Gesture Recognition System

Prerna Sharma
Computer Science Engineering,
Krishna Engineering College,
Ghaziabad-201007, India.
sharma.prerna.13spt@gmail.com

Naman Sharma
Computer Science Engineering,
Inderprastha Engineering College,
Ghaziabad-201010, India.
naman.om.sharma@gmail.com

Abstract. Mostly communication in current scenario is happened via vocal sounds with body language gestures. Vocal sound play an important role in communication but at the same time, various body language expressions add more importance to communication. Even in few cases, body language played a very important role like communication between deaf & dumb people or traffic signal etc. In this paper, a method is defined for recognizing Gesture and Posture. This approach is tested on 6 gesture classes and 6 posture classes.

Keywords: SVD-PCA approach, Posture Recognition, Gesture Recognition, Feed Forward neural Network.

I. INTRODUCTION

Body gestures have broad range of gestures and postures like eye movements, variation in the pitch of vocal sounds etc. Generally body language involves hand movements. Gestures performed through hands gives a better expression to your words like representation of a number, expressing any feeling etc. Gestures are important tool of communication in any sign language or gesture based machine control. So, an algorithm is designed which works on recognizing gestures .

This recognition system can also be used in various areas like Tele-presence system [13], 3D animation system [12], sign language recognition [11], Virtual reality [14] and many more.

Application of this work is in area of HCI (Human Computer Interaction) based system. For extracting the features of input images, Principal Component Analysis (PCA), Singular value Decomposition (SVD) methods are used and neural network is trained using these features for classifying the gestures.

A. SVD

SVD is an approach used for extracting the silent features of image used for data dimension reduction and training purposes. ―SVD is based on mathematical theorem which states that a rectangular matrix A can be broken down into product of three matrices - an orthogonal matrix U, a diagonal matrix S, and the transpose of an orthogonal matrix V‖. [10]

The equation of this theorem is generally presented like:

$$A_{mn} = U_{mm} \quad S \, V^{T}_{Mnnn} \tag{1}$$

here $U^TU = I$, $V^TV = I$; S is diagonal matrix containing square roots of eigen values from U or V. U are orthonormal eigenvectors of AA^T , and columns of V are orthonormal eigenvectors of A^TA.

B. PCA

Principal Component Analysis is a linear transformation method used in statistical techniques. This method used for data dimension reduction and feature extraction. It defines through the multiplication of two matrices, which shows the co-relation between various features. [10]

Theorem is presented as follows:

$$Y=P'X \tag{2}$$

here X is correlated variable matrix, Y is uncorrelated variable matrix which is evaluated by multiplying X and co-variance matrix, P'.

C. Feed-Forward Neural Network

―An ANN consists of a sequence of layers; each layer consists of a set of neurons. All neurons of every layer are linked by weighted connections to all neurons on the preceding and succeeding layers‖. [9]

Every neuron in network can receive the signal and process that signal and generate the output signal. Neurons are interconnected to each other, and every connection is calculated through a real number, called weight coefficient, that shows the degree of importance of that connection in network.

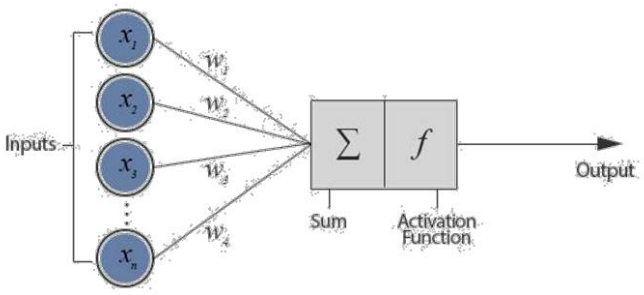

Fig. 1. ANN Architecture

Two functions are defined for predicting the behavior of any neuron in any particular layer

1. Network Input function
2. Network Output function

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Output function, Can be calculated as on network layer i, weight w_i , input x_i is defined as follows:

$$net_i = \sum w_i x_i + bias \quad (3)$$

II. Related Studies

Licsar [4] introduced a system for hand gesture recognition on vision based approach used Fourier Descriptor algorithm for classifying of static gestures in hand images only and remove the background using Background Subtraction method.

A Survey paper [6] published on gesture recognition. In that survey, they discussed on various gesture recognition techniques using different algorithms like neural networks, HMM (Hidden Markov Model), particle filtering, etc. Hu [7] explained a method for pose recognition using joint edge detection. He detected face, torso and skin pixels and detects proper joint locations in input image and markov chain-Monte Carlo Model is used for recognizing the posture.

Nguyen [8], 2013 explained a method for gesture recognition usinh neural network model in static input images. He used background subtraction and skin pixel detection techniques to extract the main reason in image and implement median filtering to remove the noise and recognize the gesture.

III. Proposed Methodology

A novel method is defined and implemented of recognizing the gesture and body pose recognition using SVD-PCA approach and feed forward artificial neural network. Methodology is explained below clearly:

1. Posture Recognition System

In case of recognizing postures, firstly two types of pose images are taken, one for train purpose and other for testing purpose. Then system converts the images into gray levels and detects the edges. After that segmentation is applied using thresholding technique and tracing the contours to extract the silent features of input image. And features are extracted using SVD-PCA approach and features of train dataset images is used to train the neural network and features of test dataset is given as an input to the network, so that it can identify the features and match them with the trained image features and classify the postures.

2. Gesture Recognition System

In case of recognizing gestures, similarly as the above system, trained hand dataset images are taken and then hand is detected through skin detection technique. After that various morphological operation are performed on that image to improve the quality so that it can clearly show the skin pixels. Now Features are extracted from trained image dataset using SVD-PCA approach and use that features to train the network. In case of testing the system, test dataset hand images are taken and apply the same procedure till morphological operations and after extracting features, network match these features with the trained images and classify the gestures.

IV. Algorithm

Following steps represent the proposed method:

1. Input Dataset

Input dataset is prepared that shows an image containing hand and upper body portion and through this image skin pixels and edges are detected which used in gesture-posture recognition.

2. Basic Processing Methods

a) Gesture Recognition

Skin pixels are detected using RGB color space and then some specific morphological operations are performed.

b) Posture Recognition

Gray conversion is done on input image and then canny edge detection algorithm is used for detection of edges and contours are obtained.

3. Feature Extraction

a) Gesture Recognition: SVD-PCA method is used to extract the feature which used signal matrix, eigen vectors of input image which is used to train the network and classifying purpose. A image of SVD features is shown below:

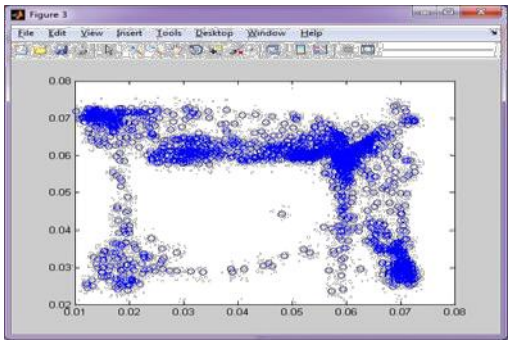

Fig. 2. SVD-PCA features of gesture class

b) Posture Recognition

SVD-PCA features are extracted; for each class, features are calculated through SVD-PCA approach and used for training and classifying. Following graph show the SVD-PCA features for a posture class:

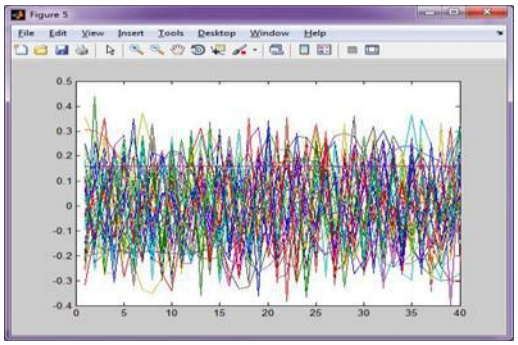

Fig. 3. SVD-PCA features of posture class

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V. RESULTS

Results are calculated on the basis of confusion matrices generated by the neural network. And here, we formalize them in tabular method which shows the correct recognition percentage of detected gestures and postures.

Dataset	No. of Classes	Accuracy
Gesture	6	95.9 %
Posture	6	90.3 %

Table 1. Accurate Results

VI. CONCLUSION

Proposed methodology recognized specific postures and gestures in any body image. Results are more accurate than the previous work done. But here, in proposed technique, background is uniform and only some type of gestures and postures are recognized.

In future scope, Defined work can be performed on complex background images. This method tracks posture in upper body only. It can be extended to complete body posture recognition.

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