International Journal of Advanced Science and Technology
Vol.71 (2014), pp.41-48
http://dx.doi.org/10.14257/ijast.2014.71.04

A Hybrid Approach of Face Recognition Using Bezier Curve

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Abstract

This paper proposed an efficient, intelligent and less complex method of face recognition. A hybrid approach of face recognition is proposed here using the neural networks and Bezier curves. Detection of structural facial features such as eyes, eyebrows, nose, lips and mouth boundaries is an essential process for various image processing task such as face recognition. In this paper we introduced a method to denote the landmark on face using Bezier curve and then by further processing of these Bezier curves, image recognition is done.

Keywords: *Bazier Curve, Face Recognition, Eyebrows, Hybrid*

1. Introduction

Human beings are normally quite perfect in image identification and recognition but it is fairly complex and difficult task using computer. The basic concept of image recognition system is to find out the identity of a person through captured image compared with the already stored image in the database. People see others face as a routine process. They judge the people identity not on the basis of whole face but certain main facial features, mainly this is the facial features extraction. If we see the human recognition characteristic they can identify the faces from vary long distances with shows that only outline structure of human face with its facial characteristics is enough to recognize the face.

In human faces shape and size of eyes, eyebrows, nose, lips, mouth and their distance relationship are considered as good features to further process the image recognition task. For moving the system efficient it is required to get necessary information from face and discard the other common not necessary useless information. Face recognition approaches are classified in the four types *i.e.*, Knowledge based approach, feature invariant approach, template based approach and appearance based approach. Knowledge based approach rely upon rules drive from the knowledge base of the face geometry. Mostly the rules are defined on the basic of relative distance and positions of facial features like eye pairs, nose, mouth, chin *etc*. Feature invariant approach find structural features of digital image. Features are detected and grouped according to the geometry of the face. It is very critical to select the set of appropriate features. Noisy Images and occluded Images which weaken the feature boundaries cannot be suitably detect using this approach. The appearance based methods are used for face recognition with eigenface, neural network and Information theoretical approach. Appearance based approach considers the human face as pattern of pixel Intensities. As per the present scenario of crime and need of surveillance face recognition framework is necessary required at railway station, airport, government offices of repute, multiplex, mall *etc*.

ISSN: 2005-4238 IJAST

2. Related Work

The framework of face recognition system involves many complications. Facial features extraction is a important part of the whole face recognition framework. The major face recognition techniques which are applied on frontal faces are eigen features hidden Markov Model, geometrical feature matching, neural networks and Template matching. Mathew a turk and Alex P Pantland [1] present an approach to the detection and identification of human faces and describe a working, near real time face recognition system which tracks a subject heads and then recognize the person by comparing the characteristics of face to those of known individuals based on eigenface recogniton. Ara V Nefian and Monson H Hayes [2] presented a new method based on the extraction of 2D DCT feature vector, described and recognize the face using HMM. Thai Hoang Le, Len Bui [3] present a novel approach for solving face recognition problem by combining 2D Principal Component Analysis (2DPCA) for extracting feature vectors, and Support Vector Machine (SVM), the most powerful discriminative method for classification to improve the classification rates. The most used neural network in face recognition task[4] is the feed forward network, which includes multilayer perceptron and Radial-Basis function networks. Another popular network is the Self Organizing Map(SOM),or kohonen network[5] which is mainly used for data clustering and feature mapping. Template matching is generic operation in face recognition which is used to find the similarity between two entities(Points, curves or shapes) of the same type in the availability of prototype. The face to be recognized is matched against the stored template. Deformable template model [6] can be used to match patterns when the deformation can not be easily modeled directly.

3. The Proposed Model

The ultimate aim of this work is to develop an efficient and intelligent framework for image recognition(Frontal Facial Images) task. The grey scale images should be provided as an input or after checking the color bands(in case of color images) convert the image in to grey level one. Afterwards some preprocessing of image is being done on these grey level images and get the histogram equalized and binarized images as shown in the Figure 1 (a,b,c,d,e).

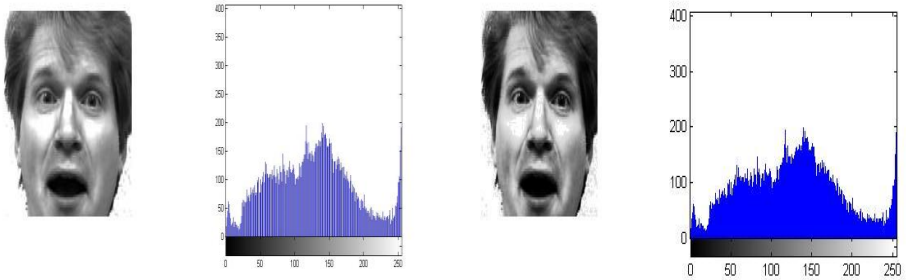

Figure 1a, 1b. Original Image & Histogram and Histogram Equalized Image and its Histogram

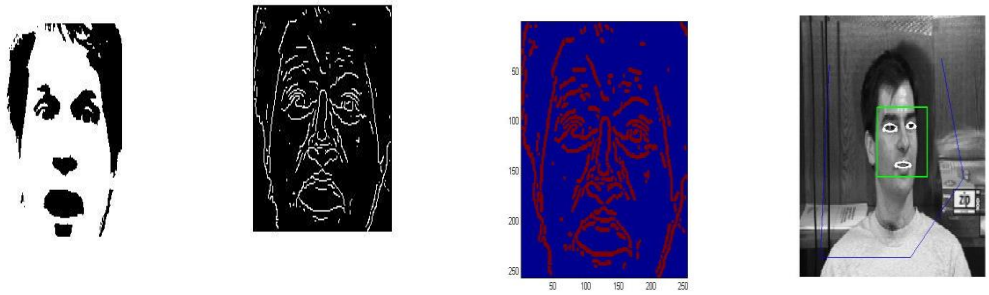

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Figure 1c, 1d, 1e. Binarization ,Canny Edge Detection and Image After Thinning and Drawing Bezier curves on Eyes and Mouth

After Preprocessing of image edge detection is applied and then thinning is applied on the image to remove the useless pixels from the scene and finding the exact pixels and find the boundaries of facial features. The selection of facial features is very cumbersome and important process for recognition of image.

This paper has included the selection of these crucial features [9] and then draw the Bezier curves accordingly to these facial features and represents these features in the form of Bezier curve. When we extract facial features the main task is to find the edges and contours. The corner points on main landmark of face like eyes, Mouth and face contour are extracted using SUSAN (Smallest Univalue Segment Assimilating Nucleus) corner detection process.

3.1. Operator SUSAN:

While extracting the facial features there is difficulty in integrating the local edge information. The normal edge detection operator may not extract feature contour validly [6]. Operator SUSAN (smallest Univalue Segment Assimilating Nucleus) is being selected to extract the corner points of local feature area [7]. The principle of operator SUSAN is to make a mask on the circle area of one point with the radius of r (we set r=4) and then observe every point in the whole image on the consistency of this point with all points contained in the mask area[8].

$$c(\bar{r},\bar{r}_0) = \begin{cases} 1 \text{ if } |l(r) - l(r)| \le t \\ 0 \text{ if } |l(r) - l(r)| > t \end{cases}$$

$$n(\bar{r}_0) = \sum_{\bar{r}} c(\bar{r},\bar{r}_0)$$

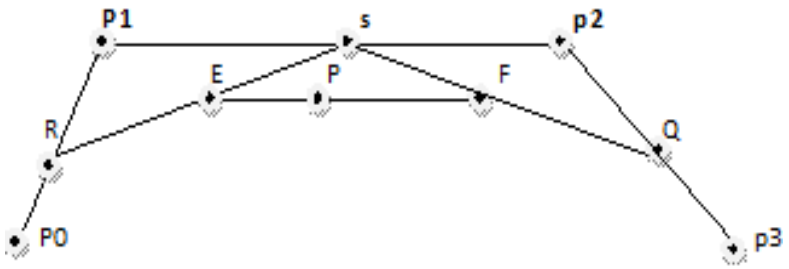
$$R(\bar{r}_0) = \begin{cases} g - n(\bar{r}_0) & \text{if } n(\bar{r}_0) < g \\ 0 & \text{otherwise} \end{cases}$$

Here in $c(\bar{r},\bar{r}_0)$ is the measurement of the luminance of two pixels it is a the threshold of different between pixels beyond it, two pixel will be taken for having different luminance.

Commonly it is set to be 27;n($\vec{r}_0$) means the area of USAN. If it is smaller, then the edge intensity is bigger;g is the geometry threshold , which means the max value of the USAN area. Beyond it, that pixel is not on the edge. Commonly it is set to be $\frac{3}{4}n(\vec{r}_0)_{max}$.According to the properties of operator SUSAN, it can be used not only to detect the edge, but also to extract the corner point therefore, comparing with the operator such as sobel ,Prewitt and other, It is more appropriate to extract the features of eyes and mouth on the face, especially to locate the corner points of eyes and mouth automatically which are required to draw the Bezier curve.The ultimate aim is to show every features contour by Bezier curve and obtain four representative control points for each curve .Once the features are located Bezier curve is approximated. Two anchor points are located at the two end points of the curve and to represent the contour two other control points are obtained.

3.2. Bezier Curve Detail

Bezier curves are commonly used in design that is based on four control points[10]. The application of de Casteliue's algorithm to generate curves based on four control points is shown in figure.



Point R is placed between P0 and p1 at the given value of u in fraction and similarity, points S and Q are also placed thereafter E is placed at a fraction u on R to S and so is point F. Finally, the desired point P is located at fraction u of the way from E to F. the process is repeated for every u between 0 and 1. The curve p(u) so generated from P0 is attracted towards p1 and p2 and ends at p3. This is the Bezier curve defined by four points. The Bezier curve can be generated by different configuration of four points. It has been described that the de castelian algorithm has been employed for quadratic and cubic parametric representation when three points and four points are used. However the algorithm generalizes gently for the case M+1 control points po, p1,p2,p3……pm. The general expression for a Bezier Bernstein polynomial is

$$p(u) = \sum_{K=o}^{M} \frac{M!}{(M-K)!K!} u^K (1-u)^{M-K} P_K, 0 < u \leq 1$$

Here $0!$ and $u^K = 0$ when u and k are both 0

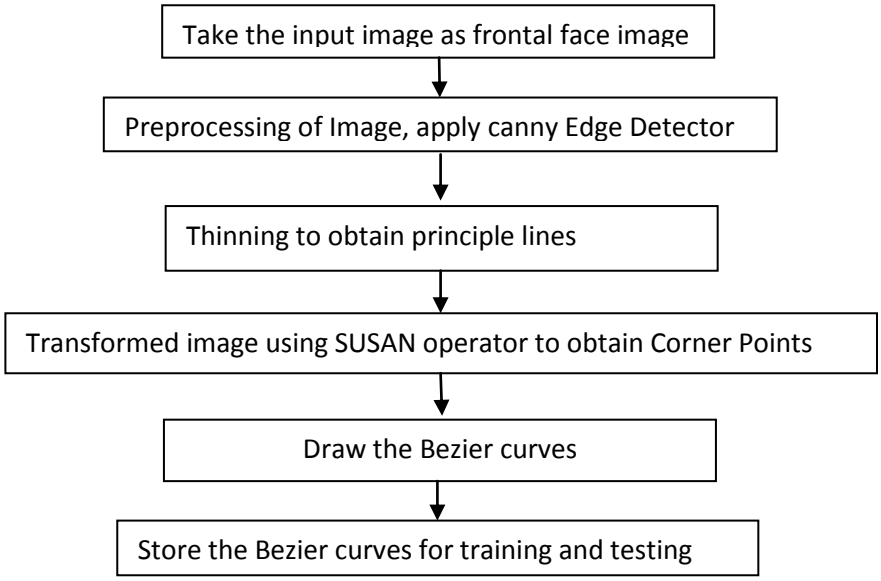
$$P(u) = \sum B_{k,m}(u) P_k \ \ or \ \sum_{k=0}^{n} P_k B_k(u), 0 \leq u < 1$$

Where blending function $B_{k,M}(u)$ are given by

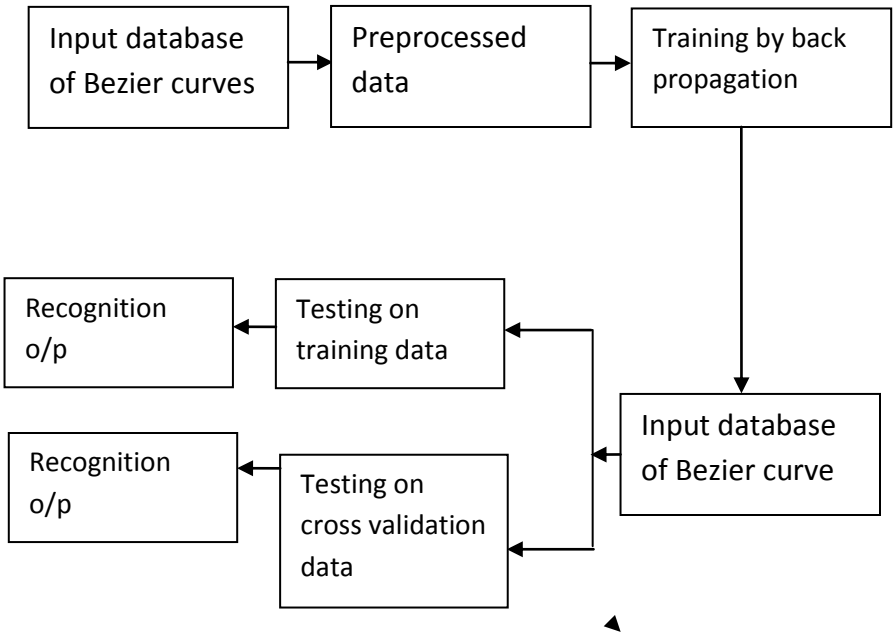
$$B_{k,M}(u) = C(M,K),u^k(1-u)^{M-K},C(M,K) = M!/(M-k)!\,k!$$

and p1 ,p2, p3,……pm are the position vector of the M+1 vertices of generalized characteristic polygon. After drawing the Bezier curves of main facial features *i.e.*, Eyes, Mouth,the intelligent aspect is being added and the various segments of facial features are input to the neural network. The various images are being trained through this process and after training the testing is performed and get 85 % recognition.

3.3. The Process Flow



3.4. Neural Network Training and Testing



The network is Trained Using Back Propagation Neural Network Training [11] using a self crated database of approx 50 frontal face images of various persons. Back Propagation Algorithm is selected because it is very less complex and efficient in pattern recognition task. 272 neuron has been decided for input layer which will take the Bezier feature vector as input, hidden layer comprises 65 neuron and output layer with 30 neurons .once the network is trained ,it is tested using the different set of Faces in which 60 percent images are being taken from self crated database on which the network were trained.

4. Conclusion

In this paper, the image is preprocessed and then corner points are detected using SUSAN operator and using those corner points Bezier curves are drawn on extracted features that are eyes and mouth. The feature vectors are generated using the curve database and then the network is trained using backpropagation algorithms and then it is tested on self created database and Yele database and got 85% recognition rate on these database.

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