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Feature extraction strategies for Indian Sign Language Recognition: A Review

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Abstract: Sign language is the language used by the general population with hearing and talking disabilities for communication in their day to day life. There are many sign languages such as Indian Sign Language (ISL), American Sign Language (ASL), and Chinese Sign Language (CSL), British Sign Language BSL). More research work is done in ASL side than ISL because ASL uses a single hand for making signs. But ISL is a language which is double-handed sign language so it becomes quite difficult for making recognition system for it. By couple of years researchers from India try to develop ISL recognition systems. There are mainly four stages associated with sign language recognition – image acquisition, preprocessing, feature extraction and classification.

Keywords: Indian Sign Language, Non-verbal form of communication, Hearing and Speech disabled, Preprocessing, Feature extraction, Classification

I. INTRODUCTION

Communication is characterized as an exchange of considerations and messages either by speech or visuals, signs or conduct. People with hearing and talking incapacity utilize their hands to express their thoughts which are called sign language. Sign language is the most important tool of communication for people with hearing and speaking disabilities [2]. This language utilizes just visually transmitted patterns rather than sound patterns since it is nonverbal communication language [2] which utilizes different body parts, such as hands, to make a sign [1]. Sign language is broadly known and acknowledged medium of communication for hearing and talking disabled individuals. Every nation has its own sign language, for example, Indian Sign Language (ISL) is used in India. In British, British Sign Language (BSL) is used. American Sign Language (ASL) and Japanese Sign Language (JSL) are used in America and Japan respectively. Normal individuals cannot understand sign language. So they need an interpreter who interprets sign language of deaf and dumb people. So deaf and dumb people cannot directly communicate with normal people, this causes isolation between them. There is a need for such a system which provides a bridge between deaf – dumb people and normal people. This system provides a platform for people with hearing and speech impairments to the rest of the world. The sign language recognition system can automatically recognize the signs and helpful for communication to deaf and dumb people with the outside world. The goal of the sign language recognition system is to present an efficient and accurate mechanism to transcribe text or speech thus the communication between visually and hearing impaired people and normal people will be smooth. In the process of recognition of Indian sign language, there are some challenges. First is, unlike other sign languages, ISL uses both hands to make signs so it is difficult to extract the proper shape of the sign. Second is, some signs involve an overlapping of hands this causes difficulties in recognition. The third is, some sign involves motion due to this recognition become more difficult. The gesture representing different signs for numeral and alphabets are shown in Fig. 1 and Fig. 2 respectively.

(a) (b) (c) (d) (e) (f) (g) (h)

(i) (j)

Fig 1: Numeral signs for Indian Sign Language. 1(a) number sign 0, 1(b) number sign 1, 1(c) number sign 2, 1(d) number sign 3, 1(e) number sign 4, 1(f) number sign 5, 1(g) number sign 6, 1(h) number sign 7, 1(i) number sign 8, 1(j) number sign 9.

(a) (b) (c) (d) (e) (f) (g) (h)

(i) (j) (k) (l) (m) (n) (o) (p)

(q) (r) (s) (t) (u) (v) (w) (x)

(y) (z)

Fig 2: Alphabetic signs for Indian Sign Language. 2(a) alphabet sign A, 2(b) alphabet sign B, 2(c) alphabet sign C, 2(d) alphabet sign D, 2(e) alphabet sign E, 2(f) alphabet sign F, 2(g) alphabet sign G, 2(h) alphabet sign H, 2(i) alphabet sign I, 2(j) alphabet sign J, 2(k) alphabet sign K, 2(l) alphabet sign L, 2(m) alphabet sign M, 2(n) alphabet sign N, 2(o) alphabet sign O, 2(p) alphabet sign P, 2(q) alphabet sign Q, 2(r) alphabet sign R, 2(s) alphabet sign S, 2(t) alphabet sign T, 2(u) alphabet sign U, 2(v) alphabet sign V, 2(w) alphabet sign W, 2(x) alphabet sign X, 2(y) alphabet sign Y, 2(z) alphabet sign Z

II. DIFFERENT APPROACHES FOR INDIAN SIGN LANGUAGE RECOGNITION

There are two main approaches for sign language recognition. There is glove-based approach and vision-based approach. In glove-based technique signers have to wear a colored glove or sensor glove. On the of chance, signers wear glove then the segmentation and preprocessing tasks become easy. The disadvantage of this approach is that signers have compulsory wear sensor hardware with

a glove. The vision-based approach uses image processing algorithms to detect and track signs. This approach is easier for signers because they do not have to wear a glove.

The glove-based approach is shown in Fig. 3 and vision-based approach for sign language recognition is shown in Fig. 4.

Fig. 3: Glove-based approach for sign language recognition [10]

Fig. 4: Vision-based approach for sign language recognition [11]

III. OVERVIEW OF INDIAN SIGN LANGUAGE RECOGNITION SYSTEM

The main steps involved in Indian sign language recognition are Image acquisition, preprocessing, feature extraction and classification. In both the stage training side as well as a testing side every one of these means is incorporated. To procure images digital camera, webcam integrated with a laptop or any external webcam can be used. For preprocessing, different segmentation and filtering techniques can be utilized. Contour extraction, Hybrid wavelet transform, Hu invariant moment like methods can be used for feature extraction. For classification k-nearest neighbor, dynamic time warping, artificial neural network, support vector machine are different classification procedure can be used. Fig. 5 demonstrates the general thoughts for Indian sign language recognition.

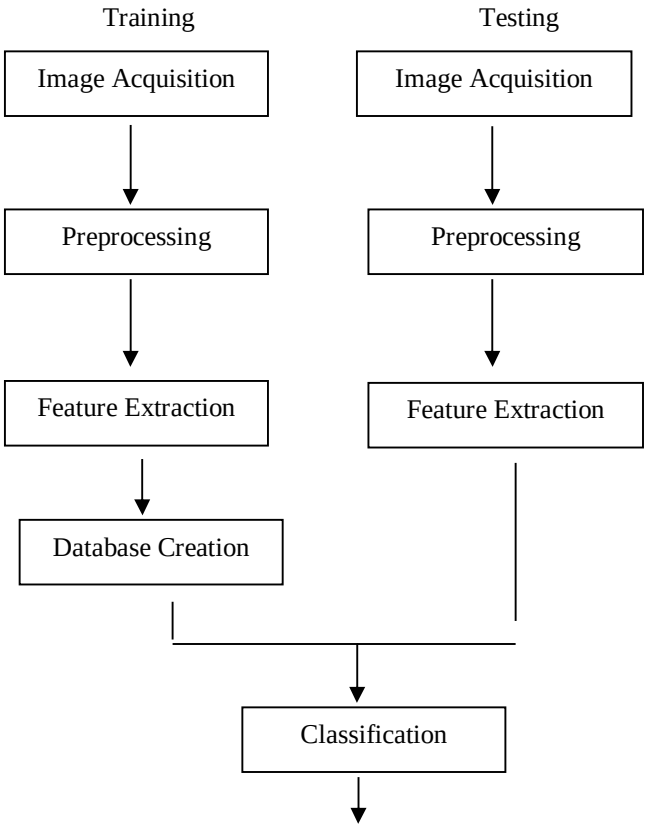


Fig. 5: Block diagram of Indian Sign Language Recognition System

A. Image Acquisition Page Layout

Image acquisition should be possible by either taking videos through webcam incorporated with PC or external webcam or by taking pictures through a digital camera.

B. Pre-Processing

Preprocessing is the procedure which can be utilized to remove noise. Preprocessing methods are used to get shape or region of interest from an image. So one can get required a binary image for feature extraction. TABLE 1 show some segmentation and noise removal methods which can be used for Indian sign language recognition.

TABLE I PRE-PROCESSING TECHNIQUES

Techniques	Description
Thresholding [1]	Gives binary image for feature extraction
Morphological Operations[1]	Remove noise and give the binary image
Global Thresholding algorithm[3]	Tackles any segmentation problem as a classification problem, and image level is divided into classes
Median filter[3]	Eliminate noise from the segmented image
Hand segmentation[4]	Extracting hand sign from the image, YCbCr color model is used for separation
Hand Tracking[5]	Skin color detection is used for hand tracking. YCbCr color space is used
Segmentation[6,7]	Process of partitioning the digital image into multiple sets of pixels. RGB color space is used. HIS model is used

C. Feature Extraction

Feature extraction is the way toward getting important features from the interested area of the image. These features can be utilized for classification. TABLE 2 show some feature extraction methods which can be used for Indian sign language recognition.

TABLE 2 FEATURE EXTRACTION METHODS

Techniques	Description
Contour extraction [1]	Find external boundary points to detect the shape of interested area of an image.
Hybrid wavelet transform [2]	It is generated from two constituent orthogonal transforms which gives better result in image compression. Haar – Walsh, Cosine Haar are various Hybrid wavelet transform techniques.
Fourier Descriptor [1,4]	Fourier descriptors are the complex value of boundary points achieved through fast Fourier transform of boundary pixels.
Histogram of Oriented Gradients (HOG) [12]	It is a descriptor used to identify objects.
Scale-Invariant feature transform [8]	This method is used to depict and recognizes various local features in image.
Hu invariant moment [3]	This technique is used for scale and position invariant pattern identification.
Edge Oriented Histogram (EOH) [9]	It is unique feature which represents frequency and directionality of the brightness variations.

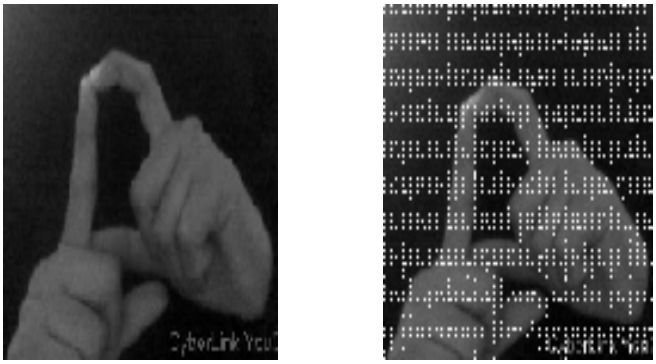
Some feature extraction techniques are described in detail as take after

1) Fourier Descriptor: Fourier descriptor is a technique used in object recognition to represent the shape of a boundary of a segment in an image. It is a method for encoding the shape of a two-dimensional object by taking Fourier transform of the boundary, where (x,y) point on the boundary is mapped to complex number x+iy. The original shape can be recovered from the inverse Fourier transform. First the coordinates of the outer contour points are transformed into complex valued coordinates for getting shape signature. Fourier descriptors are achieved through applying fast Fourier transform of the shape signature of an image because these descriptors are calculated in frequency domain. These features are utilized in content based image retrieval. The sample result for these descriptors shape signature is represented in Fig. 6.

(a) (b)

Fig. 6: 6(a) input image, 6 (b) shape signature of image

2) Histogram of Oriented Gradients (HOG) Descriptor: Histogram of Oriented Gradients (HOG) is a feature descriptor used to identify objects in image processing. The HOG descriptor technique counts occurrences of gradient orientation in interested parts of an image. HOG decomposes an image into small squared cells, processes a histogram of oriented gradients in each cell, and normalizes the result using a block-wise pattern and return a descriptor for each cell. These features use histogram to depict intensity distributions or to identify local edges in interesting area of an image [8]. This is done by dividing the image in to small units which is known as cell. And after division it made one dimensional histogram in each cell and for group of cell histograms are normalized which are utilized as descriptors of an image. Fig. 7 shows sample result for HOG descriptors.



(a) (b)

Fig. 7: 7(a) grayscale image, 7 (b) hog descriptors extracted image

3) Scale Invariant feature Transform (SIFT): The Scale-Invariant feature transform (SIFT) is a method to recognize and depict local features in images. The SIFT image features also allow for objects in numerous images of a similar area, taken from various positions to be recognized [12]. The SIFT approach takes an image and changes it into a large collection of local feature vectors. Every one of these feature vectors is invariant to any scaling, rotation or translation of the image. These features can be used as a descriptor as well as a feature detector. To get these features first the interesting points of an image are located for a scale space then filter the points of interest. These features uses for classification could make robust algorithm for the recognition system.

4) Hu Invariant Moment: An image moment is a certain specific weighted average of the image pixels' intensities or a function of such moments, for the most part, had some attractive property or understanding. Image moments are utilized to describe objects after segmentation. Hu invariant moment is derived from the theory of algebraic invariants. Hu invariant moment is utilized for scale and position invariant pattern distinguishing proof [3]. The benefit of utilizing Hu invariant moment is that it can be utilized for disjoint shapes.

5) Edge Oriented Histogram: The EOH (Edge Oriented Histogram) features depend on gradient data acquired by the Sobel operator which makes an image emphasizing the edges. Distinctive orientation containers are fixed, and a rectangular candidate sub window is given with the gradient magnitude of every pixel allotted to an orientation container which is nearest to gradient orientation of the pixel. It ends up both simple and quick to register with the utilization of one basic image per orientation container to compute the gradient magnitude summation for any applicant sub window [9]. EOH has been used for detecting sign boundaries. In image space, an EOH represents the frequency and a directionality of the brightness variations.

D. Classification

Classification is the important phase of any recognition system. Classification analyzes the numerical properties of various image features. And after that organizes data into various required categories. K-nearest neighbor, neural network and Support vector machine are different classifiers utilized for classification.

IV. CONCLUSIONS

This survey paper mainly centers on various strategies for feature extraction which can be used to recognize Indian sign language. Those extracted features can be utilized for grouping to characterize the image into different classes.

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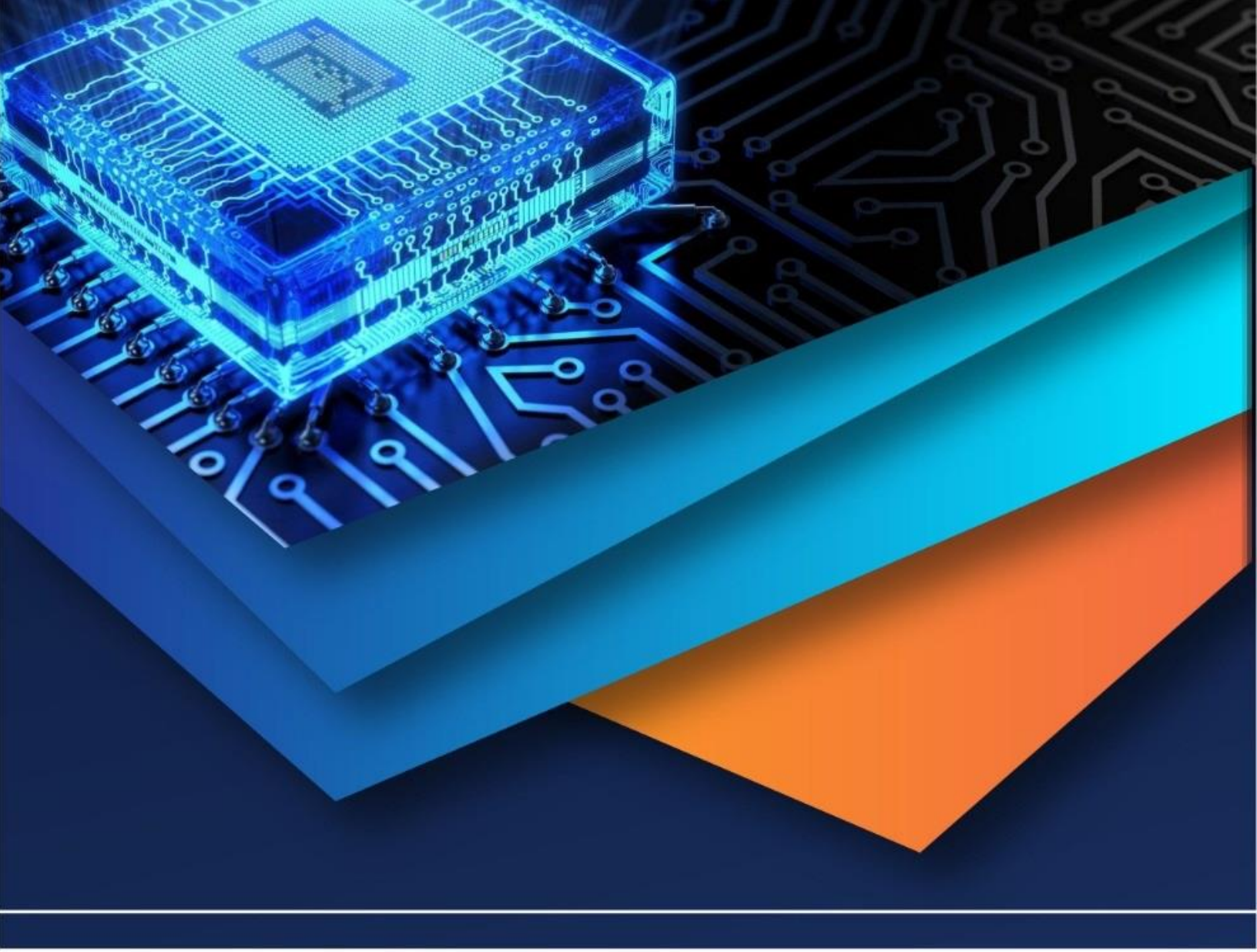

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