Smile Detection for User Interfaces

VVS. Murthy\(^1\), T. Vinay Sankar\(^2\), Ch. Padmavarenya\(^2\), B. Pavankumar\(^2\), K. Sindhu\(^2\)

\(^1\)Department of ECE-DST FIST sponsored, KL University, Vaddeswaram, Guntur.
\(^2\)Project Students, Signal Processing Research Group, ECE Dept, KL University

ABSTRACT

The mental state of a person is judged by detecting smiles. The smile detection starts with the facial recognition. The main advantage of the smile detection is it ensures whether smiles are detected by the camera or not. We compare those set of images and determine which image has the best smile. Now, across the mouth region to detect the corners we use Shi-Tomasi corner detection algorithm as reference and explained the results in detail in this paper.

Keywords: Smile Detection, Corner Detection

I. INTRODUCTION

The most common facial expression which we observe in humans is smile. The smile gives a favorable expression on others and makes one more approachable. It bespeaks a person joy, felicity, admiration or gratification. The mental state of a person is judged by detecting smiles. It has many applications in video cameras, mobile phones, security systems, distance learning systems, video conferencing, interactive systems like gaming etc. For example, in an auditorium where there is a seminar, by looking at facial expressions of the people we can know “how much does the audience enjoyed” the content of multimedia. The smile detection starts with the facial recognition. The main advantage of the smile detection is it ensures whether smiles are detected by the camera or not. Generally in the present system, capturing the decision boundary of spontaneous expressions is very difficult.

The most active research topic from the last two decades is on the machine analysis of facial expressions. In this paper we mainly focus on the smile detection in images. The first camera with smile shutter function was released in 2007 by Sony. According to this, only three human faces can be detected and photo is taken automatically when they smile. This is not precise method as it can detect only big smile but not the fragile smile. This shutter would also be activated if the person makes a face with teeth coming out. In our project intensity differences between the pixels also the features.

In this project we start the process by detecting the face from the image input. Next we identify the mouth of the person and check whether the person is smiling or not. In order to identify the best smile we compare the set of images we have.

2. BLOCK DIAGRAM

The block diagram of the process has been given here.
3. METHODOLOGY

3.1 Procedure

Firstly, we give a set of human images as an input. We compare those set of images and determine which image has the best smile. Those images may relate to the same human or distinct persons.

In this face of the subject in the image is detected by using Viola-Jones feature recognition algorithm. After narrowing the required region of analysis in face part we apply Viola Jones algorithm again to detect the mouth region of the person. Now, across the mouth region to detect the corners we use Shi-Tomasi corner detection algorithm. This algorithm locates edges and features of the mouth. After detecting the required points using corner detection we plot the second degree polynomial line of best suited. We take the derivative of that best suited line which gives the concave shaped points, from that point we can detect whether the subject is smiling or not.

3.2 Smile Detection

More number of techniques are used to detect whether the person is smiling or not. Generally, smiling person has more number of edges than unsmiling person because of the presence of teeth in smile. In the first technique we detect by counting the number of edges. But this method is most inaccurate when the person pose a close lipped smile or open mouthed without smiling. In next technique we first put a threshold value and plot the edge detection points whose minimum threshold value is met, and then we calculate the line of best suited.

4. REFERENCE ALGORITHMS

4.1 Viola-Jones Face Detection Algorithm

Using this algorithm we detect the face of an object. This algorithm uses Haar features where face is in an image. This detection mainly involves sum of image pixels inside the rectangular areas as shown in fig 1.

The value of any feature is sum of all pixels present within the cleared rectangular box subtracted from sum of all pixels present within shaded rectangles. Detection of face should have several window sizes as face size within the image. This method is very time consuming and expensive if all Haar features swept over all windows in wider range. In order to speed up the process we use cascade of classifiers as shown in fig 2. If the image passes one cascade it means it weakly indicates the presence of face. If it passes all the cascades it strongly proves the presence of face.

![Figure 1](image1.png)

![Figure 2](image2.png)
4.2 Shi-Tomasi corner detection

This corner detection is mainly based upon Harris corner detector. In Shi-Tomasi we use different thresholds parameters. We start explaining with the Harris corner detector. The basic idea of Harris detector is we should easily recognize the point by looking through a small window and shifting a window in any direction should give large change in intensity.

Below figure shows the flat region, edge, corner.

![Fig 3](image)

**Fig 3**

- **Fig 3(1)** No change in any direction
- **Fig 3(2)** No change along edge direction
- **Fig 3(3)** Significant change in all directions

Change of intensity for the shift:

\[ \sum_x \sum_u w(x, y) [l(x + u, y + v) - i(x, y)]^2 \]  \hspace{1cm} (1)

For small shifts \([u, v]\) we have a bilinear approximation:

\[ E(u,v) \approx [u, v] M[\frac{u}{v}] \]  \hspace{1cm} (2)

Where \(M\) is a 2x2 matrix computed from image derivatives:

\[ M = \sum_{x,y} w(x, y) \begin{bmatrix} l_x^2 & l_x l_y \\ l_x l_y & l_y^2 \end{bmatrix} \]  \hspace{1cm} (3)

Intensity change in shifting window: Eigen value analysis where \(\lambda_1, \lambda_2\) – Eigen values of \(M\)

Measure of corner response:

\[ R = \text{det} M - K(\text{trace} M)^2 \]  \hspace{1cm} (4)

\[ \text{det} M = \lambda_1 \lambda_2 \]  \hspace{1cm} (5)

\[ \text{trace} M = \lambda_1 + \lambda_2 \]  \hspace{1cm} (6)

\(R\) depends only on Eigen values of \(M\): \(R\) is large for a corner, \(R\) is negative with large magnitude for an edge, \(|R|\) is small for a flat region.

The Shi-Tomasi modification of Harris corner detector is

\[ R = \min(\lambda_1, \lambda_2) \]  \hspace{1cm} (7)

This is the most commonly used method as it gives the most accurate values than Harris detector.

4.3 Thresholding

It is applied in the last stage of smile detection by which the smiling teeth is detected. For an effective detection, the initial image is first converted into Lab color space so that the difference in the intensity values of the pixels will be increased. When a person smiles there will be more white pixels region when compared to a non-smiling face, this is used as a feature in thresholding.

5. IMPLEMENTATION

The computer vision toolbox in MATLAB is used in computationally effective manner to perform the different algorithms used in our project. Several distinct features of this toolbox are used to complete the task of detecting smile. Our process of detecting smile is explained in different stages as discussed below.
Face Detection

From the discussed Viola-Jones Algorithm we complete the task of detecting the face from the images. This detected face is an output of the pre trained modified Viola-Jones feature detection cascade.

Detecting the Mouth

The lower one third part of the image which is obtained from the face detection is trimmed off from the original image.

The exact mouth region is located from the trimmed part in the above process by performing the Viola-Jones Algorithm.
Fig.10: Detected Mouth with smile

Fig.11: Detected Mouth with no smile

**Smile Detection**

Our last step in detecting the smile involves converting the obtained mouth region into Lab color space and fixing out the number of white pixels of teeth as threshold which varies when a person has a smiling face from that of a non-smiling face.

**Detected Smiles**

The above figures Fig 12 convey the output that is displayed on the command window which shows whether the person is smiling or not. We can also analyze the detected smile by finding out the number of corner points in the mouth region. The mouth region with a smiling face has relatively more number of pixels when compared to a non-smiling face.

Fig.13: Corner Detection with smile

Fig.14: Corner Detection with no smile
The obtained results of the corner points in images are listed in the following table.

<table>
<thead>
<tr>
<th></th>
<th>Smiling face</th>
<th>Non Smiling face</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fig 4(a)</td>
<td>23</td>
<td>11</td>
</tr>
<tr>
<td>Fig 4(b)</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>Fig 4(c)</td>
<td>36</td>
<td>17</td>
</tr>
<tr>
<td>Fig 4(d)</td>
<td>20</td>
<td>17</td>
</tr>
</tbody>
</table>

6. CONCLUSION

Through the feature detection and corner detection, we were able to detect whether or not the person is smiling in the photo along with the face detection. This automated identification of smiles has many potential applications including: customer reaction for market analysis, improved camera features for advanced functionality.

REFERENCES


