ENHANCED K-MEANS BASED FACIAL EXPRESSIONS RECOGNITION SYSTEM

[1]TANVI SHEIKH, [2]SHIKHA AGRAWAL

CSE Department CSIT Durg[1], Assistant Professor CSE Department CSIT Durg
Email:tanvisheikh1990@gmail.com[1], Shikha.Agrawal030@gmail.com

Abstract— Automatic facial expression recognition is an interesting and active research topic for research in the recent years. Facial expression recognition plays a vital role in Human Computer Interaction. Facial expressions are one of the key features of facial recognition. In this research work, Enhanced K-Means algorithm is proposed for classification of facial expressions from frontal facial images. To classify the expressions, algorithm uses two features: density of pixels and ratio of height to width of cropped boundary regions. The recognition system comprises preprocessing, feature extraction and expression classification. Based on the features extracted, Enhanced K-Means algorithm will classify the expressions into one of the expressions happy, sad and neutral. Expression classification will apply on the dataset of 200 images of KDEF (Karolinska Directed Emotional Face Database) database and expected to improve the performance of existing recognition system.

Keywords— Facial Expression Recognition, Facial Expressions, Enhanced K-Means Algorithm and Successive Mean Quantization Transform (SMQT).

I. INTRODUCTION

Facial expression is one of the most natural and direct means for humans to communicate their emotions [1]. Facial expression recognition means finding the expressions of an image and recognizes which expression it is such as happy, sad, angry and neutral. Some application area related to face and its expression includes personal identification, access control, video calling and teleconferencing and human computer interaction [2]. Automatic facial expression recognition has been used in various real life applications such as security systems, interactive computer simulations and computer vision. Face detection and face localization is the primary problem in the automatic identification system of facial expression, including the face into simple background and complex background. In 1971, Ekman and Frisen discovered six different facial expressions that are universally accepted as basic emotion include happiness, sadness, fear, disgust, surprise and anger along with neutral face [3]. Facial expression recognition system solves the problem of face detection and feature extraction. Commonly three main steps are followed for expression recognition. First, detection of face boundary, second feature extraction and the last is facial expression recognition. Feature extraction referred to facial expression information [4].

II. RELATED WORK

A number of research works has been proposed for the techniques to recognize facial expressions. Mandeep Kaur and Rajeev Vashisht presented comparative study of facial expression recognition techniques, in which Principal Component Analysis and Singular Value Decomposition methods are compared and gave excellent result for expression recognition on JAFEE database [4]. Pushpaja V. Saudagare and D. S. Chaudhari introduced system for facial expression recognition by using neural network. Neural network used in this is feed forward back propagation neural network and one more method Principal Component analysis is used for feature extraction. The features used to recognize the expressions are forehead, midforehead, mouth and cheek [5]. Sachin D. More and Sachin Deshpande proposed Fuzzy Model for Human Face Expression Recognition [2]. It is a new approach for facial expression recognition. In this, fuzzy pattern rules are used for recognition that is formed by the extracted features and the face region is detected on the basis of skin color. It presented that, system fails to recognize the expressions. Similarly by Hehua Chi, Lianhua Chi, Meng Fang and Juebo Wu introduced a Cloud Model for Facial Expression Recognition. In this technique, the concept of cloud droplet and backward cloud generator is used for feature extraction in terms of numerical values. Cloud droplet is a group of images that are preprocessed for further processing. Cloud model uses these features to classify the expressions. The result of this technique is feasible and effective for facial expression recognition [7].

III. METHODOLOGY

A. EXISTING SYSTEM

To recognize the facial expressions from static images, various techniques are proposed. One of the techniques is K-Means Clustering Algorithm. K-Means algorithm is most widely used algorithm but

it has some disadvantages such as random initialization of initial centroids, less accurate, not efficient for huge datasets and it also requires specification of number of clusters at first [6].

K-Means Clustering Algorithm: K-Means Clustering algorithm is the most popular and simplest algorithm of clustering. It groups the input data points into the specified number of clusters based on the features. In the existing system, clusters are defined based on the expressions. K-Means algorithm is shown in the Algorithm 1[8].

Algorithm 1: K-Means Clustering Algorithm

Input:
k // the number of clusters,
D= {d1, d2,…, dn} // set of n data items.

Output:
A set of k clusters.

Steps:
1. Randomly select k data points from D as the initial cluster centers;
2. (Re) assign each data point to the cluster, to which the data point is nearest;
3. Update the cluster means, i.e., calculates the mean value of the data points for each cluster;
4. Repeat, until no change.

B. PROPOSED SYSTEM

In the proposed system "Enhanced K-Means Clustering algorithm" is to be used for Facial Expression Recognition. This will provide three clusters of expressions..This overcomes the drawback of random selection of initial centroids as in K-Means algorithm. It provides more accurate result than K-Means algorithm and also efficient for large datasets.

Enhanced K-Means Algorithm: This algorithm has two phases illustrated in Algorithm 2. First phase provides the initial centroids systematically to produce clusters with better accuracy and in the second phase assigning the data points to the appropriate clusters [9]. Because it provides a separate algorithm to calculate the initial centroids systematically, the final clusters are more accurate.

Algorithm2: Enhanced K-Means Algorithm

Input:
k // the number of clusters,
D= {d1, d2,.....,dn} // set of n data items.

Output:
A set of k clusters.

Steps:
Phase 1: Determine the initial centroids of the clusters by using Algorithm 3.
Phase 2: Assign each data point to the appropriate clusters by using Algorithm 4.

Algorithm 3 illustrates the Phase1 of algorithm 2. At the first, compute the distance between each data point and all other data points in the data-point set D. Then locate the closest pair of data-points from the set D and create a new set of data points Am having these two data point and delete them from D. Then find the closest data point to the set Am and add it to Am and delete it from D. Repeat this process until the number of data point in Am reaches a threshold. When a threshold value met, perform step second and create a new data point set Am+1. This process will be repeated for 'k' such data point sets. Finally, the initial centroids will be obtained by averaging the vectors in each data point set.

Algorithm3: Finding the initial centroids

Input:
D = {d1, d2,....., dn} // set of n data items
k // Number of desired clusters

Output:
A set of k initial centroids.

Steps:
1. Set m = 1;
2. First of all compute the distance between each data point and all other data- points in the set D;
3. Then find the closest pair of data points in the set D and create a new data-point set Am which contains these two data- points, delete these two data points from the set D;
4. After that find the data point in D that is closest to the new data point set Am, Add it to Am and delete it from D;
5. Repeat step 4 until the number of data points in Am reaches 0.75*(n/k);
6. If m<k and reaches a threshold, then at this point m = m+1, create another set of data by follow the steps from 3-5.
7. And now, for each data-point set Am (1<=m<=k) find the arithmetic mean of the vectors of data points in Am, these means will be the initial centroids.

Steps for forming of final clusters are shown in Algorithm 4. Initially compute the distance between each data points and all centroids. Then assign the data points to the closest centroid and for each cluster, recalculate the centroids and repeat until the convergence criterion is met. At this point, final clusters are obtained. Euclidean distance is used to determine the distance between data points and cluster

centroids.

Algorithm4: Assigning data-points to clusters
Input:
D = {d1, d2,.....,dn} // set of n data items
C= {c1, c2,.....,cn} // set of k centroids

Output:
A set of k clusters.

Steps:
1. Firstly compute the distance between each data-point di (1<=i<=n) and all the centroids cj (1<=j<=k) as d (di, cj);
2. Now for each data-point di, find the closest centroid cj and assign di to cluster j.
3. Then for each cluster j (1<=j<=k), recalculate the centroids;
4. Repeat
5. for each data-point di,
a. Compute its distance from the centroid of the present nearest cluster;
b. If this distance is less than or equal to the present nearest distance, the data-point stays in the cluster;
c. Else for every centroid cj (1<=j<=k) compute the distance d (di, cj); End for;
6. Assign the data-point di to the cluster with the nearest centroid cj Endfor (step (2));
7. For each cluster j (1<=j<=k), Recalculate the centroids until the convergence criteria is met.

C. PROPOSED SYSTEM OVERVIEW

The proposed Facial Expression Recognition System divides the task of facial expression recognition into three major parts; preprocessing, facial feature extraction and expressions classification. The step by step process for facial expression recognition is shown in figure1. Preprocessing part includes four functions auto color, auto brightness, auto contrast and noise reduction. In facial feature extraction step face detection, segmentation by edge detection and feature extraction will be performed. At last, based on the extracted features Enhanced K-Means algorithm will classify the expressions into happy, sad and neutral expressions.

IV. PREPROCESSING

Preprocessing is the most important and the required step of the image processing. It is performed to get uniform and noise free image for further processing. This step includes the following functions:

Auto Brightness- Auto brightness function adjust the brightness of the image.
Auto Contrast- Auto contrast function automatically calculates the favorable contrast for the image will increase the brightness of the image.
Auto Color- Auto color function adjust the color of the image.
Noise Reduction- Noise reduction will eliminate the unnecessary noise from the image.

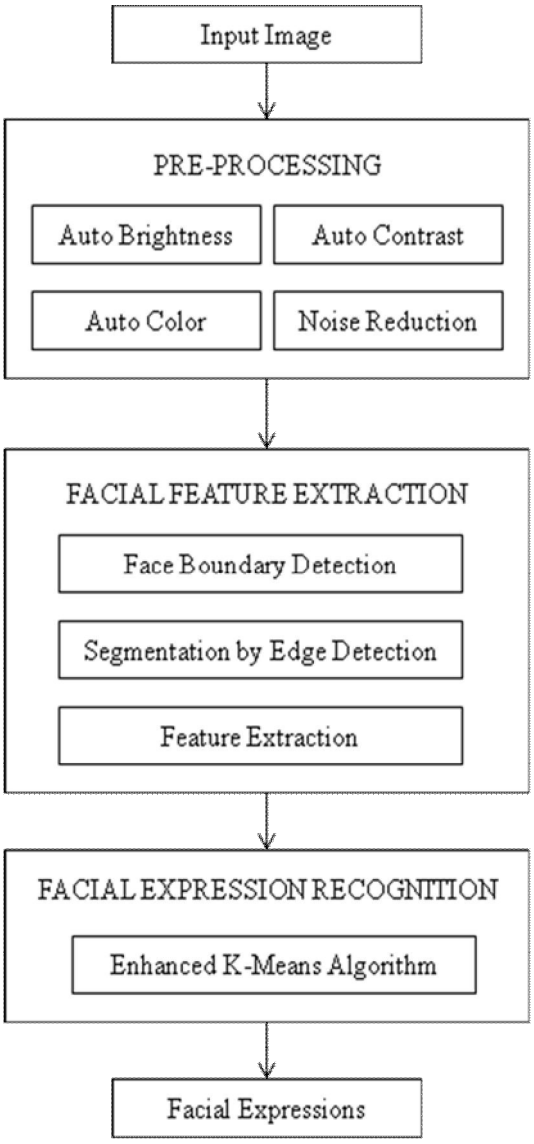

Fig.1: Flow process of proposed Facial Expression Recognition System

V. FACIAL FEATURE EXTRACTION

Facial feature extraction is the second foremost part of the facial expression recognition system. This comprises three phases: face boundary detection, segmentation by edge detection and feature extraction. Face boundary detection phase is performed to identify the face in the image that contains the eyes, nose and mouth. After that segmentation is performed to identify the region of interest. In this research work mouth is taken as region of interest for the processing. Finally the features of mouth region will be extracted.

(i) Face Boundary Detection:

Face boundary detection phase is also a very important step for the facial expression recognition. In this phase, the face boundary is detected and for that Successive Mean Quantization Transform (SMQT) features is used [10]. The Successive Mean Quantization Technique performs an automatic structural breakdown of information. This information will be applied on local areas in an image to take out illumination insensitive features [11].

(ii) Segmentation by Edge Detection:

Segmentation of image means partitioning the image into multiple parts. In this system, segmentation is used to detect the interested regions such as eyes and mouth from images and for that edge detection method is used. After edge detection the region of interest is then cropped for feature extraction. Six edge detection methods are tested, named as: Roberts, Sobel, Prewitt, Laplacian of Gaussian, Zero-Cross and Canny. Canny method is chosen because it gives best results for edge detection.

(iii) Feature Extraction:

In this phase, the features of cropped interested region will be extracted and stored for classification. Mouth is taken as the region of interest and the features will be extracted. Two features will be calculated: first is density of pixels and second is ratio of height to width of cropped boundary regions. The calculation of ratio is done by dividing the cropped mouth region into three zones: upper, middle and lower zones. Smile expression falls in the upper and middle zone, neutral expression falls in the middle zone and the sad expression falls into the middle and the lower zone. These values will be used in the next and the last component of system for expression recognition.

VI. FACIAL EXPRESSION RECOGNITION

Facial expression recognition is the final step of the expression recognition system. After feature extraction, facial expressions will be classified. For this, Enhanced K-Means algorithm is proposed. Enhanced K-Means algorithm has two phases and in the first phase this will provide a separate algorithm for the calculation of initial centroids and in the second phase, assign the data points to the appropriate clusters. This will take calculated numerical values as an input and classify the expressions into three different classes of expressions happy, sad and neutral. In existing system algorithm initial centroids are randomly selected whereas proposed algorithm calculates it systematically. In the paper [9], Enhanced algorithm shows improvement in accuracy of the clusters and also efficient for huge dataset.

VII. EXPECTED RESULT

A database of 200 images is collected. Images are taken from the Karolinska Directed Emotional Faces (KDEF) Database [12] is collected. The proposed system will be implemented on the database using MATLAB and expected to improve the system performance of recognition. The proposed system interface is shown in figure 2, that consists functions will be performed during the facial expression recognition.

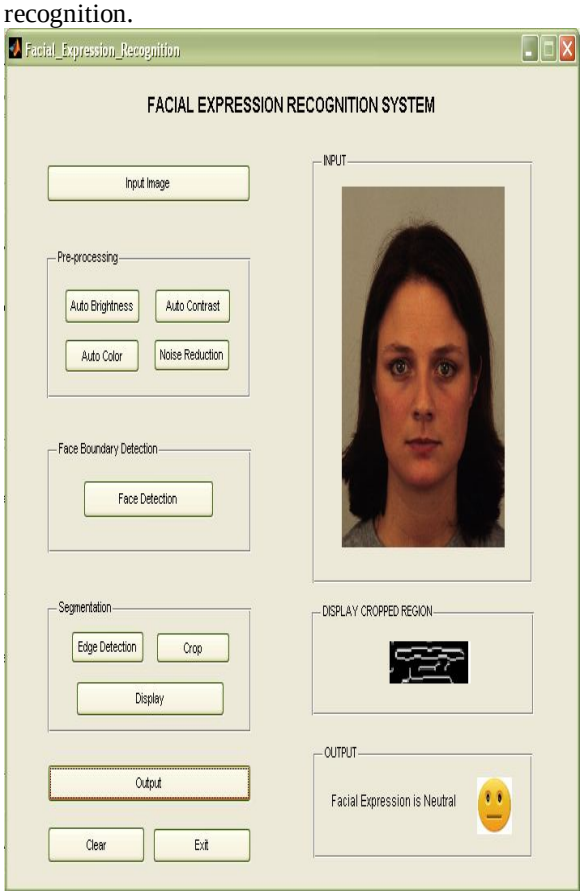

Fig.2: Proposed Facial Expression Recognition System Interface.

CONCLUSION

In this paper a fast and effective approach for facial expression recognition is proposed that recognizes the three principle expressions happy, sad and neutral into three clusters. Enhanced K-Means is the proposed algorithm for facial expression recognition. It gives better result than K-Means algorithm and it is also effective. So, it is expected that Enhanced K-Means algorithm will improve the performance and also increases the rate of success for recognition.

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