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Comparative Analysis of Hand Gesture Recognition Techniques

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ABSTRACT
During past few years, human hand gesture for interaction with computing devices has continues to be active area of research. In this paper survey of hand gesture recognition is provided. Hand Gesture Recognition is contained three stages: Pre-processing, Feature Extraction or matching and Classification or recognition. Each stage contains different methods and techniques. In this paper define small description of different methods used for hand gesture recognition in existing system with comparative analysis of all method with its benefits and drawbacks are provided.
Keywords-Classification, Feature Extraction, Hand Gesture Recognition, Human computer Interaction (HCI), Image Pre-processing

I. INTRODUCTION

Image Processing is a deal with Pictorial information for human interpretation and examine [1]. Gesture Recognition is in Computer science and language technology with goal of interpreting human gesture via method and algorithms. Gesture is basically use for Non-verbal communication. Adroit gesture can add to the impact of a speech Gesture Clarity your ideas or rein force them and should be well suited to the audience and occasion. Gestures are being used in HCI many since many years. Earlier, hardware based gesture recognition was more prevalent. User had to wear gloves helmet and other heavy apparatus. Sensor actuator and accelerometer were used for gesture recognition. But the whole process was difficult in real time environment. Hand Gesture can be sub divided in to two types static and Dynamic as shown in Figure 1.1.

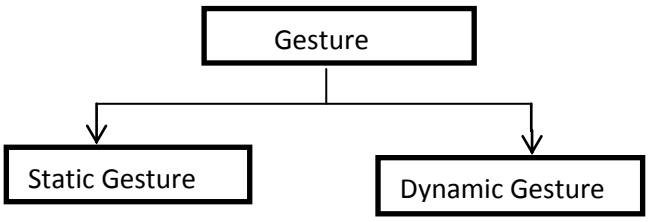

Fig.1.1: Types of Gesture

In Static hand gesture shape of hand gesture is used to express meaning or feeling. Dynamic Hand Gestures are composed of series of hand movements for track motion of hand [2].Hand Gesture Recognition is topic in computer vision because of more application, such as HCI, sign language interpretation, and visual surveillance [3].

II. HAND GESTURE RECOGNITION

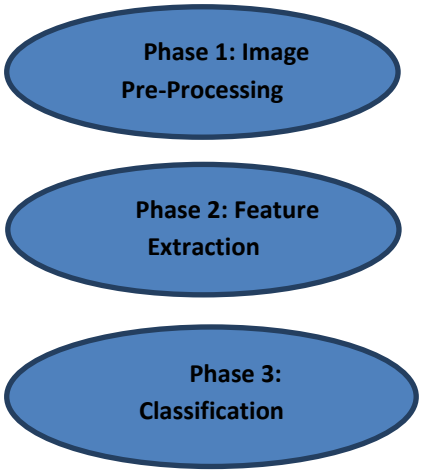

Fig. 1.2: Three common stage of gesture recognition system

In earlier days hand gesture detection was done using mechanical device to obtain information of the hand gesture. The essential aim of building hand gesture recognition system is to create a natural interaction between human and computer where the recognized gestures can be used for controlling or conveying meaningful information. Generally there are three stages in most of the gesture recognition system. The tree stages may be enumerated as image pre-processing, feature extraction and classification or recognition shown figure 1.2 [4].

2.1 Image Pre-Processing

In preprocessing stage operation are applied to extract the hand gesture from its background and prepare the hand gesture image for feature extraction. Skin segmentation is the process of dividing an image into multiple parts. This is used to

identify objects or other relevant information or data in digital images. There are many different ways to perform image segmentation, including: RGB, HSI, YCbCr, CIE-Lab [5].

2.2 Feature Extraction

Good Pre-process leads to perfect features extraction process and the latter play an important role in a successful recognition process. Feature extraction is a complex problem and in which whole image or transformed image is taken as input. The goal of feature extraction is to find the most differentiate information in the recorded images. Feature extraction operates on two- dimensional image array but produces a feature vector [6].

1) Contour Detection

Contour detection in images is a fundamental problem in computer vision tasks. Contours are distinguished from edges as follows.

Contour tracking algorithm [7]:

Step 1: Scan the image from top to bottom and left to right to find first contour pixel marked.

Step 2: To scan clockwise direction searching pixel sequences.

Step 3: Scan clockwise until the next pixel valueXJ = 1.

Step 4: If XJ = 1, position of XJ ≠ (i1, j1) and position of XJ≠ (i2, j2), Store position of XJ into x and y arrays and set (i, j) = position of XJ . When J > 3 set (i1, j1) = position of XJ−1 and (i2, j2) = position of XJ−2.

Step 5: If step 4 become false then set x[J] = x[J−1], y[J] = y[J − 1], (i, j) = position of XJ−1, (i1, j1) = position of XJ and (i2, j2) = position of XJ−2. Step 6: Repeat steps 2 to 5 until position of XJ = position of X1.

By computing proposed contour tracking algorithm, the position of all contour pixel is stored into x and y arrays.

2) Histogram Based Feature

Many researches have been applied based the histogram, where the orientation histogram is used as a feature vector. It is indicate 2D vector contain the strengths and angles that present locally throughout the image [8]. The mean and standard deviation of orientation histogram about the x and y directions, correlation function, Cor (x, y) according as j shifts. The mean and standard deviation of orientation histogram about the x and y directions, correlation function, Cor (x, y) according as j shifts.

$$\text{Cor(j)}= \frac{1}{M} + \frac{1}{N} \quad (1)$$

Where

$$M=A * \sqrt{(E(q^{1x}) - E(q^{2x}))^2 + (\sigma(q^{1x}) - \sigma(q^{2x}))^2} \quad (2)$$

$$N=B * \sqrt{(E(q^{1y}) - E(q^{2y}))^2 + (\sigma(q^{1y}) - \sigma(q^{2y}))^2} \quad (3)$$

E() is the expectation operation and σ() is the standard deviation operation. q1 and q2 are the patches of input images about each x-axis and y-axis. q1 and q2, are the patches of model images and A**,** B are constants. After correlation function calculate orientation histogram for each block calculated and classified.

3) Moments Invariant

Features associated with images are called invariant if they are not affected by certain changes regarding the object view such as translation, scaling, rotation and light conditions [7]. Hu proposed 7 famous invariant moments. It is used in many image classification approaches and not affected by translation, scale or rotation [9].

2.3 Classification or Recognition

Recognition process is used by feature extraction method and classification algorithm. In recognition stage, new feature vector can be classified after system is trained with enough. So, classification accuracy is good. Classification is done using popular methods like, k-Means, Mean shift, Hidden Markov Model, Principal Component analysis, Dynamic time warping.

1) k-Means Clustering:

The k-means problem is to determine k points called centers so as to minimize the clustering error, defined as the sum of the distances of all data points to their respective cluster centers [10]. The algorithm starts by randomly locating k clusters in spectral space. Each pixel in the input image group is then assigned to the nearest cluster center and the cluster center locations are moved to the average of their class values. This process is then repeated until a stopping condition is met. The stopping condition may either be a maximum number of iterations or a tolerance threshold which designates the smallest possible distance to move cluster centers before stopping the iterative process.

2) Mean Shift clustering

It is a nonparametric clustering technique which does not require prior knowledge of the number of clusters, and does not constrain the shape of the clusters [10]. The main idea behind mean shift is to treat the points in the d-dimensional feature space as an empirical probability density function where dense regions in the feature space correspond to the local maxima or modes of the underlying distribution. For each data point in the feature space, one performs a gradient ascent procedure on the local estimated density until convergence.

3) Hidden Markov Model (HMM)

In describing hidden Markov models it is convenient first to consider Markov chains. Markov chains are simply finite-state automata in which each state transition arc has an associated probability value; the probability values of the arcs leaving a single state sum to one. Markov chains impose the restriction on the finite-state automaton that a state can have only one transition arc with a given output; a restriction that makes Markov chains deterministic. HMM is defined as a set of states of which one state is the initial state, a set of output symbols, and a set of state transitions. A HMM can be shown as Figure1.2 [2]. Set of hand positions in each state *A1* to *Ai* represent the input states. The probability of transferring from one state to another state *Pab*, P*ba*represent the state transitions. The one specific posture or one gesture *B1* to *Bi* represents the corresponding outputs. So the database of HMM has many samples per single gesture, the relation between the number of samples and the accuracy is directly proportional, and the speed is inversely proportional.

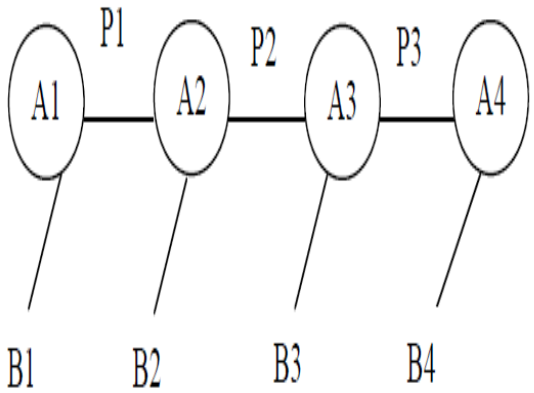

Fig. 1.3 HMM

4) Principal Component Analysis (PCA)

PCA based approaches normally contain two stages: training and testing. In the training stage, an Eigen spaces is established from the hand posture training images using PCA and the hand posture training images are mapped to the Eigen spaces for classification [11]. In testing stage, a hand gesture test image is projected to the Eigen spaces and classified by an appropriate classifier based on Euclidean distance. PCA lacks the detection ability.

5) Dynamic Time Wrapping (DTW)

DTW has been used to find the optimal alignment of two signals. The DTW algorithm calculates the distance between each possible pair of points out of two signals and that signal is as defined as their associated feature values. Using these distances to calculate a cumulative distance matrix and find the least expensive path through this matrix and represent ideal warp of synchronization of the two signals that causes the feature distance between their synchronized points to be minimized. This process is done after the signals are normalized and smoothed. DTW is useful in various applications, such as speech recognition, data mining and movement recognition [12].

III. ANALYSIS

Hanning Z., et al. [13] presented hand gesture recognition system based on local orientation histogram feature distribution model. Skin color based segmentation algorithms were used to find a mask for the hand region, where the input RGB image converted into HSI color space. To compact features representation, k-means clustering has been applied.

Mohammad et. al.[14] For segmentation it is uses YCrCb color space for accurate skin detection. It is use encoded nonlinear RGB.. For contour detection find boundary region of detected hand then draw rectangular box around the contour and find center of hand. Classification is done using Hidden Markov Model (HMM). In this markov chain emits a sequence of observable outputs. It is model parameter $\lambda = (A, B, \pi)$ Where A is transition Matrix, B is Observation Matrix and π is initial probability distribution. In this markov chain emits a sequence of observable outputs.

Saad [15] proposed the process for detecting, understanding and translation sign language gesture to vocal language. There are two mode recording and translation mode. In recording mode, user adds gesture to dictionary. In translation mode, gesture is compared with gesture stored in dictionary. Dynamic Time Wrapping algorithm is used to compare gestures. It is provide 91% accuracy. It is not suitable for finger movement.

Ayan [16] proposed hand gesture recognition under varying illumination. Overall process has two step: 1. Segmentation: To achieve segmentation of hand from complex background using Information Measurement Ratio based threshold technique. 2. Training & recognition: Principle Component Analysis (PCA), Euclidian distance is used for recognize hand accurately and efficiently. PCA is fast, simple and accurate. It has also reduced dimensionality of picture and cheaper in terms of time. It is give reduce time complexity but not apply on orientation of hand gesture recognition.

Table 1 Comparison of Existing Methods

Techniques	Advantages	Limitation
k- Means	Produce tighter clusters.	Prediction of k difficult for fixed number of cluster
Mean shift clustering	Cluster assumed work on single parameter. Robust	Ambiguity in optimal parameter selection
Hidden Markov Model	Easily extended to deal with strong TC tasks. Easy to understand	Long assumptions about data. Huge number of parameter need.
Principal Component Analysis	Achieve satisfactory real time performance.	Lack of diction ability
Dynamic time warping	Reliable time alignment robust to noise	Complexity is quadratic,distance metric needs to be defined.

IV. CONCLUSION

Recently, Gesture recognition is very active area of research. Hand gesture recognition is often sensitive to poor resolution, drastic illumination conditions, complex background, cluttered background, multiple hand gesture detect and occlusion among other prevalent problems in the hand gesture recognition system. In this paper various method for each stage of Hand Gesture Recognition system used. In pre-processing stage, perform sequence of steps like segmentation, filter and edge detection which is used different method and algorithm to detect hand region and filter noise. In Feature extraction stage most commonly used contour tracking algorithm, moment invariant and histogram orientation gradient are used. For classification HMM, Clustering, PCA and DTW is used. Comparative analysis of all methods is discussed in this paper.

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