)	Support Vector Machine	98.1%	-
[22]	P.V.V Kishore, P. Rajesh Kumar	Video	Canny fused Wavelet based	Elliptical Fourier descriptors	Fuzzy	91%	MATLAB

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[11]	P.V.V Kishore, P. Rajesh Kumar	Video	Active contours	Texture features	Fuzzy	96%	MATLAB
[23]	P.V.V Kishore, P. Rajesh Kumar	Video	Wavelet based	DWT and Elliptical Fourier descriptors	Fuzzy	96%	MATLAB

V. CONCLUSION

The main purpose of this paper is to evaluate different techniques to recognize sign languages and to conduct a comparative summary of Indian Sign Language (ISL) recognition systems. Most research work focused on the recognition of static ISL signs from images or video recorded under controlled environment. Some system uses only hands in only one background. The signer needs to wear dark full sleeve cloths because most systems are signer dependent. Most of the systems focused only on hand gesture recognition, facial features are ignored. The major challenge in sign language recognition is to develop signer independent system which can recognize both hand and facial features. The researchers should concentrate to develop segmentation techniques that can extract both handgestures and face features from images or video with any background for single handed as well as double handed ISL signs.

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