Hybrid Topology for Feature Extraction and Classification of Vision Based Hand Gesture Recognition

Muthukumar.K, Amudha.A, Gomathy.V

Abstract: ***Examining widespread ISL interpretation systems, to formulate a novel vision based HGR algorithm for ISL, to accomplish the proposed algorithm in real time application. Thus this work is aimed to develop an automatic ISLR for hearing impaired people in India. To attain this, this work formulated the following methodology. An improvised preprocessing topology is designed for the introductory stage. For the segmentation process, skin colour segmentation is carried out. Hybrid topology of feature extraction technique is implemented to identify the vision based hand gesture recognition. Finally, an efficient ISLR framework was created. Hand gestures (HG) are way of expressions mainly developed for a deaf / speech-impaired person to share their thoughts with others. It is also denoted as a way of exchanging people's expressions/feeling. Sign Language (SL) is a well regulated form of HG which comprises signs and visual motions. Hence it is used for communication purpose. These SL are mainly used for a deaf / speech impaired people. Thus it serves as a tool for their interaction with society. SL delivers its information through various of parts of body viz. hand/fingers/ head and also though body movements/ facial expression. However, SL is not implemented amongst the hearing people and hence only few people can understand it. This results in communication barricade between the deaf/speech-impaired community and the remaining part of the human society. Hence, this problem has yet to be solved. So the HGR using computer technology has been developed. Thus this chapter describes about process involved in HGR.***

Index Terms: Sign Language, Hand Gesture, Local Binary Pattern, Feature Extraction

I. INTRODUCTION

A. PREAMBLE

A human Computer Intervention application is very useful in the Sign Language (SL) system. SL is one where gestures play a major and principal role in interaction between or among people through communication. Thus this chapter analyses the interpretation of SL particularly in India.

B. APPLICATIONS OF SL

The system of SL recognition is very useful anywhere where hearing impaired persons have to communicate with others and/ or machines too. A list of applications is enumerated here under. Incidentally, it can be noted some of the applications have already been in use.

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Muthukumar. K, Research Scholar, Department of EEE, Karpagam Academy of Higher Education, Coimbatore. Tamilnadu, India.

Dr. Amudha.A, Professor & Head, Department of EEE, Karpagam Academy of Higher Education, Coimbatore. Tamilnadu, India.

Dr. Gomathy.V, Associate Professor, Department of EEE, Sri Krishna College of Engineering and Technology, Coimbatore. Tamilnadu, India.

C. Translator

It is a way of simplifying communication among the hearing and hard of hearing people, as these type of persons lack good dialect skills no longer need the help of a translator, which is very expensive and is not commonly available.

D. SL learning Tool

Human Computer Interface (HCI)

This can be of much use by the hard of hearing individuals to supply input to the computer interface.

Interfacing in Virtual Environment

When the gestures are used to control the computer controls, it becomes a natural and inherent way to have an interaction with the computers.

Recreation and Games

SL can also be taught through games hobbies. Some games can also teach sign language for eg.,

Sign Language to Text Conversion

This can be carried out with the help of predefined dictionary of sign videos, which aids in learning SL.

Sign Interpretors:

It is implemented for interpreting sign of speech impaired people.

E. CHALLENGES IN SLR

SLR is mainly affected by alteration in image, scaling and illumination distresses. Response time and the cost of elucidation of SLR are the factors which can measures the efficiency of the system Fig.1.1 displays the factors that affect the SLR.

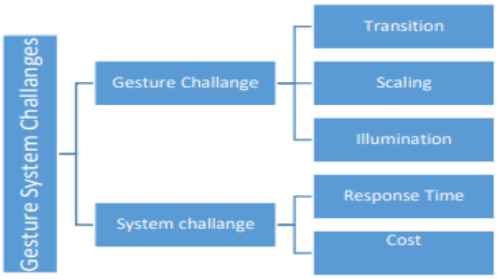


Fig.1.1. Gesture system challenges

F. ISL

It is true that the SL is entirely different from the spoken format of any language. Hence there may not be any remarkable relationship between the SL and the local language.

This is particularly pertinent to India, where there are numerous regional languages and the variations of signs and syntax, even within a particular language. Several attempts were made to gather and codify the prevalent signs in India. In 1977, four dictionaries of sign language in India with variations according to regions came, based on an analysis done by Vashista, Wood word and Wilson by gathering signs from four major urban cities (Delhi, Calcutta, Bombay and Bangalore). Further efforts were made by Ramakrishna Mission Vidyalaya, Coimbatore (2009) and IIT, Gauhati (2012) to make a standard ISL. The study by Ramakrishna Vidyalaya was rather comprehensive, which collected 2037 signs from various sources from 42 cities spread over 12 states, and it tried to provide a common sign language code for all over India. This indicated the complexity of the database of Indian Sign Language. It has become more essential to make research into ISL and make a standard format for it because of the fact that no sufficient efforts seem to have been undertaken in this regard. It is imperative to standardise ISL as around 35 lakhs of people suffer from hearing problems and more than ten million suffer from speech difficulties. There are a lot of difficulties of its own nature as ISL has to take into account its own sentence arrangement, morphology and grammar. The hand gestures are both static to indicate various signing and the relative positioning of hands on different other parts of the body like face shows complex meanings in ISL. in ISL both hands are used for indicating alphabets and signs, but contrarily in ASL they use a single hand for alphabets. Most notably syntax also differs between ASL and ISL. In ASL subject-object-verb pattern is followed, whereas in ISL the arrangement is subject-verb-object. In India, 4 linguistic families are there. But for ISL mostly the Dravidian Language pattern is taken as the base. The awareness and accessibility of l such sign languages for the people of India is very low due to a host of reasons which are mainly in the nature of social, economical and technological. Even simplest ISL tools are not available because not much research has been conducted in ISL linguistics and connected technological advancements. Lack of sufficient number of SL interpreters is another reason for the poor ISL literacy level. To help the millions of people suffering from hearing and speaking difficulties, it is imperative and highly important to empower such people through technological intervention, refinement and development of the techniques. Steps are needed to aid them in effective communication and also learning. A proper interaction system has to be identified to suit the Indian context and for that research efforts combined with refinement initiatives are required.

G. NECESSITY FOR THE ISL IN HUMAN COMPUTER INTERVENTION

Many people who are deaf use only gestures, which are called as SL, for communication purposes. SL, which are standardized are called deaf and dumb languages. The SL has some intrinsic and own basic principles, as it is used by the people communicating through symbols or messages encoded by gestures mainly because they are unable to use spoken language. Nevertheless, the SLs are highly following a basic structure and format, they are the best suited for vision algorithms in the field of HCI. By way to help the speech disabled persons to interact with computers.

Particularly, in these recent days researchers have started to give vital focus on HCI. The development of application is the need of the hour considering the fast pace of processing speed of the modern day computers. Though Artificial Intelligence is a method used for emulating human brain, it can never replace the human interventions. So, it is necessary to enhance the interfaces between human and the machine. This evolution of HCI starts with 2D graphical based interfaces based on texts and followed by interfaces supported by multimedia to full-fledged multimodal 3D virtual environment (VE) systems. Now, it is moving towards interface without touch, with the assistance of gesture of the people. Humans use different forms of communication - verbal and non verbal. Verbal communication refers to speech and writing whereas non verbal forms are mainly gestures, facial and bodily expressions. Symbolic gestures like pantomimes, which signify an action or instinct is prevalent in all cultures. (For example, showing a thumb near the mouth, expressing the feeling of thirst, folding both the hands close to chest, representing greetings and so on.) A common neural system in body processes both the spoken language and the symbolic gestures.

H. Hand Features

A huge number of hands ST are suggested so far. Thus those suggested ST are implemented to retrieve binary images from the hand. Thus Fig.1.8.1. demonstrates the elementary concept of HGR module.

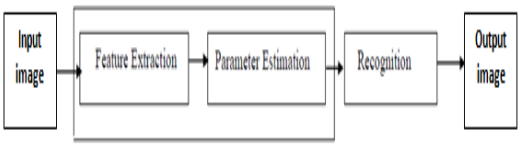


Fig.1.5.1 HGR module

- Creates frame about various signs and then it is stored in database.
- Develops HGR module.
- Enables the prototype of ISLR system.
- Recognize the HG finally.

II. PROPOSED METHODOLOGY

For feature extraction, contour of hands is utilized. This methodology is robust for scaling / rotation but it is large time consuming process. In, by calculating the center of gravity of hand, the tips of the hand were identified and from this, skeleton of hand is observed. In Fourier descriptors are implemented. In this methodology, the coordinates found at the boundary pixels are taken as real/imaginary parts of a number. Thus the Fourier coefficients collected using discrete transformation is considered as features. Although this proposed method has lower computational cost, it cannot able to manage the disjoint shapes because in this method coefficients of boundary pixels are measured as features. In Gabor feature for HGR is discussed. In this topology, Principal Component Analysis (PCA) is introduced which results in reduction of dimension. Local histogram is implemented to represent color features but when the histogram is very narrow, and then it results in false edges and regions.

Distance vector method is tailored for feature extraction method. Hence in order to overcome the aforementioned problem, the projected system introduced two different methodologies namely Discrete Wavelet Transformation (DWT) and DCT.

In these methods, DWT utilizes only low level approximation of an image as a feature vector. Hence, appropriately, the vector size of the feature gets reduced. In this method, both the boundary pixels and approximate image is considered for extracting feature from the image.

A. PROPOSED SYSTEM

Thus outline of the projected system4 process namely
(i) Acquisition of image
(ii) Preprocessing
(iii) Feature Extraction.

B. LOCAL BINARY PATTERN (LBP)

It performs local operations on the neighborhood of an image pixel. The neighborhood of a pixel is the pixel adjacent to a particular pixel.

Local Binary Pattern (LBP) was ended up being extremely proficient means for picture portrayal and has been connected in different examination. The LBPs are tolerant against monotonic brightening changes and can identify different surface natives like corner, line end, spot, edge, and so forth. The most understood and gainful variation of LBP i.e. Square LBP with uniform/no uniform cases is used as the foremost methodology for the extraction of hand features.

C. Feature Extraction using LBP

Local binary pattern is an effective method for feature extraction. LBP algorithm makes the binary encoding of each pixel in the image, and translates into a decimal number based on a certain order [2]. The LBP algorithm solves the problem about various binary-modes and increases the statistical features. In this algorithm, parameters control how LBP are computed for every pixel in the input image. . The equation for LBP feature extraction is given as: [36].

$LBP_{(x,y)} = \sum 2^{x}$ …….. (4.1)

Where g_x^{α} gray values of symmetric neighborhood pixel (x = 0, 1, 2….x-1)

X $^{\alpha}$- Circularly symmetric neighbor set

Y $^{\alpha}$- Radius of circle

An LBP feature encodes the local texture information, where user can utilize for some important tasks like; classification, and recognition. In this input image are splits into non overlapping cells. The following LBP algorithm illustrates the procedure about image feature extraction method.

D. CLASSIFICATION TECHNOLOGY

SVM

In this projected system, for evaluating ISLR SVM classifier is implemented Thus this section deals about the SVM topology in detail.

SVM is a progressive classifier adopted as classifier in ISLR. It has higher proficiencies in pattern recognition. SVM classification algorithm developed a new topology to formulate the decision boundary. In linear methods, the boundary may be if the form of line/ curves or may be hyper plane. The points which are closer to its boundary level are termed as support vectors. Thus this type of classifier maximizes the distance amongst the support vectors and thus it enables an improved separation between the classes.

Advantages

1. Make use of kernel technique. Hence low dimensional data are transformed into higher one.
2. Utilizes quadratic programming (QP) to choose the boundary.
3. Better generalization
4. Less over fitting.

Thus the proposed SVM has been projected for different types and they are as follows;

- Linearly separable - Vapnik and Lerner (1963)
- Linearly nonseparable–y Guyon et al. (1993)
- Nonlinear can be solved by Kernel Approach- Cortes and Vapnik (1995)

Case 1:

The training data which can be separable by hyper plane is given as

$$D = \left\{ \underset{x\ i}{\rightarrow}, y_i \right\}, i = 1\ to\ N,\ y_i\ \in \{-1, +1\}$$

And the same one is depicted in figure 1.9

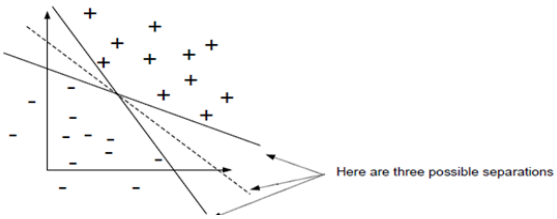
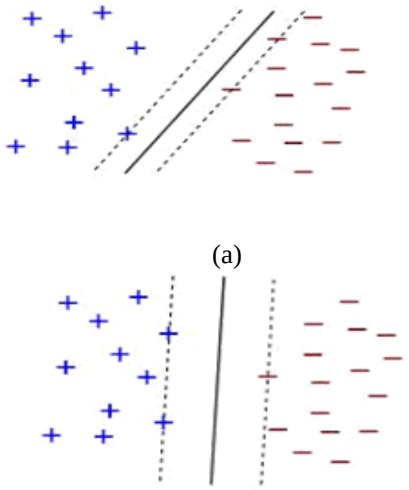


Fig.1.9. Separations by Hyperplane

Thus from the figure it is noted that there are three possible separations. Among those, the best separation point is found by increasing the margin value amongst the positive and negative case.

Thus the margin maximization is clearly stated in Fig.1.10.



(a)

(b)

Fig.1.10. (a) Hyperplane (Small Margin) (b) Hyperplane (Large Margin)

E. SVM for Nonlinear Case

SVM can also implemented to solve the problems which are highly nonlinear classification and is shown in Figure 1.11.

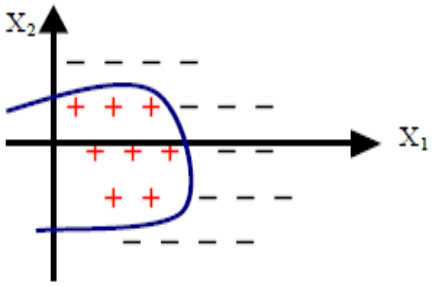


Fig.1.11. SVM for Nonlinear Case

Trick followed by Kernel

If data lies far away from linear or otherwise if the data set is inseparable, then kernels is implemented in mapping the input data with a high-dimensional space. Thus the mapping formed using linearly separable as depicted in Figure1.15.

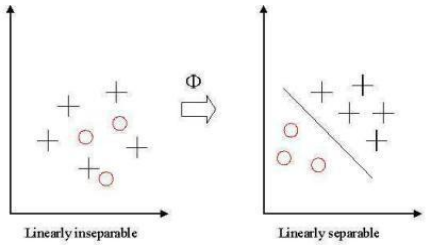


Fig.1.15. Kernel Mapping

According to the Kernel:

$$K(Xx, y) = \emptyset(x).\emptyset(y)$$

From Mercer's Theorem:

A class of mappings Φ has the following property and are stated below:

$$\emptyset(k)T\emptyset(Y) = K(X, Y)$$

K- Corresponding kernel function.

III. EXPERIMENTAL EVALUATION

A. PREAMBLE

In the previous chapters, a novel methods adopted for ISL recognition have been discussed. Feasibility of LBP, DCT and DWT based features are implemented for describing signs have been studied. An SVM Classifier is utilized for the task of ISL recognition. Thus the physical setup adopted for the experiments and the results obtained from them are discussed in this chapter.

B. EXPERIMENTAL SET-UP

Two different types of dataset are utilized in this work. The informational indexes utilized here includes ISL digits (0-9) and courageous ISL letters in order (A-Z) and are depicted in Fig. 2.1 and 2.2.

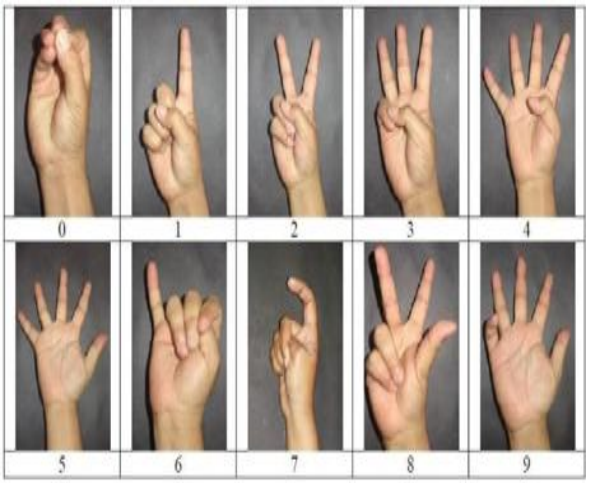


Fig.2.1. ISL numeral set

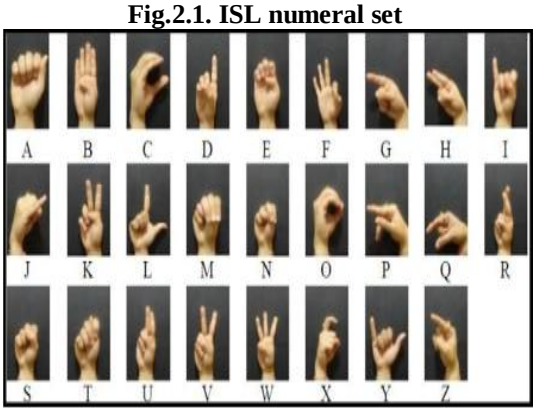


Fig.2.2. ISL Single Handed Alphabet Sets

These data set are captured using Cyber shot H70 camera. They are caught under an auto mode. Thus the standard document design of JPEG is used to catch these pictures. Hence, each picture is 4608×3456 pixel and thus it needs around 2.2 MB storage room.

Thus to make this effective, the pictures are again modified to 200×300 RGB pixels and hence the memory is reduced to 25 KB. These collections are gathered from 100 followers. Out of them, 69 were male and the remaining are female around the normal age about 27. Thus minimum of 5 pictures are caught from every follower.

Hand Posture	Number of Testing image	Correct			Accuracy		
		DWT feature extraction Method	DCT feature extraction Method	LBP feature extraction Method	DWT feature extraction Method	DCT feature extraction Method	LBP feature extraction Method
	50	45	45	46	90%	90%	92%
	50	46	47	48	92%	94%	96%
	50	40	41	43	80%	82%	86%
	50	45	44	48	90%	88%	96%
	50	46	44	48	92%	88%	96%
	50	46	47	49	92%	94%	98%

Table 3.1. Accuracy of FE methodology

From the table it is concluded that LBP based technique shows a better accuracy than the other methodizes. In this proposed topology, SVM based classification method is then adopted to recognize the hand gesture. Thus the, accuracy of the hybrid topology is depicted in table 3.2.

Method	Training Samples	Overall Accuracy
LDA	50	75%
DCT-LBP	50	88.94%
DWT-LBP	50	89.30%
LBP + SVM	50	95.6%

Table 3.2. Overall Accuracy

From the table, it is proven that the hybrid topology with the combination of LBP and SVM has higher accuracy.

Thus in order to evaluate the performance of the proposed topology, 5 parameters namely accuracy /Sensitivity/Precision/ FNR and FDR are calculated and is depicted in Fig.3.3.

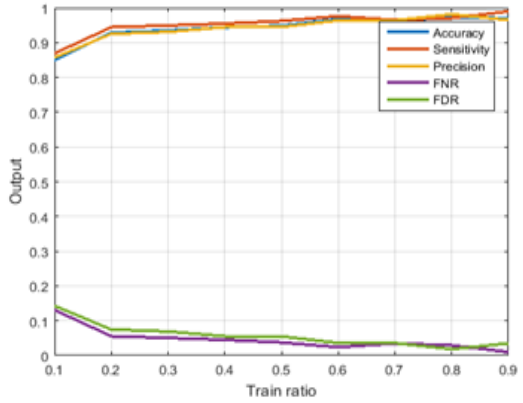


Fig.3.3. Evaluation of LBP using SVM

C. RESULT COMPARISONS

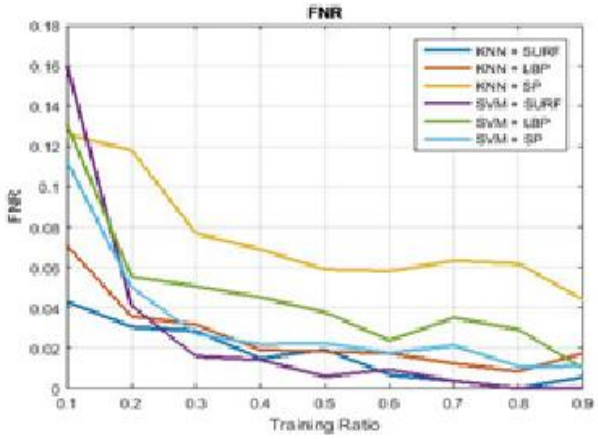


Fig.4.1. Comparison based on FNR

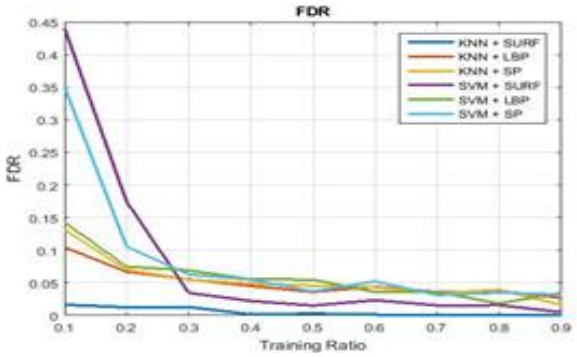


Fig.4.2. Comparison based on FDR

The Fig.4.1 to 4.2 depicts the performance evaluation in terms of accuracy, sensitivity, FDR and FNR for different methods. SVM and LBP combination results in 0.96% accuracy. While analyzing sensitivity, LBP feature with respect to SVM will results in an enhanced performance when compared with other combinations. The table 4.1 displays the numerical data for accuracy and sensitivity.

Technique	Accuracy	Sensitivity
SVM+LBP	94	96
SVM+SP	93	96
KNN+SURF	93	97
KNN+LBP	95	97
KNN+SP	92	92

Table 4.1. Experimental Analysis of SVM classifier

Thus from all these analysis, it is concluded that proposed SVM+LBP technique plays a vital role in HGR with higher accuracy.

IV. CONCLUSION

Hence this work discuss about the various method adopted in HGR. However, the so far discussed FE methods have suffers many drawbacks. For example, SURF is much efficient than SIFT, but it is not a rotational or illumination invariant. Hence, Hybrid features extraction has been implemented to overcome these limitations. Among those, while implementing DWT; accuracy is about only 50%. While applying DCT; accuracy is about 70%. However, the combination of LBP with SVM classifier will offer high accuracy. This is verified for both digital number and alphabetic representation of ISL.

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AUTHORS PROFILE

Muthukumar K Doing Ph.D degree in Field Of Electrical and Electronics Engineering, Karpagam Academy of Higher Education, Coimbatore, Tamilnadu, Inida, Since 2014 to till date. Received M.Tech degree in the Field Of Embedded System Technologies, Veltech Dr.RR & SR University, Chennai, Tamilnadu, Inida, 2012. Now currently working as an Assistant Professor, Sri Krishna College of Engineering and Technology, Coimbatore, Tamilnadu, India. His current research interests are in the field of developing Nanodevices based sensors, Embedded Controlled devices and Power Sector.

Dr. Amudha.A received B.E Electrical and Electronics Degree from Bharathiar University, Coimbatore, Tamilnadu, India in 1990 and M.E Degree in Power System from Madurai Kamaraj University, Tamilnadu, Madurai, India in 1992.She received her Ph.D.degree in Power Systems at Anna University, chennai, Tamilnadu, India. Currently she is professor and Head in the Department of Electrical and Electronics at Karpagam Academy of Higher Education, Coimbatore, Tamilnadu, India. She is a member of ISTE, MIE in India and IEEE. His research is mainly focused on Power Electronics, Power system and Power Quality Engineering.

Prof. / Dr. Gomathy V received Doctoral degree from Anna University, Chennai in the faculty of Electrical Engineering, Chennai, Tamilnadu, Inida. Master's degree Power Electronics and Drives from Government College of Engineering, Tirunelveli, Tamilnadu, India. Bachelor's degree of Electrical and Electronics Engineering from Francis Xavier Engineering College, Tirunelveli Tamilnadu, India. Now Currently Working as an Associate Professor, Department of Electrical and Electronics Engineering at Sri Krishna College of Engineering and Technology, Coimbatore, Tamilnadu, India. She has published more than 50 scientific publications and is a noted key speaker in Engineering domains. Her research interests are Power Quality Management, Soft Computing, Intelligent Controllers and Power Electronics.