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Smile Detection via Bezier Curve of Mouth Interest Points

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Abstract— This paper present a smile detection method based on the Bezier curve of the mouth interest points. Face is detected by the famous viola and john algorithm and mouth corner points is extracted by the method of Shi & Tomasi through minimum eigenvalue of matrix and also compare with other corner detection algorithm. We test Genki dataset on 100 images and gave 80 % result and on 500 images it gave 85% result.

Keywords— Smile detection, Bezier curve, interest point, Adaboost, Haar like feature.

I. Introduction

Human facial expressions have the ability to communicate emotion and regulate interpersonal behavior and facial expression of emotion was an innate, adaptive, and physiological response which could provide evidence of an individual's internal mental state. Smile is the common facial expression which indicates happiness, enjoyment or satisfaction. Due to the fast development of computer software and hardware human and intelligent robots are live together and human can give the instruction to robots in the form of facial expression. Recognition of facial expression through machine has been active research area. One difficulty in Smiley face recognition is how to handle the variations in the smiley expression and illumination when only a limited number of training samples are available[13] .Smile detection has many applications in practice, such as interactive systems e.g., gaming, product rating, distance learning systems, video conferencing, and patient monitoring. For example, the statistics on the audience smile can be a hint for "how much the audience enjoys" the multimedia content [1]. Modern digital camera have the smile mode function and camera takes picture automatically when a smiley face is detected and also have the ability to make a perfect group photo by shooting continuous frames and then select the best smiling face of each person and make a perfect group photo. Rest of the paper is ordered as follows: Section II describes literature review. Section III describes the face detection method. Section IV describes the comparison of different corner detection methods. Section V describes proposed methodology and Section VI describes conclusion.

II. Literature Survey

Caifeng Shan [3] used the intensity differences between pixels in the grayscale face images as features and provides 85% accuracy by examining 20 pairs of pixels and 88% accuracy with 100 pairs of pixels on GENKI database. Shinohara and Otsu [4] applied a hybrid approach of Higher order Local Auto-Correlation (HLAC) features and Fisher weight maps. HLAC features are computed at each pixel in an image. These features are integrated with a weight map to obtain a feature vector. The optimal weight map, called a Fisher weight map, is found by maximizing the Fisher criterion of feature vectors. Fisher discriminant analysis is used to recognize an image from the feature vector and claim result of 97.9% on JAFFE database. P.Li et al [5] applied a neural architecture that combines fixed and adaptive non-linear 2-D filters. The fixed filters are used to extract primitive features, whereas the adaptive filters are trained to extract more complex features for facial expression classification and method is test on JAFFE and claim the result of 99.0%. Soetedjo [6] used the method based-on the normalized RGB chromaticity diagram for detecting the smile and achieve the result of 94%. Akinori Ito et al [7] detect smile, they firstly used the skin color detection for the detection of face area. Then detect the feature points like two eyes nose and mouth and on the basis of lip length, lip angle and mean intensity of cheeks area measure the smile and achieve 80% accuracy.

III. Face Detection

We applied method of face detection which is based on the Viola and john [1], [2] algorithm. They breakthrough in research of face detection using an Integral image, simple Haar like feature and adapt Adaboost algorithm for converting week classifier into strong classifier and get outperform than existing face detection algorithms.

A. Integral Image- It is the intermediate representation of the original image was firstly used by Viola and john in image processing and by using this integral image rectangle feature is calculating very fast. The integral image at location p, q contains the sum of the pixels above and to the left of p, q inclusive:

$$ii(p,q) = \sum_{p' \le p, q' \le q} i(p', q')$$

where ii(p, q) is the integral image and i(p, q) is original image. Integral image computed in one pass over the original image using the following pair of recurrences:

$$x(p, q) = x(p, q-1) + i(p, q) \quad (a)$$
$$ii(p, q) = ii(p-1, q) + x(p, q) \quad (b)$$

where x(p, q)=cumulative row sum, x(p, -1) = 0 and ii(-1, q) = 0.

B. Haar Like Feature- Haar like feature in fig. 1[15] is like wavelet Haar feature and before introducing this calculation of features of an image was computationally costly. These features in form of intensity are calculated via integral window (integral image) process over the original image, sum of pixels in black region is subtracted from sum of pixels in white region. Although feature calculated+ by each sub window are extremely greater than pixels that's why an Adaboost algorithm is used for reducing the complexity of feature selection.

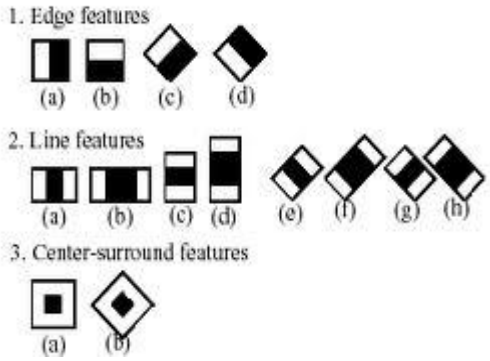

Fig. 1 Haar like feature

C. Adaboost- Adaboost in Haar cascade method is for training by supervised learning to classifying positive and negative sample, to classifying two decisions and the fig. 2[9] show how the Adaboost learn weak classifier by cascading weak classifier whose output is just random gauss and make strong classifier therefore reduced the computation time. In fig. 2 at each stage of the cascade, apply more strict rules for adding less and more different Haar feature and feature which not indicate to face is rejected.

When an image is given to a cascade of classifiers and if it passes all the classifiers then this will represent the presence of face with high probability.

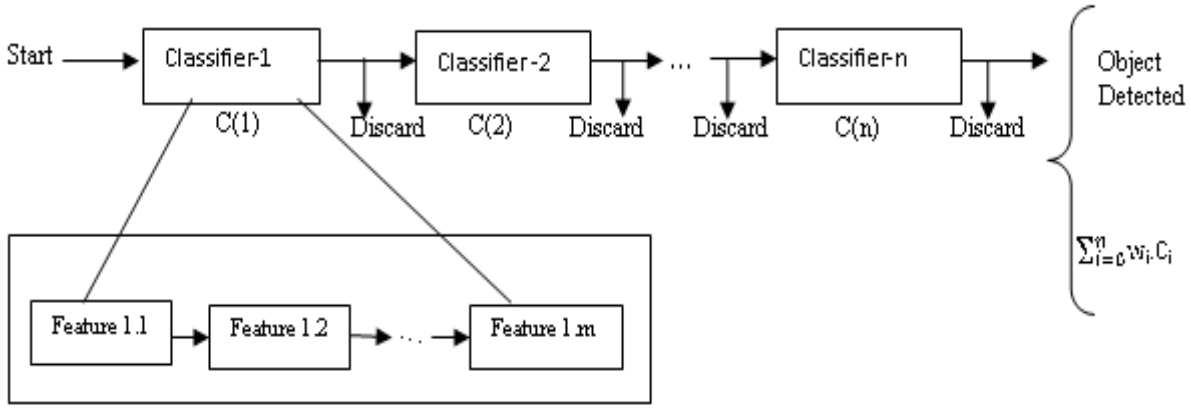

Fig. 2 Cascade of Feature Classifiers.

Mouth detection-Mouth is detected in same manner as the face is detected.

IV. Comparision Of Corner Detectors

There are various methods to extract the mouth corner points (interest points), but each has its own advantage and disadvantage [14].

A. *Susan corner detector*- S.M. Smith and M. Brady[10] introduced SUSAN operator, and find the interest point by comparing nucleus pixel to all pixel within circular mask, center pixel have intensity greater than all the pixels in the mask like centre of gravity rules and if we increase threshold at certain point it detects edges instead of corner.
B. *Rostern & Drummond corner detector*- Rostern and Drummond [8] detects the corner through local intensity comparisons of the pixels and is fastest corner detector take less time to all the other methods.
C. *Harris & Stephens corner detector*- The Harris corner detector [11] apply a selection criteria for detecting the interest points. For each pixel, a score is determined and if this score is greater than the certain value, the pixel is considered as a corner.
D. *Shi & Tomasi*- We detect the interest points by this method and is based on the Herris & Stephens corner detection. The basic difference between these methods are that, the corner is detected in Shi and Tomasi [12] method by calculating minimum of two eigenvalues of the matrix instead of calculating the score from the function F. Complete algorithm describe in following manner-

$$F(u, v) = \sum_l \sum_m w(l, m) [i (l + u, m + v) - i (l, m)]2$$

Where: F is Sum of squared differences between the original and moved window, u - l is direction window displacement, v - m is direction window displacement, w(l, m) is Weighting function of the window, either a gaussian or a window of ones, i (l + u, m + v) is intensity of the moved window, l×m is wnidow size.

Taylor series approximation of i (l + u, m + v) - i (l, m) are:

$$F(u, v) = \sum_l \sum_m w(l, m) [i (l, m) + ui_l + vi_m - (l, m)]^2$$

Now, matrix form of this approximation is-

$$F(u, v) = \sum_l \sum_m [u \quad v] w(l, m) \begin{bmatrix} i_l^2 & i_l i_m \\ i_l i_m & i_m^2 \end{bmatrix} \begin{bmatrix} u \\ v \end{bmatrix}$$

Then structure tensor form of final matrix is-

$$S = \sum_l \sum_m w(l, m) \begin{bmatrix} i_l^2 & i_l i_m \\ i_l i_m & i_m^2 \end{bmatrix} \begin{bmatrix} u \\ v \end{bmatrix}$$

Now calculating the two eigenvalues (e_1, e_2) of S and take one which is minimum and consider as the corner point or interest point-

$$E = \min (e_1, e_2)$$

We detect the interest point on mouth via Susan, Herris, Shi & Tomasi and Rostern & Drummond and fig. 3.1, fig. 3.2, fig. 3.3 shows the interest point detected by Rostern & Drummond, Herris, and Shi & Tomasi respectively.

Although speed of Rostern & Drummond method is highest but this extract more feature and also outside the lips which not efficient for Bezier curve, and Herris method some time extract very less no of interest point which also not fulfill our requirements but Shi & Tomasi method more accurately detect the interest point and give highest accuracy for our work.

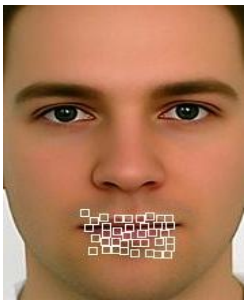
Fig. 3.1

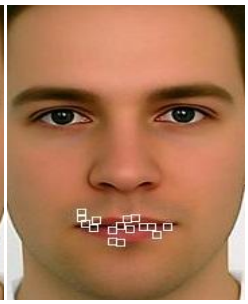
Fig. 3.2

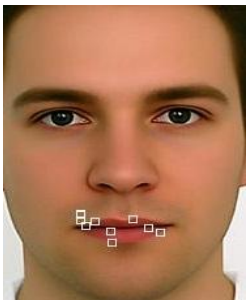
Fig. 3.3

TABLE I
COMPARISON OF CORNER DETECTOR METHODS

Corner Detector	Speed	Robustness to Noise	No of true interest point	% of true Smile detection
SUSAN	Good	Excellent	highest	65%
Herris & Stiphens	Good	Good	Lowest	75%
Rostern & Drummond	Excellent	Excellent	Middle	80%
Shi & Tomasi	Good	Good	Excellent	85%

V. **Proposed Methodology**

We extract interest points on the mouth via Shi & Tomasi algorithm and after that we construct the Bezier curve from these points and then calculate derivative of the curve of best fit and concavity of points is find and, behalf of that results are obtained. We describe complete process via block diagram.

Bezier Curve-For the construction of Bezier curve we require four points are- one starting point, one end point and two control points or handles but we takes more than four points therefore curve can give better result. Once find the curve then we use the curve fitting MATLAB tool that fit the curve second degree of polynomial and set the threshold, if meet the threshold then detected a smiley face.

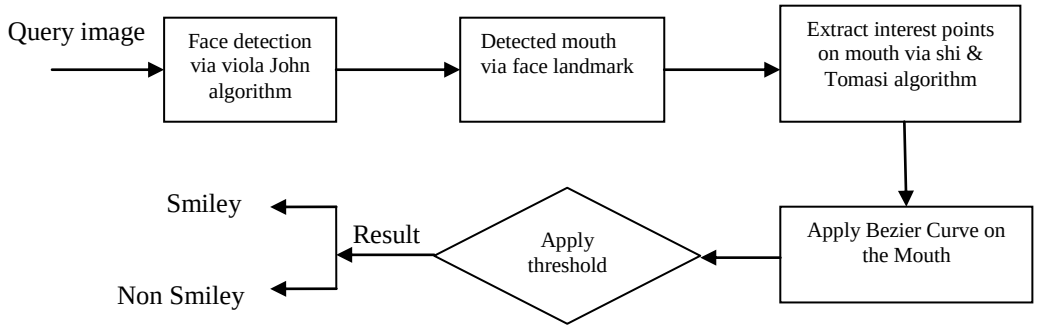

Fig. 4 Complete Process of Smile Detection

points In example fig. 5.1 shows the detected face area in query image, fig. 5.2 shows the detected mouth area in face image, fig. 5.3 shows the detected interest points on the mouth and fig. 5.4 show the Bezier curve of the interest.

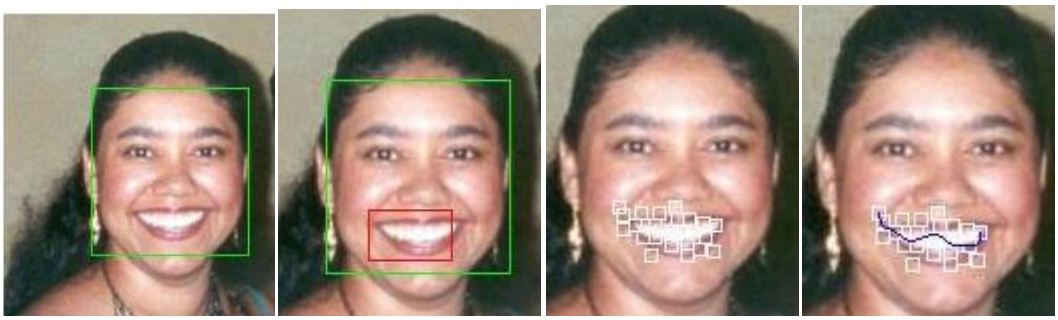

Fig. 5.1 Fig. 5.2 Fig. 5.3 Fig. 5.4

VI. **Conclusion** AND **Future Work**

In this paper we have proposed a method of smile detection which based on Bezier curve of mouth interest points and compare the methods of corner detector, and conclude that Shi & Tomasi method is best suitable for extracting the lip corners. We achieve accuracy up to 85% on Genki dataset, if the face and mouth is detected by the viola and john algorithm correctly. The main problem to achieving high accuracy is that mouth shape is different from one person to other and we have only one query image for measurement. In future we will try to find mouth corner points more

and we have only one single query image for the measurement. In future we will try to find mouth corner points more accurately by applying some operation on the query image to achieve better result.

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