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Review on Classification Methods used in Image based Sign Language Recognition System

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Abstraction-Sign language is the way of communication among the Deaf-Dumb people by expressing signs. This paper is present review on Sign language Recognition system that aims to provide communication way for Deaf and Dumb pople. This paper describes review of Image based sign language recognition system. Signs are in the form of hand gestures and these gestures are identified from images as well as videos. Gestures are identified and classified according to features of Gesture image. Features are like shape, rotation, angle, pixels, hand movement etc. Features are finding by various Features Extraction methods and classified by various machine learning methods. Main pupose of this paper is to review on classification methods of similar systems used in Image based hand gesture recognition . This paper also describe comarison of various system on the base of classification methods and accuracy rate.

Keywords: *Sign Language Recognition,Feature Extraction, Support Vector Machine, Neural Network,K-nearest neighbour, Hidden Mrkov Model, Scale Invariant Feature Transform.*

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I. INTRODUCTION

Sign Language is a language that used by Deaf and Dumb people. Deaf people use signs to express their thoughts. Sign language is defferent in every country to country with its own vocabulary and grammar. Even within one country, sign language can vary from region to region like spoken languages. So there is a need for sign language transaltor who can translate sign language to spoken language and vice versa because normal people can not understand signs. But, the availability of such translator is limited, expensive and does not work throughout the life period of a deaf person.

So, the solution is that thare can be automatic system which automatically tranlate signs expressed by deaf people into text or voice. Computerised system are most relavant and suitable for automatic transalte signs into text or voice. This computerised system are called as Sign Language Recognition (SLR)System.

Sign Language Recognition System automatically translate signs into text. Effective Sign Language Recognition system gives the chance to deaf people to express their idea without human translator.Sign Language translator To have an interaction with computer, 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].This paper focuses on a study of sign language interpretation system with reference to Image based hand gesture recognition. Image Processing is done on images of signs and extract morphological features. Apply classification methods on features to idntified words.

Figure-1 Signs of Alphabets and Numbers [62]

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II. LITRECTURE REVIEW

A. SYSTEM ARCHITECTURE:

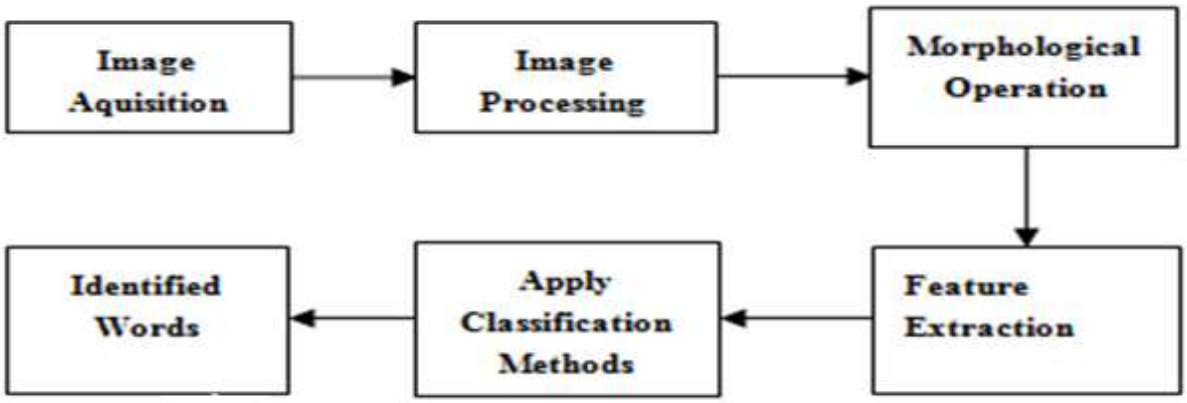

Figure 2.

Generalized Block Diagram of Sign Language Recognition System

B. METHODS OF SIGN ACQUIRING

1. LEAP MOTION:

Leap Motion controller (figure 1) is a sensor which detects the hand movement and converts that signal into computer commands. It consists of two IR cameras and three infrared LED's. LED generates IR light signal and camera generates 300 frames per second of reflected data. These signals are sending to the computer through USB cable for further processing[2].

2. KINECT SENSOR:

Kinect is Microsoft motion sensor with Xbox 360 gaming console shown in figure 2.it consist of RGB camera , depth sensor and multi-array microphone. It recognizes facial movement and speech[3].

3. DATA GLOVE:

This method 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[4].

4. VISION BASED:

In this method web camera used to capture images. After that, image segmentation has done. Feature like palm, finger extracted from input image. Different hand motion that is half closed, fully closed, semi closed was detected. Data is saved in vector and that vector is used for recognition of alphabets [5].

C. Preprocessing

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. It is a type of signal dispensation in which input is image, like video frame or photograph and output may be image or characteristics associated with that image.

D. Feature Extrcation

In Sign Language Recognition Image processing is used to better extract features from input images. Images are in static image or dynamic image of sign perform by human. In particular, the features that we extract from sign or hand gesture images should be invariant to background data, translation, scale, shape, rotation, angle, coordinates, movements etc.

E. Classification Methods of Sign Identification

1. Artificial Neaural Network

Neural network model is motivated by the biological nervous system. In [6], a neural network model was used to recognize a hand gesture in an image. The model consists of a large number neaurons as interconnected processing electrons working in unity to solve particular problems. 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. Back propagation algorithm is used for learning of the network.

2. Hidden Markov Model

Hidden Markov Model (HMM) [7] for the data containing information for dynamic hand gesture recognition. HMM is appropriate for dealing with the properties in gesture 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. The topology for an initial HMM can be resolute by estimating how many different states are intricate in specifying a sign.

3. Support Vector Machine

Classifiers of SVM[8] are nearly related to neural networks. Actually, four basic concepts:-separating hyperplane,maximum margin hyperplane, soft margin and the kernel function need to be know, for optimal utilization of SVM classifier.

4. Scale Invariant Feature Transform (SIFT)

Scale Invariant Feature Transform (SIFT) [9] , are features extracted from imges to help in reliable matching between different views of the same object, image classification and object recognition. The extracted keypoints are invariant to scale, orientation and partially invariant to illumination changes and are highly distinctive of the image.

5. *k*-nearest neighbors algorithm

k-nearest neighbors algorithm (*k*-NN) is a method used for classification and regression. In *k-NN classification*, the output is a class membership. An object is classified by its neighbors, with the object being assigned to the class most common among its *k* nearest neighbors. KNN (K-Nearest Neighbor) classifier is an instance based classier. K nearest neighbors is a simple algorithm that stores all available cases and classifies new cases based on a similarity measure[40].

F. Releted Work

M. V. D. Prasad, P. V. V. Kishore, E. Kiran Kumar, D. Anil Kumar [10] presented methods for Indian Sign Language Recognition. Principle components determined find the feature vector to a minimum to accommodate all the frames in the video sequence. Classification of the signs is done by Back Propagation Neural Network Algorithm. The recognition rate stands at 92.34%.

Suriya M. , Sathyapriya N. ,Srinithi M. ,Yesodha V, [11] this four persons presented system that recognizing sign language of 26 hand gestures in Indian sign language using MAT LAB. By using image processing the segmentation can be done. Some of the features are extracted such as Eigen values and Eigen vectors which are used in recognition. The Linear Discriminant Analysis (LDA) algorithm was used for gesture recognition and recognized gesture is converted into text.

Parul Hardeep et al. [12] provide method for recognize sign language. It has three steps: 1. Pre-processing: 2. Feature Extraction: It was done using Area, height, Euclidance distance, Average height. 3. Classification: Feed forward back propagation algorithm was used for training and classification. It was provide 85% accuracy.

Andres Jess´e Porfirio, Kelly La´ıs Wiggers, Luiz E. S. Oliveira, Daniel Weingaertner [13] , presents a method for recognizing hand configurations of the Brazilian sign language (LIBRAS) using 3D meshes and 2D projections of the hand. Videos were manually segmented to extract one frame with a frontal and one with a lateral view of the hand. For each frame pair, the rotation, translation and scale invariant Spherical Harmonics method was used to extract features for classification. A Support Vector Machine (SVM) achieved a correct classification.

Hanning et al. [14] presented hand gesture recognition system based on local orientation histogram feature distribution model. To compact features representation, k-means clustering has been applied. This system was based on static hand gesture and time consuming.

Keskin [15] performed the recognition of ASL hand configurations of the 10 digits with videos acquired using Kinect. The method is based on obtaining a 3D skeleton of the hand which, combined with 21 segmented hand parts, form the feature vector. The classifier used in the experiment the SVM had results with an accuracy rate of 99.9%.

El-Bendary et al. [16] developed an Arabic alphabet signs translator with an accuracy of up to 91.3%. Videos are taken of deaf people which convert into text. The features used are rotation, scale and translation invariant. Videos are converted into Frames. In the recognition stage, a multilayer Perceptron (MLP) neural network and a minimum distance classifier (MDC) are used for classification of features.

Quan [17] described hand signals based on spatial and temporal information extracted from video sequences. The database consisted of 30 letters of the Chinese alphabet, with 195 images representing each letter, totaling 5850 images. Support Vector Machine (SVM) used as classifier, and hit rates were 95.55%.

The author suggested to Identify the American Sign Language based on the hand gesture passed.In [18], Mohandes introduced an automatic recognition of the Arabic sign language letters. Support vector machines were used for classification and moment invariants are used in feature selection. A recognition rate of 87% was achieved.

AlJarrahand Halawani [19] developed a neuro-fuzzy system that deals with images of bare hand signs and achieved arecognition rate of 93.55%.

Jason Isaacs and Simon Foo [20] describes system that recognizing 2D hand poses for application in video-based human-computer interfaces. They have developed a *two* layer feed-forward neural network that recognizes the 24 static letters in the American Sign Language (ASL) alphabet using images. T*wo* wavelet-based decomposition methods have been used. The first produces an *8*- element real-valued feature vector and the second a 18-element feature vector. Each set of feature vectors is used to train a feed-forward neural. The system is capable of recognizing instmces of static ASL finger spelling with *99.9%* accuracy.

Pedro Trindade, Jorge Lobo and Jo˜ao P. Barreto [21] had proposed hand gesture recohnition by tiny pose sensor to the human palm, with a minute accelerometer and magnetometer that combined provide 3D angular pose, to reduce the search space and have a robust and computationally light recognition method. Starting with the full depth image point cloud, segmentation can be performed by taking into account the relative depth and hand orientation, as well as skin color. Identification is then performed by matching 3D voxel occupancy against a gesture template database. Preliminary results are presented for the recognition of Portuguese Sign Language alphabet, showing the validity of the approach.

Tanzila Ferdous Ayshee, Sadia Afrin Raka, Quazi Ridwan Hasib, Md. Hossain, Rashedur M Rahman [22] had proposed Hand Gesture Recognition system for Bengali Characters. They uses image processing and fuzzy rule based system to develop an intelligent system which can act as an interpreter between the Bengali sign language and the spoken language. Initially the data is processed from raw images and then the rules are identified by measuring angles.

Miss. Krupali Suresh Raut,Mrs. Shital Mali, Dr. Sudeep D. Thepade, Mr. Shrikant P. Sanas [23] had give their approch on Recognition of American Sign Language Using LBG Vector Quantization . novel method of American sign language recognition with Shape and Texture features has been proposed. . The database includes 26 for American sign language alphabets taken by 12 different people. The images are saved in a jpeg file format and stored in separate folder. Thus there are total 312 images were use for our project and 8 code book sizes (from 4 to 512). The nearest neighbour (KNN) algorithm is considered as performance comparison criteria for proposed character recognition techniques.

Double Handed Indian Sign Language was proposed by Kusurnika Krori Dutta, Satheesh Kumar Raju K, Anil Kumar G S, Sunny Arokia Swarny B [24]. In this system the double handed Indian Sign Language is captured as a series of images and it's processed with the help of MATLAB and then it's converted to speech and text. They the matching between extracted features of real time acquired image and that of features stored in data base. The Statistical calculation is done by them for the matched pairs and then its recognized and equivalent text is being displayed

Alphabetic Hand Sign Interpretation proposed by Suchin Adhan and Chuchart Pintavirooj using Geometric Invariance [25]. They apply a B spline curvature concept for supporting a triangular-based feature extraction element in a hand interpretation process. Area, inner angle and adjacent area ratio which derived from a curvature reference set are created a feature string for each alphabet posture in the template. By testing and Mtching all templets they recognitised with all 24 hand alphabets. Tamil Alphabets Sign Language Translator

P. Jayanthi, K. K. Thyagharajan [26], have proposed Tamil Alphabets Sign Language Translator. They accomplished Hand Segmentation Using Lab Color Space (HSL) by extracting the 'a' component of the LAB image. The background is non-reflecting single color. The feature extraction is done with the help of Generalized Hough Transform technique. Features of databsed are mathched by feartures generated by system and is able to recognize 31 Tamil Language Alphabets.

G. LIST OF VARIOUS CLSSIFICAION METHODS AND ITS RESULTS

Table-1

Reference Number	Research based System	Classification Method	Input Source	Output	Features	Accuracy in %
27	American Sign language	Feed forward, back propagation algorithm	Images	Alphabets and Numbers	fingertip finder, eccentricity, elongatedness, pixel segmentation and rotation	94.32

28	INDIAN SIGN LANGUAGERECOGNITION SYSTEM USING NEW FUSION BASED EDGE OPERATOR	back propagation algorithm	Video	Alphabets, Numbers, and some words	Shape data of Hands and Head	92.34%
29	Thai Sign Language	back propagation of neural network	Microsoft Kinect sensor at 0.8 - 1.2 meter distance	16 Hand Gestures	Dimention Measures	83.33%
30	4 camera-Sign Language Recognition	ANN backpropagation algorithm	Images by 4-Camera Model	Alphabets A to Z, Numbers	Hand shapes	95.10%
31	American Sign Language Detection System	Artificial Neaural Network	Images	Alphabets	hand shape, size and color	65%
32	American Sign Language Recognition	feedforward backpropagation of Artificial Neural Network	Image	Alphabets	all feasible triangle area patches constructed from 3D coordinates triplet.	95%
33	Dynamic Gesture Recognition	Support Vector Machines	Microsoft Kinect sensor	LIBRAS dataset	Global Features Like Stuctural Movements and Local Features like Position,Hand Configuration	Avarge 94%
34	Sign Language Recognition and Retrieval System	Support Vector Machine	Images	32 American Sign Language distinctive letters and numbers	eigenvectors	signer-dependent signs with an accuracy of 100% and signer-independent signs with an accuracy of 62.37% that will increase to 78.49% if dissimilar signs only used
35	Arabic Sign Language	Linear Discriminant analysis	Microsoft Kinect sensor	20 Arabic language words	Dimention Measures	99.8%.
36	VISION BASED MULTI-FEATURE HAND GESTURE RECOGNITION FOR INDIAN SIGN LANGUAGE MANUAL SIGNS	Nearest Mean Classifier (NMC), k-Nearest Neighborhood (k-NN) and Naive	Images	36 alphabets ,0-9 Numbers	feature descriptors such as chain code, shape matrix, Fourier	99.61% with k-NN,Real time recognition for number

		Bayes classifier			descriptor, 7 Hu moments, and boundary moments	signs 0-9, of fusion descriptor with NMC gave 100% accuracy.

Table-2

Reference Number	Research based System	Classification Method	Input Source	Output	Features	Accuracy in %
37	Indian Sign Language Recognition	nearest neighbour classifier	Images	Alphabets	Hand Region	99.23%
38	Real Time Hand Gesture Recognition System for Android Devices	Support Vector Machines	Images from Smart Phone	0-9 Numbers	convex points in contour,point furthest away from each convex vertex	93%
39	Bangali Sign Language Recognition	Inter Correlation Function	Images	18 Bangali Words	Contours	90.11%
40	Indian Sign Language Recognition	Dynamic Time Warping Algortihem,K -nearest neighbor algorithm	Images	Alphabets	shape (scale, rotational and translational invariance)	96.15%
41	Indian Sign Language Recognition System under Complex Background	Conditional Random Field	Video	10 English Words	global transformations, zones and geometric features	One Hand: 90.0%, Two hand:86.0%
42	Chinese Sign Language Recognition	Extreme learning machine	Kinect	20 signs	Location feature,Spherical coordinate feature	69.32%
43	AUTOMATIC SIGN LANGUAGE IDENTIFICATION	random forest algorithm	Images	19 signers for British and Greek signlanguages	hand-shape, orientation, location and movement.	95%
44	Static Indonesian Sign Language Recognition System	SIFT Algorithm	Images	Alphabets	Contours,ractangles, center points	62.6%,
45	LIBRAS Sign Language Hand Configuration Recognition	Support Vector Machine	Video	61 Hand Configuration	shape (scale, rotational and translational invariance)	96%
46	Recognizing Words in the Sign System for Indonesian Language	Generalized Learning Vector Quantization	Kinect	SIBI words	Angle, Shape, Depth	96,67%

		(GLVQ) and Random Forest (RF) training algorithm from WEKA data mining tools are used as the classifier				
47	LDCRFs-Based Hand Gesture Recognition	Latent-Dynamic Conditional Random Fields (LDCRFs)	stereo color image sequences from video	alphabet characters (A - Z) and numbers (0 - 9)	location, orientation and velocity	96.14%
48	Sign Language Recognition	Hidden Markov Model, Dynamic Time Wrapping	RGB-D data captured by Kinect	20 cetegries of gesture	Motion Trajectory Feature	89% for HMM,82 % for DTW

Table-3

Reference Number	Research based System	Classification Method	Input Source	Output	Features	Accuracy in %
49	Real-time Ukrainian sign language recognition system	hidden Markov models	videos	85 signs	Hand Shape	91.70%
50	Video Gestures Identification And Recognition Of Indian Sign Language	General Fuzzy Minmax Neural Network	video	4 to 5 sentences, some words	shape signatures :centroid distance and complex coordinates (position function)	92.92%
51	Filipino Sign Language Recognition	e fuzzy C-means (FCM)	Videos	42 words	upright speed-up robust feature (U-SURF)	54%.
52	A Mobile Application of American Sign Language Translation via Image Processing Algorithms	K-means clustering, Bag-of-feature,Support Vector Machine (SVM)	Images	16 different American Sign Language gestures	Scale Sapce, Intrest Points,Discriptors	97.13%.
53	Vision-Based Approach for American Sign Language Recognition	K-ClusterEOH-Match algorithm.	Images	A to Z	Region with labled, Area of Region	88.26%
54	Spelled sign word recognition	key frame detection	Images	Alphabets and words	rotation-, size- and colour-	84.20%

		algorithm			invariant.	
55	Indian Sign Language Recognition using Transform Features	KNN (K-Nearest Neighbor) classifier	Images	Alphabets	Fractional Coefficients	91.02%
56	Real-Time Computer Vision-Based Bengali Sign Language Recognition	K-Nearest Neighbors (KNN)	Images	10 Bengali alphabet	Geometrical properties of the hand shapes	96%
57	Persian Sign Language Recognition	minimum distance (MD), K-nearest neighbor (KNN), neural network (NN), and support vector machine (SVM)	Video	20 dynamic signs	Engles	95.56%
58	Hand Posture Recognition	k-NN classifier and SVM classifiers	Images	Alphabets	shape (scale, rotational and translational invariance)	96%
59	Brazilian Sign Language	Templet Matching based on euclidian distance	Kinect sensor	LIBRAS alphabet	euclidian distance	89%
60	Indian Sign Language Translator	Templet Matching	Images	10 numbers, 26 alphabets and 10 different phrases.	External Boundry Points,, 28 Fourier descriptors	Alphabets:85.73 % ,Numbers:95.5 % ,Phreses:97.5%
61	Static Indonesian Sign Language Recognition System	SIFT Algorithm	Images	Alphabets	Contours,ractangles, center points	62.6%,

III. CONCLUSION

In this review paper, different techniques of sign language recognition are reviewed on the basis of Classification Methods. For sign acquiring methods, vision based future extraction methods are more reliable. We can easily find different features of sign like hand shape, rotation, angles, movements, coordinates, pixel intensity etc from images. And various machine learning techniqes are very useful to classify these features and according to classifiction we can accuratly identify signs. According to this paper more research has been done on words, alphabets and numbers. In future it will go more in dimension on continues sentences of signs. Further review can be possible for more classification technques. Other classification methods like combination of various neaual network algorithems, fuzzy logics, genetic alogorithems etc. can also be implement for idntify fetaures of signs.

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