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Effect of Mouth's Local Minima on Emotion Detection

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Abstract— Emotion detection has been an important research element for several years. This is because emotion is an important factor of non-verbal human communication. To automate and replicate human emotion and make devices and services more personal and intelligent, machines must be taught to best understand our displayed emotion. There are a lot of methods to handle this problem. In this paper we discuss using mouth's vertical local minima applied on image pixel information. The experimental results show promise of feasibility of the mentioned method.

Keywords— Image Processing, Emotion Detection, Facial Expression Classification

I. INTRODUCTION

Emotion detection consists of 3 phases – face recognition, feature extraction, and expression classification. There are several ways in dealing with expression classification such as k-nearest neighbour (K-NN)[1], Support Vector Machine (SVM)[2], and Artificial Neural Network (ANN).

In recent years, Shuiziet. al.[3] proposed 7 kinds of expressions from course to fine based on a classification tree, Franziska et. al.[4] tested by manipulating the emotional valence of biographical knowledge associated with individual persons, Ch. VenkataRamiReddy et. al.[5] proposed an approach based on fusion of features extracted from different techniques, and so on.

II. EMOTION DETECTION BY MOUTH'S LOCAL MINIMA

In this research, we have used Viola Jones's Algorithm[6] for facial feature extraction, namely eyes, nose and mouth. However, we shall only be dealing with the mouth and it's influence in determining the human emotion. To do that, we crop the original image to the detected face region as shown in fig. 1 consisting of width 175px and height of 86px.

Fig. 1: Cropped mouth region

A. Exercising Local Minima

The human mouth comprises of upper lips, mouth opening, and the lower lip. Here we shall be taking the intensities of the image and its geometric feature. After cropping the mouth region, we shall see that taking the pixel information for every column, there occur a local minima (one in case of a closed mouth and more than one in case of an open mouth) between the upper and lower lip as demonstrated in fig. 2. This occur on every column irrespective of the right side of the face has been exposed to more light than the left or vice versa.

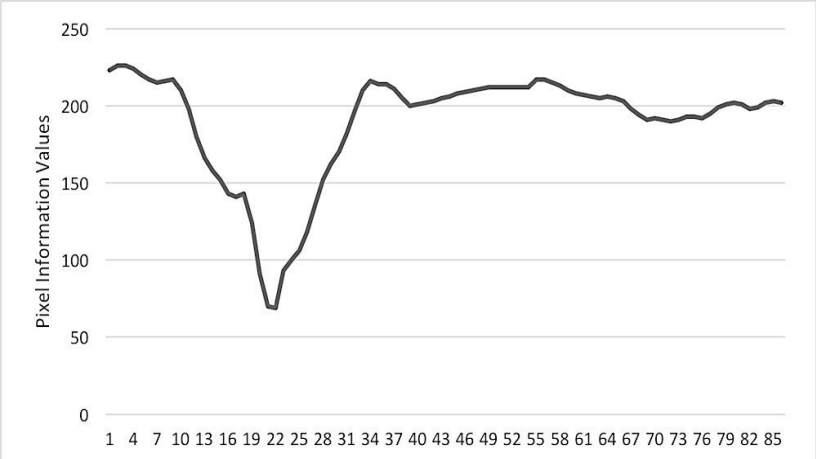

Fig. 2 Chart of pixel information taken for a single column

The position of this local minima is crutial for further steps towards emotion detection.

B. Determining Trend-line

After determining the position of the local minima or the mouth opening between the lips, for every column of every row of the mouth, a polynomial trend-line can be derived replicating almost the contour of the emotion expressed as shown in figure 3. The trend-line of second order polynomial of $y = \alpha x^2 + \beta x + \gamma$ for this case equates to $y = -0.0002x^2 + 0.0329x + 25.779$.

C. Emotion Recognition

The final step is classification of emotion. Emotion classification takes into account eyebrows, eyes and mouth when determining the exact emotion of a human face. From the above trend-line it can be concluded that when $\alpha$is negative, the mouth displays happy, joy or a state of euphoria. The greater the numerical value of α, the more is the state of happiness. Similarly, when $\alpha$is positive the emotion displayed are that of sadness and depression, and when $\alpha \cong 0$ the emotion displayed is that of straight face. So the emotion displayed by the mouth in fig. 1 is that of a straight face with a glimpse of happiness.

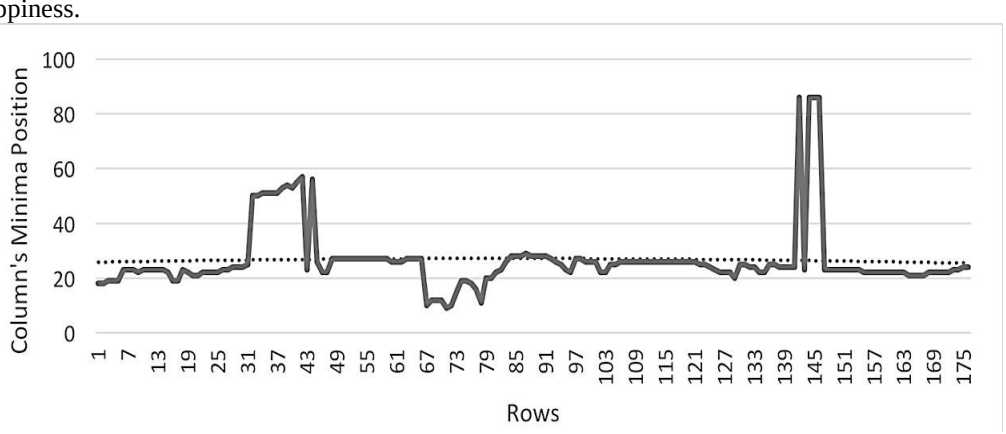

Figure 3: Position of minima for every row

III. EXPERIMENTAL RESULTS

To better understand the feasibility of the process, facial images were picked randomly from FACS[7] database. Some of them are shown in detail below from fig. 4 to fig. 11. A polynomial trend-line of degree 2 has been taken for faster computation and analysis.

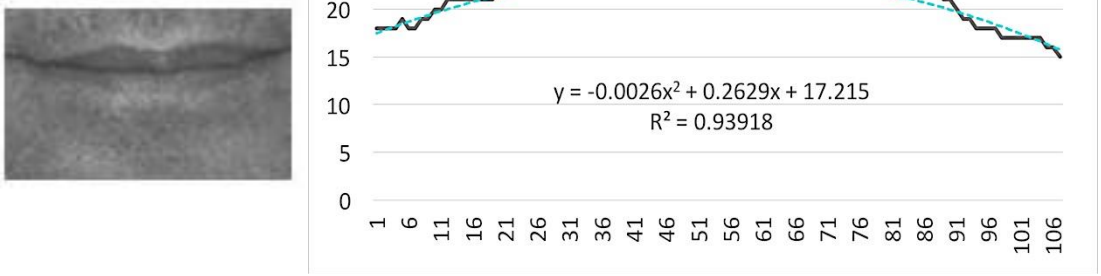

Fig. 4 A faintly happy face and the head facing the camera

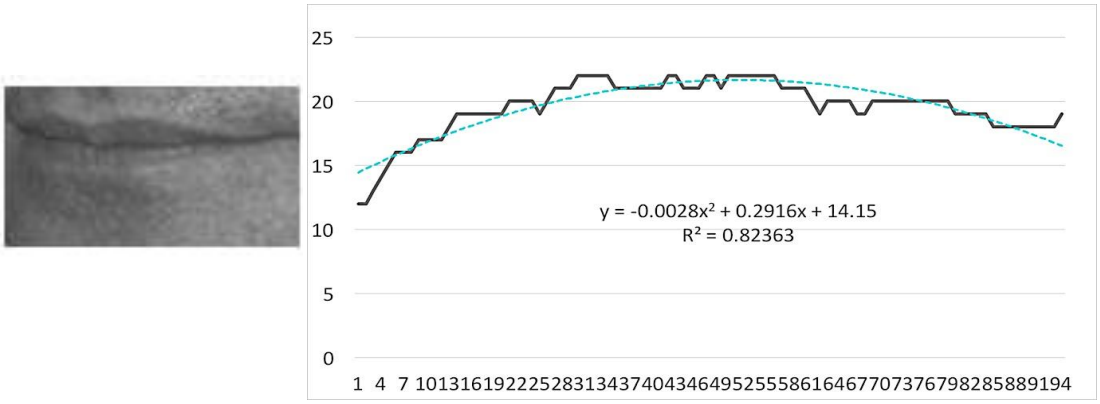

Fig. 5 A touch of happy face and the head tilted towards the left of the camera

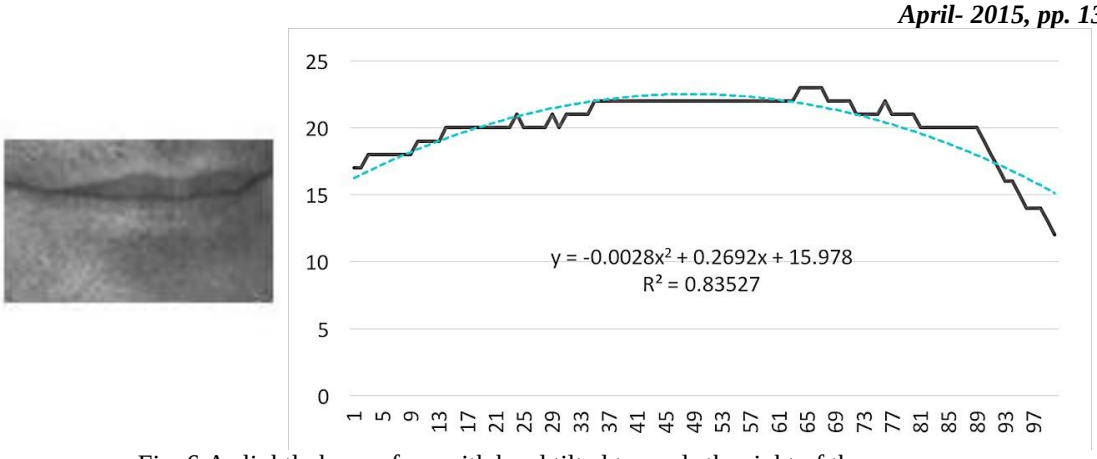

Fig. 6 A slightly happy face with head tilted towards the right of the camera

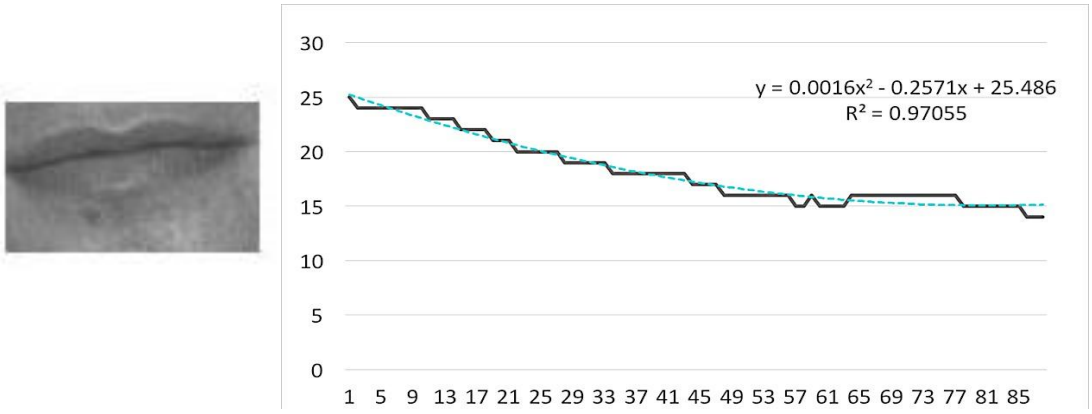

Figure 7: A straight face with head resting a little to the right shoulder

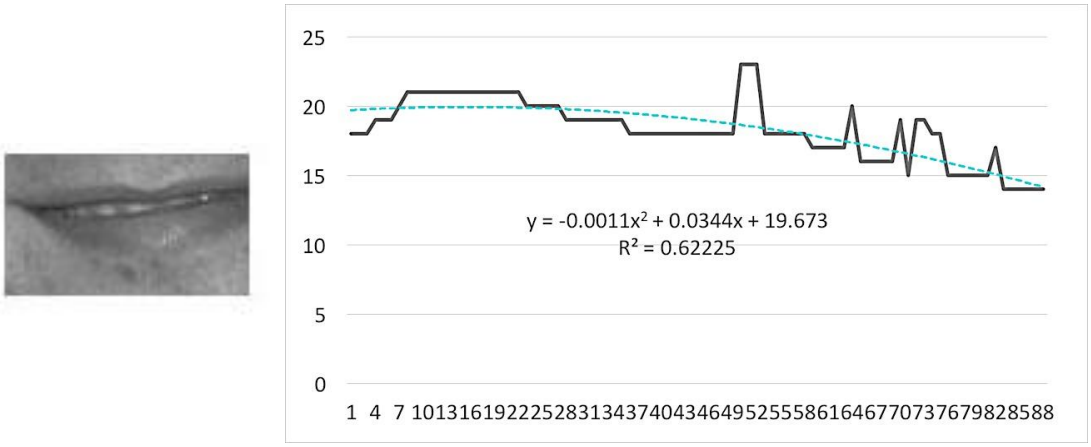

Fig. 8 A slightly happy face with partially open mouth

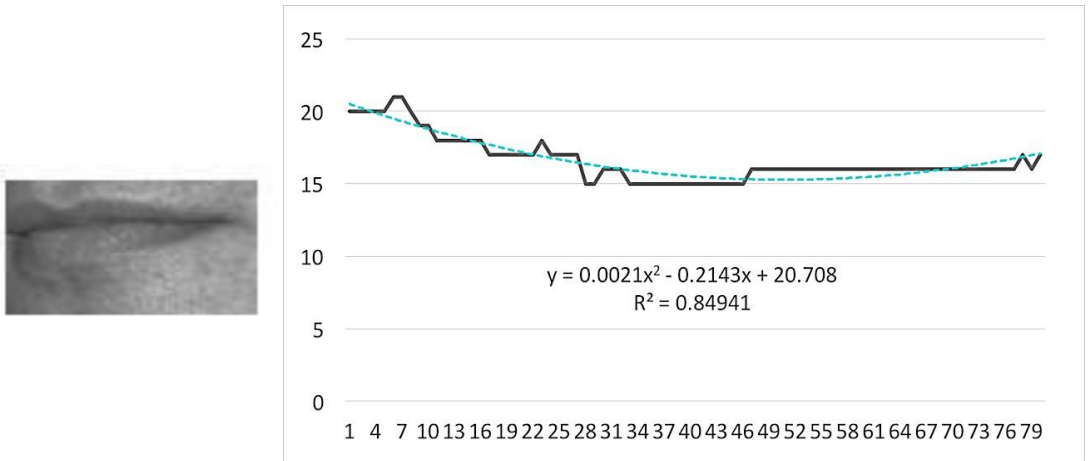

Fig. 9 A little sad face with head pointing to the user's right

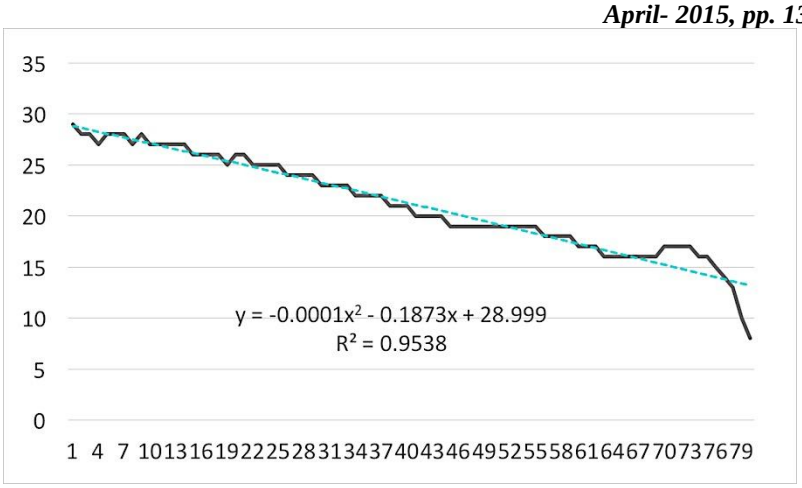

Fig. 10 A slight smile with head pointing to the user's left and looking up a bit

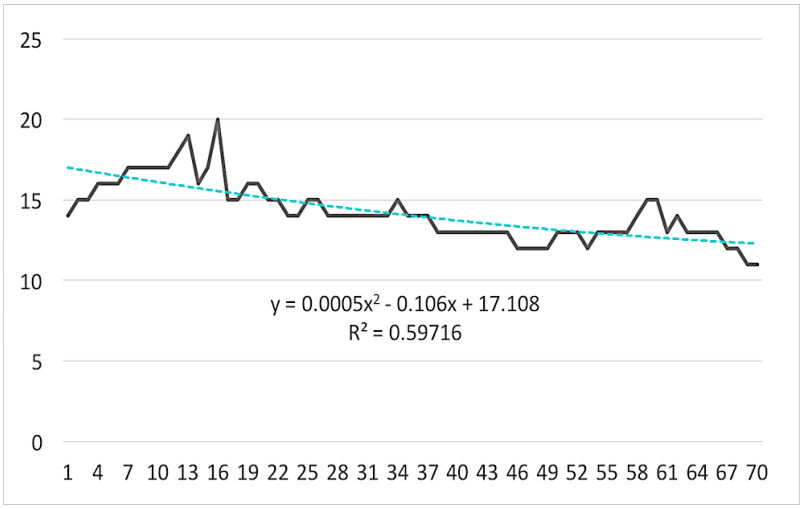

Fig. 11 Smiling a bit with teeth partially visible

TABLE I CLASSIFICATION USING MOUTH'S LOCAL MINIMA

Image	α	Positive/Negative	Analysis
Fig. 4	0.0026	Negative	Little Happy
Fig. 5	0.0028	Negative	Happier than fig. 4
Fig. 6	0.0028	Negative	As happy as fig. 6
Fig. 7	0.0016	Positive	Little Sad
Fig. 8	0.0011	Negative	Little Happy
Fig. 9	0.0021	Positive	Little Sad
Fig. 10	0.0001	Negative	Straight Face
Fig. 11	0.0005	Positive	Straight Face

IV. CONCLUSIONS

In this paper, we discuss a simple, computationally efficient heuristic method to solve the problem of emotion detection using mouth's local minima. The accuracy of this approach lies mainly in the accuracy of determining and extracting the facial feature, mouth, end to end and the accuracy of trend-line polynomial that can be seen by the statistical R^2 function. Increasing the degree of polynomial trend-line increases accuracy of R^2, introducing more complexity in computational time for the same. A learning process may also be introduced to better understand a person's degree of emotion and an individual's personalization.

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