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Survey and analysis of Indian Sign Language Recognition research

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Abstract: Research in sign languages domain is emerging among the researchers. In world, many develop sign languages exist and other like Indian sign language is still in developing phase. So to provide a helping hand to research aspirant of Indian sign language, this is an attempt which is an outcome of assimilation of recent surveyed work. We did an in-depth analysis of work by various researchers, studied their efforts, summarized it and presented in this paper. The findings are discussed in detail. Also the results achieved are quite comparable with the existing work in the domain of Sign language recognition.

Keywords: Indian sign language, gestures, neural network, framework, blobs

I. INTRODUCTION

Sign language recognition is best expresses through the gestures. In step with the International Journal of Language and Communication Disorders, "Sign language will be thought of as a set of gestures, movements, postures, and facial expressions akin to letters and words in natural languages." Gestures have long been thought of efficient human computer interaction technique that may probably deliver more natural, artistic and intuitive ways for human activity with our computers and gaining utmost importance in our daily lives. People in general will communicate primarily by sound and vision. The meaningful expressions of motion are recognized by victimization gestures. Gestures are reasonably the nonverbal speech and are used consciously further as subconsciously. Gesture is the most significant communication alternative to exchange concepts, thoughts etc among deaf and dumb people. Gestures are a basic concept of communication and were used by humans even before speech developed; they have potential to be a large fortification to an intuitive human-computer communication.

II. RECENT LITERATURE SURVEY

This section provides a detailed survey based on the work carried out in this domain by various researchers across the globe in the last few years and is as given below.

It summarizes various algorithms right from segmenting, tracking of non-rigid hands and head of the signer in sign language videos to its classification based on ANN using error back propagation algorithm that are used to design a sign language recognition system. Active contour energy minimization is done using signers hand and head skin color, texture, boundary and shape information. Each sign-gesture in the video is converted into either a voice or text command. The dataset consists of 351 Indian Sign language gestures and the system has been implemented successfully under different possible video environments. The recognition rates are computed for different video environments. They have implemented in MATLAB using the tools and tested with the two scenario such as Using gestures with cluttered background having used training & testing samples 220 and achieved a testing results as 91.5% when training with 2 samples per gestures was done where as achieved a testing result of 75% in the second scenario where it was trained and tested with 200 samples taking 4 samples per gestures in a simple cluttered background environment. [1]

Here, a simple approach right from frame data acquisition, preprocessing like edge detection, wavelet transform, image fusion technique to segment shapes in videos, a feature such as Elliptical Fourier descriptor based extraction and principal component analysis for feature set optimization and reduction was used. Database of extracted features are compared with input video of the signer using a trained fuzzy inference system. The proposed system converts gestures into a text and voice message with 90.90 percent accuracy when the ISL dataset of 80 gestures was used with 10 different signers.[2] The authors have further done the refinements in their work. The refinement was in the form of training a fuzzy inference system by using features obtained using DWT and Elliptical Fourier descriptors by 10 different signer videos for 80 signs with a recognition rate of 92.14%. The work was accomplished by training a fuzzy inference system by using features obtained using DWT and Elliptical Fourier descriptors by 10 different signer videos for 80 signs with a recognition rate of 92.14%.[3]

The Authors discussed about the challenges in Indian Sign Language (ISL) gestures and presented a framework to recognize ISL alphabet and number sign-gestures. They have used vision based approach where a signer has to wear handmade color gloves. The method adopted was segmenting the hand gestures by separating all the color components, setting the threshold levels by OTSU method, creating the R, G, B masks then object mask as binary image

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by setting 1 to area of interest color and zero elsewhere. Finally we obtain a segmented image by concatenating all the components. After this a finger tip algorithm is applied to a segmented image. This finger tip calculation involves finding the corner points by Harris corner detection and clustering approach to eliminate the extra points. Lastly the gestures were recognized by Principal Component Analysis approach. The dataset contains 510 gestures images which include 25 alphabets and 9 numbers and recognition accuracy got was 94% of the signs made correctly.[4]

A novel vision-based recognition technique is proposed using B-Spline Approximation for shape matching of static gestures. The boundary extracted from the Region of Interest is approximate to a B-Spline curve by taking the Maximum Curvature Points (MCPs) as the Control points. Then the Key Maximum Curvature points (KMCPs) are extracted by making the B-Spline curve subjected to iterations for smoothening. These KMCPs are the key contributors of the gesture shape. Hence a translation & scale invariant feature vector is obtained from the spatial locations of the KMCPs in the 8 Octant Regions of the 2D Space which is given for SVM classification. The dataset used was of ISL alphabets and numbers sign-gestures. They have experimented with 50 samples of each static alphabet from A-Z and numbers from 0 to 5. The experimentation results shows that feature vector extracted for each member of the dataset is uniquely identifying and got reasonable recognition accuracy.[5]

Adhitya et. al have developed a vision based Sign Language Recognition (SLR) System for ISL alphabets and single digit number signs using contour based potential energy. This potential energy is used as a key element for the Fourier descriptors as a feature vector to uniquely identify the gestures and further training by feed forward neural network. A database containing 540 images with 15 images of each of 36 signs are used for conducting the experiment. 10 images of each sign are used for training and 5 for testing. They have achieved an average recognition rate of 92.22 % when tested with total 180 images.

Here, a Vision based HGRS to recognize ISL alphabets is proposed. For recognition, Genetic algorithm was used after preprocess hand tracking, segmentation modules. The simple methodology is proposed but no experimentation results are discussed. [7].

In this the authors have nicely discussed the performance evaluation of the typical SLR system by comparing amongst the deployed K-NN, Naïve Bayes and PNN classifiers. Classifier always tries to improve the classification rate by pushing classifiers into an optimized structure. The classifier used for classification is validated using sensitivity, specificity error rate, predictive value, likelihood value, plotting the classification and misclassification error rate according to the sample datasets. In each hand posture, a measure of properties like area, mean intensity, centroid, perimeter and diameter are taken; the classifier then uses these properties to determine the sign in different angles. A probability based approach to estimate that a sign belongs to each of the target classes that is fixed. An analysis of different classifiers is done in which the Navie bayes approach is proved to be better for sign language classification system. However, the results in this work are biased by the size of the database: on the one hand, the lack of training data and the large amount of singletons leads to a very difficult task. The methods used in this work are focused towards good recognition accuracy and not toward real-time performance and thus it meets the sample experimental requirements.

An efficient gesture classification scheme is propose for recognizing Indian sign language using the view based fusion approach. The decision making in this system employs fusion technique for three classifiers namely KNN, MLP and SVM to classify sign language isolated signs. The process involves two layer classifications. At first, coarse classification is done according to single classifier and second classification is fusion based on combination methods. The fusion works they have proposed is divided into a three-steps process namely (i)Train the classifiers with the training feature vector (ii) Usethe selected classifiers to classify the test features vector to an output label (iii) Perform aggregation to combine the results and make the final decision. The Classifier Combination KNN+SVM classifier gives better result when the aggregation method is bayes. Conducted experiments with Indian sign language datasets show classifiers performance and error rate is low in NN+SVM. The results based on accuracy and error rate and time again proves that the KNN + SVM combination produces best classification accuracy with the combination rule of bayes method. An effort to determine the best method is inevitable, when there are many competing approaches to classification problem. The best algorithm is decided based on the parameters that depend on the structure of the available data and prior knowledge. The best combination method, just as for the best ensemble method, depends much on the particular problem. If the accuracies of the classifiers can be reliably estimated, then the majority approaches may be considered. However, we rely on bayes method due to its consistent performance over a broad spectrum of applications. Hence the classifier outputs correctly estimate the posterior probabilities, by considering bayes combination method.[9]

It describes a vision based gesture recognition system which can recognize wide classes of hand gesture. .In their proposed scheme we incorporate three different basic stages such as hand shape, trajectory and motion for gesture recognition. Experimental results demonstrate that our proposed recognition system can be used reliably in recognizing 16 static signs and 24 dynamic signs having both local and global motions of native Indian sign language.[10]

It focuses on design of a hand gesture recognition system for recognizing ISL gestures based on 2D-DCT used for compression and Self organizing Map (SOM) or Kohonen Self Organizing Feature Map (SOFM) NN for pattern recognition purpose. SOM process involves four major components such as initialization, Competition, Cooperation and Adaption whose simulink block model was prepared and tested for processing time of the overall systems. Training time depends upon the number of epochs used for training. The aim of this test is to reduce training time, while maintaining the network accuracy rate. The results obtained are the average of ten consecutive simulations, shows the best recognition rate of about 80% is achieved with the least amount of processing time(72 sec) is for the case of 1000 training epochs.[11]

They used ISL single hand Dataset with a simple approach of identifying state of fingers to recognize the gestures. The methodology adopted is the HSI based segmentation is done on input videos, finger tip detection and

extraction of features and recognition of alphabet is carried out. The feature used was angle between two fingers, the state of finger as open, close or semi-close. They have tested with 8 gestures such as I, V, W, U, L, O, C, J and obtained an accuracy of 68.12%.[12]

III. METHODOLOGY

Sign language is the usual language used by the deaf people for communication purpose. Even though they properly communicate with each other by using Sign Language, they face many difficulties when they try to communicate with people who can hear, especially those who are not familiar in Sign Language it is like sensing the existence of an invisible communication wall. Hence an efficient method should be developed to acquire and recognize the sign gesture languages. In our proposed work we have designed a frame work for analyzing and recognizing the sign gesture language. Here inputs are selected from multiple input sources. The input gestures are taken with the help of image acquisition process where camera is used to acquire the image of the sign gesture. Our proposed system aims at bridging communication gaps between the deaf community and other people. It provides a theoretical framework for researchers to work in this domain.

The following Fig 1. depicts the architectural flow of pattern recognition and combined with the block representation of simple sentence formation from the recognized gestures.

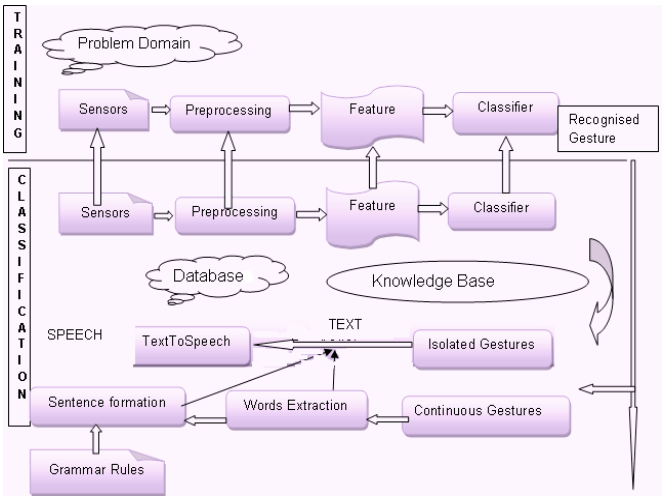

Figure. 1 Architectural Flow

This framework supports sensors taking care of gesture data acquisition in both vision and device setup followed by preprocessing algorithms and converting in the acceptable form. Then the features are extracted and selected which gives unique pattern/values for every sign gestures to be classified. Then the classifier algorithms are implemented which are giving a comparable accuracy. This framework is standard where the classifier algorithms need to be changed and results can be tested by providing training and accordingly classification is done with bare minimum changes in the framework setup. The controller is the heart of this framework which is controlling the sign gestures acquisition, processing and storing in the database and acting as an interface between the different modules of pattern recognition and gesture sentence formation with the grammar rules. This grammar rules can be enhanced catering the complete vocabulary of at least Indian sign language gestures dataset.

IV. FINDINGS AND DISCUSSIONS

We did a detailed survey of sign language domain work carried by various researchers in last few years. Their comparative and critical analysis is done based on the parameters extracted from their works. The parameter we have taken as the Method/approach adopted, Dataset used and the results they have discussed in their paper. We have also given our observation as per the interpreted study we have done through those papers. Table 1 highlights the survey findings of ISL based recognition. The generic framework for sign language recognition system is additionally bestowed. A theoretical study shows that this system bridge communication gaps between the deaf community and people. This will act as a helping aid tool for the researchers in this domain and once it will be totally operational the system will positively facilitate in minimizing communication gaps, easier collaboration and can also enable sharing & exchanging of concepts and experiences. The study reveals that it's quite possible and can act as a guiding tool to all or any researchers in the sign gesture acquisition and recognition domain. We have worked on ISL dataset, thus its findings are conferred here. The Indian sign language (ISL) diversity, vitality and identity were examined in 5 cities with the aim of prioritizing sign language literature development India-wide. This was accomplished with lexical similarity analysis, idiom intelligibility testing with recorded text tests and language perspective assessment. The results counsel one language with several dialects. The details are listed in the summarized Table 2.

Here the contribution is presented and reflected in [14-16] of some of the researchers in the Sign language domain. It mainly focused on vision based approach only. We have studied some of the techniques such as HMM, IOHMM, Multistream HMM, MVC, PCA, FSM, SRN etc and some of its outcomes are also discussed. The study survey suggests that HMM and its variant techniques are the usual trend to be applied in Sign Language. Also the survey and comparative of various techniques as per the modules proposed in our methodology with reference to ISL dataset is best described in (Sheth & Futane 2013) [20]. So this sort of comparison helps us in deciding our own methodology for recognition framework.

Further the following table 3. highlights the summarized results obtained when tested on ISL dataset with respect to our methodology suggested in this framework of Sign language recognition.

V. CONCLUSIONS AND FUTURE DIRECTIONS

A detailed recent survey is done and studied with thorough understanding of techniques/methods they have adopted and experimentation carried out. This study has helped us to get clear understanding of our methodology we have adopted in this framework. It mainly focuses on study of theoretical framework for sign gestures acquisition along with the recognition process in detail. The study area selected for the experimentation purpose is subset of Indian sign language. It reflects my research findings in the field of Indian sign language recognition domain stretch from the

construction of Indian sign language dataset to its feature extraction/selection methods applied and the gestures are classified and recognized. This comparative literature work has motivated us in proposing our methodology. Our proposed method helps in recognizing each and every gesture with higher accuracy and effortlessly. This is followed by neural network training which delivers the exact recognized output from the sign gesture.

This framework had been tested from its sign gesture acquisition from multiple sources. We employed feature extraction stage along with the morphological operations which forms an efficient process in extracting the required measures for recognition. Further the recognized gestures are used to form the sentence and outputted in both way as text or speech. We have simulated and tested the framework skeleton with different algorithms such as blob detection, simple thresholding approach, Shape feature extraction based Neural Network technique and General fuzzy min-max neural network based algorithms. The results of our method shows that it is more efficient when we compare with other existing works related to sign gesture recognition with reference to ISL. We have achieved reasonable and comparable accuracy in all our algorithms but we found that GFMMNN is robust and gives maximum recognition rate of 92.92% when tested with a video gestures for forming the sentences [16]. Further the exhaustive testing with additional video dataset has marginally improved to 94.02%. In nutshell, it is clear that results achieved are quite comparable to the recent work in this domain.

This will also help the junior research scholars to carry their innovative work in this area tackling the problems of deaf and mute people in an ease manner.

In future work, some more features will be considered in order to improve further accuracy of gesture identification from video input & exhaustive grammar rules will be constructed and meaningful sentence formation will be done by expanding the dataset of ISL gestures.

Table I. Findings of ISL based recognition

Paper ID	Method/Approach	Dataset Used	Results Discussed	Observation
(P. V. V Kishore & Kumar 2012)[1]	Classification using ANN (Back Propogation algorithm)	351 signs of Indian Sign Language under different possible video environments.	Got 91.5% when training with 2 samples per gestures was done where 75% result got when tested with 200 samples taking 4 samples per gesture.	ISL was used Accuracy from 75 to 91.5% is obtained.
(Deora & Bajaj 2012)[4]	Vision Based OTSU Method and PCA Used	ISL 25 Alphabets and 9 Numbers Dataset	94% of the sign are recognized	Not mention anything about volume of gestures.
(Geetha & Manjusha 2012)[5]	Vision Based B-Spline Approximation, SVM	ISL alphabets and numbers 50 each samples taken	No statistic provided Reasonable accuracy is obtained	-
(Adithya et al. 2013)[6]	Vision based contour based potential energy Feed Forward neural network	ISL alphabets and single digit number signs. Total 540 (15 *36 signs).	92.22 % when tested with total 180 images.	Static Sign were considered
(Ghotkar et al. 2012)[7]	Vision based Genetic algorithm	ISL alphabets	-	no experimentation results are discussed
(Sahoo et al. 2012)[8]	Study informative paper that has highlighted various sign languages in existence and progress of ISL.	-	-	No experimentation is done.
(Kishore, P V V, P. Rajesh Kumar 2011)[3]	Elliptical Fourier descriptor, PCA , fuzzy inference system DWT	ISL Dataset of 80 gestures was used with 10 different signers	90.90 % accuracy (initially) Improved to 92.14% when DWT was used	-
(Krishnaveni & Radha 2012)[9]	fusion techniques for three classifiers namely KNN, MLP and SVM	ISL isolated sign	classifiers performance and error rate is low in NN+SVM. Also proves that the KNN + SVM combination produces best classification accuracy with the combination rule of bayes method when the results based on accuracy and error rate and time are checked	No statistical results are discussed but good fusion technique combinations of existing classifier are discussed.
(Bhuyan et al. 2008)[10]	Framework for vision based HGR	ISL from Tomkins dictionary	Results demonstrate that our proposed recognition system can be used reliably in recognizing 16 static signs and 24 dynamic signs	-

			having both local and global motions of native Indian sign language.	
(Tewari & Srivastava 2012)[11]	Vision Based approach ISL Based on 2D-DCT, Kohonen Self Organizing Map Algorithm. NN.	ISL dataset simulink block model was prepared and tested for processing time of the overall systems	The results obtained are the average of ten consecutive simulations, shows the best recognition rate of about 80% is achieved with the least amount of processing time(72 sec) is for the case of 1000 training epochs.	The aim of this test is to reduce training time, while maintaining the network accuracy rate
(Shangeetha R K, Valliammai. V 2012)[12]	HSI based segmentation	ISL single hand Dataset of 8 gestures such as I, V, W, U, L, O, C, J	accuracy of 68.12%	

Table II. ISL Varieties

Contributory Paper Reference No	**Category, Methods, Approach and Dataset Used**	**Results Obtained**	
(Futane et al. 2012)[16] (Futane 2011)[15] (Futane et al. 2009)[14]	Theoretical study Indian Sign Language Varieties	**Sign Language Varieties**	**Findings**
		Mumbai	Most appropriate for initial development Have highest prestige and closest lexical similarity. Moderately high dialect intelligibility
		Hyderabad & Chennai	Most closely related with each other followed by Hyderabad and Mumbai. Chennai have literature developed in them
		Kolkata	Least similar dialect followed by Chennai, Kolkata has literature developed in them.

Table III. Algorithms Result Obtained

Sr No	**My Contributory Paper Reference No.**	**Algorithm/Methods**	**Dataset**	**Results Obtained in % age**
1	(Futane et al. 2011),[15] (Bhavsar Swapna et al. 2011)[13]	Color blob detection Algorithms	220 static ISL alphabets Isolated	81.81
2		Thresholding	66 static ISL numbers Isolated	89
3	(Futane & Dharaskar 2013)[17], (Futane & Dharaskar 2012)[16]	General fuzzy minmax NN	ISL word gestures Videos Isolated and Continous	94.02

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