# Lips biometric feature description based on polynomial

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**Abstract.** Research in biometric methods is very important because it has entered many fields until it has become a reference in identifying the personality in addition to providing a community service through its exploitation in technology. Several biometrics techniques have been developed and improved, including lip reading, which is one of the biometrics such as iris, palms, and fingerprints. It is very important to extract the characteristics of the lips in order to track the movement of the lips. Several methods have been proposed in order to extract the features of the lips and to identify their movement. In this research a mathematical method was proposed to describe the frame of the lips by extracting the area of interest in the image of the face represented by the mouth, and then conducting a detection of the edges in order to obtain the edges of the lips, and then followed by the process of obtaining the mathematical relationship that describes the geometric location of the points of the edges of the lips by adopting the polynomial as one of the methods Fit curves. The proposed algorithm was applied to facial images of females or men without a moustache, in addition to children, and the percentage of obtaining distinction and description of the character, through polynomial coefficients to equalize the lips, was high that increases with the high degree of the polynomial in addition to the accuracy of the image, but at the expense of the time taken to obtain the parameters polynomial. The convergence of the original flanges of the flanges that are adopted by the polynomial was obtained to more than 94%, and the best rank of the polynomial was (8) in terms of convergence, time and image resolution.

**Key words**: lips as bio factors, lip characterization, personality recognition, curves fitting, polynomials.

## 1. Introduction

the research that has gained great interest in previous years is research in the field of biometrics, as many of the biometric techniques have been developed and improved. One of these biometrics is lip reading, fingerprints, iris, etc. The extraction of lip characteristics and the recognition of lip movement are among the difficulties in the field of lip reading. Several methods have been presented by researchers to extract lip feature and recognize lip movement[1].

The process of extracting the feature of the lips or tracing the lips is a complex process with the same problems of face detection, such as the difference between people, the variation of lighting, etc. methods for extracting the properties of the lips are very delicate to negative circumstance factors. The degree of sharp convergence between the lips and the face complicates processes for extracting the lips, in addition to other facial features such as the presence of the mustache, tongue and teeth. Because of this, methods of lip color or shape have been adopted for the purpose of identifying and tracking the lips. methods adopted in this field include: active contour models, shape models, and active appearance models[2].

## 2. Previous Work

The study that was presented by Xiaozheng Zhangm, et al. (2002), showed, the chromaticity area of the hue saturation value, as the Hue components give high differentiate. The area of lips is reached by separating the connected areas that are the same shade of the lip color, it is clear that color discrimination techniques will not work with gradient images[3].

Ahmad and Sabah, (2010), This research deals with the lip positioning of the visual speech recognition system, as it presented an efficient method for determining the position of the lips of a person in the images taken from the video. The basis of these methods in the first step uses a model YCbCr to find a part of the flanges, then in the second step uses all the lip information was reached in the previous step, after that it calculated mean for each value and finally Euclid is calculated from the vector of ROI, The pixels with the least distance are considered a lip pixel[4].

Nasuhal et al. (2013), The analysis of lip reading may be a widespread application, for example (AV-ASR), the important part in lip reading is lip segmentation, model chan-vese is a section-based segmentation law which is fully employed as a tracking methodology as the laws can sense the frame of an object. Which cannot be reached by color scale as the standard common curve cannot be applied [5].

Panning et al. (2013), Describes the segmentation of the mouth region of the face, which can be a problem in the face detection stage. The researcher provided a technique for cutting lips supported by RG-color bar chart, The researcher used the Gaussian filter that describes the location of the pixels of the skin which is used for a distinct ideal threshold [6].

Noda et al. (2014), It was used CNN as a tool to extract the properties of the lip images, The visual characteristic obtained using a grid CNN give better results than visual characteristic obtained by PCA[7].
Morade and Patnail (2016), an analysis that a person uses visual information while trying to discover speech in special circumstances such as noise and hearing loss. Moving visual lips reading is a way for comprehend speech through addressing the movement of the lips, since Region of Interest it is a noisy, non-linear area, so the process of detecting lip activity is a difficult task. The researcher presented a two-stage lip analysis using a characteristics pull model that accurately describes and provides economical calculations. The first phase was used in 3D Discrete Cosine Transform or 3D (3D-DCT) With a sensitive discrimination analysis in order to minimize the ratio of characteristics, these options create a completely unique lip analysis system with a small vector for the characteristics [8].
Khansaa and Stanciu (2020), The researcher suggested a system for facial recognition, as he presented a system that could be performed in a intelligent building. Facial recognition is done through a series of images or video tracking, this technology distinguishes people by relying on a specific algorithm, the algorithm applied by the researcher to discover objects is Viola–Jones, the proposed system provides two-step facial recognition: the first is to detect the face from the video directly Using the computer's webcam[9].

## 3. Existing Trends In Lip Localization

Over the long decades, the applications that interest of automatic processing / analysis of human faces have grown significantly, The lip and mouth area has become the focus of attention for these applications, The most distorted part of the face is the lip area, then its detection represents a non-obvious problem, in addition to the lighting conditions, head rotation and facial expressions are passivity operators that influence on image dissection and processing[10].
The visual parts of the human speech production system are the mouth and lips region, these parts hold most of the information for visual speech is found in these parts, In order to capture relevant visual information, it is necessary to discover / locate these areas[11],two main types of techniques to detect / localization lips in digital images[11]:

### *1.1. Model based lip detection procedures*

approach comprise “Snakes”, Active Shape Models (ASM), Active Appearance Models (AAM), and deformable templates[10]. With or without using the face image to train the system, a lip model (s) is constructed, and then for any newly entered image, a specific search form is used to determine the lip area, depending on some of the stipulated criteria[10].

### *1.2. Image-based lips detection procedures*

Include locative data, pixel colour and sharpness, lines, corners, edges, and motion[10]. For the two above categories we show most of the lip detection scheme:

***3.1.1. Snakes or Active Contour Models****:* To discover the shape the suggested method is snake. Reducing the energy and repetitively of the spline to fit the local minimum limits is the basis for the work of this method[11].Using the snake technique to discover the lip and mouth area, Disadvantage for this method is, if the Principle locality is away from the edges lips then it may match the mistaken charectaristic such as the nose and chin, identifying sharp curves such as the corners of the mouth is difficult as spline do not bend easily, Having hair on the face may give false results and Sometimes it so complexity to reach its goal and takes a extensive time to adjust the parameters of the snake[10].

***3.1.2. Active Shape Models****:* operated for discover face lineaments, especially lips area, (ASM) statistical approach of object shapes that are frequently modified to convenient the object discovered in digital images. ”landmarks” set of n represents the shape[10]. By using the Marked Object Delimited Training Set in the images, the statistical model is built in order to diversify the generic forms of a training set. model is used for the purpose of matching new entries with the shapes that the model is trained on [10].

***3.1.3. Active Appearance Models****:* Active Appearance Models (AAM) like ASM, AAM Expanded to include the entire image's gray scale information with shape information as an alternative of using the edge definition along the landmark as in ASM, Since these models have some preset parameters about the shape, they converge use little repetition and since there are more parameters that must be dealt with, they are not necessarily quick[10].

***3.1.4. Deformable templates****:* its parameterized mathematical model, used for the purpose of tracking the movement of an object so that the model can set itself to fit a specific object. where it corresponds to the figure depending on the value of the number of integration along the relevant border.
The best convenient of the flexible model is found by reducing the power function of the parameters. Because of its flexibility and ability to impose geometric determinants on object and incorporate local image evidence., it considered a useful model. Disadvantages deformable templates: complexity of high computational time, and contraction and mold rotation.

### *3.2. Image-based lips localization procedures*

The discovery lips using color information has attracted the researcher's attention recently, as long as there is a difference between lip color and the color of the area around the lips in the face

***3.2.1. RGB model****:* primary colors are Red (R), green (G) and blue (B), Mixing variable amounts of these primary colors produces color, secondary colors result from adding the primary colors. Secondary colors are light magenta, cyan, and yellow.

Difference in color components within the RGB space between the lip and skin regions, the red color predominates in both regions, the skin seems more yellow than the lips and contains more green components than the blue colour[12].

***3.2.2. HSV model:*** HSV color system, 'H' represents Hue , 'S' represents saturation. Using the HSV color system, 'H'color is the main feature for the purpose of lip detection, the hue value of the face pixels is greater than that of the lip pixels[10].

***3.2.3. YCbCr model:*** In digital videos, this color space is used, y is the luminous component, the lips have a low (cb) value and the (cr) value is high as the lip area is redder than the face. The (ycbcr) model is based on this fact in the process of discovering the lip. Therefore, by adopting a certain equation the value of the components of cr is raised while the value of the components of cb is reduced [12].

It is difficult to apply Model-based lip-detection methods online systems as it requires a lot of processing time and training time. ASM is faster than AAM, but on the other hand the image based methods does not provide enough performance for images with poor color contrast despite the computing efficiency. Models based on color than others are more susceptible to changes in lighting conditions[12].

## 4. CURVE FITTING

It is used in data analysis and helps in predicting the analysis and clarifying graphically how the data points are related, whether a linear or non-linear model. Adaptation of curves may be used for the purpose of smoothing data and improving the curve and is concerned with finding centers along the curve. It checks the relationship between the independent variables and the dependent variables in order to find a good suitable model for that data.

Numerical structure in fitting curves has a higher amount than relationship, using a type of data entry that formulates a mathematical function. Uses curves alignment to match a suitable model or curve to present data points is a primary necessity for many areas such as computer graphics, image processing and data mining. the type of models to fit the curve are linear, polynomial of various degrees, power fit, logarithmic curve fit and non-linear curve fits, curve fitting not only works on disorganized data in different models, but also performs different tasks for the purpose of reducing noise, creating mathematical relationship between variables and evaluating attributes between data models[13].

### *4.1. Types of Curve Fits*

Curve fitting contain from three categories: Least Squares curve fits, nonlinear curve fits, and smoothing curve fits.

***3.1.1 Least Squares Curve Fits:*** Long time Least Squares method that was popular, the basis of the method's work is to reduce the error squares for the major data and the expected data using specific formula, and although this method has the advantage of being simple and understandable, it is ineffective to fit the function to the data set, The main weakness of this technique is its sensitivity to extreme data as the data must be checked for plausibility before installation. If the data point differs significantly from the majority of the data, it may lead to the resulting slope deviation. The KaleidaGraph's Data Selector provides a simple way to remove extreme data graphically from the chart.

The Least Squares fits method in KaleidaGraph are: Linear, Polynomial, Exponential, Logarithmic, and Power[14].

***4.1.2. Nonlinear Curve Fits:*** Nonlinear curve matching is compounded in k through the general curve matching function. Using this function, you can specify the required equation or choose one of the library functions.

***4.1.3.Smoothing Curve Fits:*** smoothing fits in KaleidaGraph are Different from the other two types, this type of curve fitting does not give an equation for the resulting curve because there is no single equation used to exemplify the curve. When the purpose is to improve the appearance of the outline for a smooth curve drawing, this type of curve alignment is appropriate. The smoothing fits method in KaleidaGraph are: Smooth, Weighted, Cubic Spline, and Interpolate[14].

***4.1.1.1. Polynomial regression:*** For nonlinear models, polynomials can be used for their convenience, although many models in actual problems are not suitable for linear models, the effect of fit is weak. Although polynomials have good error training for trained data, it is easy to generate over-fitting. The curve will fit the training data better. Particularly when the model order increases, However, for test data other than training data, higher-order models often do not have a good favorable effect on low-order models. [13].

Polynomial regression typically has two solutions: the gradient descent method and the normal equation. polynomial regression model separated into linear model, quadratic curve model, cubic curve model, etc. according to the number of highest items. The linear model as follows[15] in equation (1):

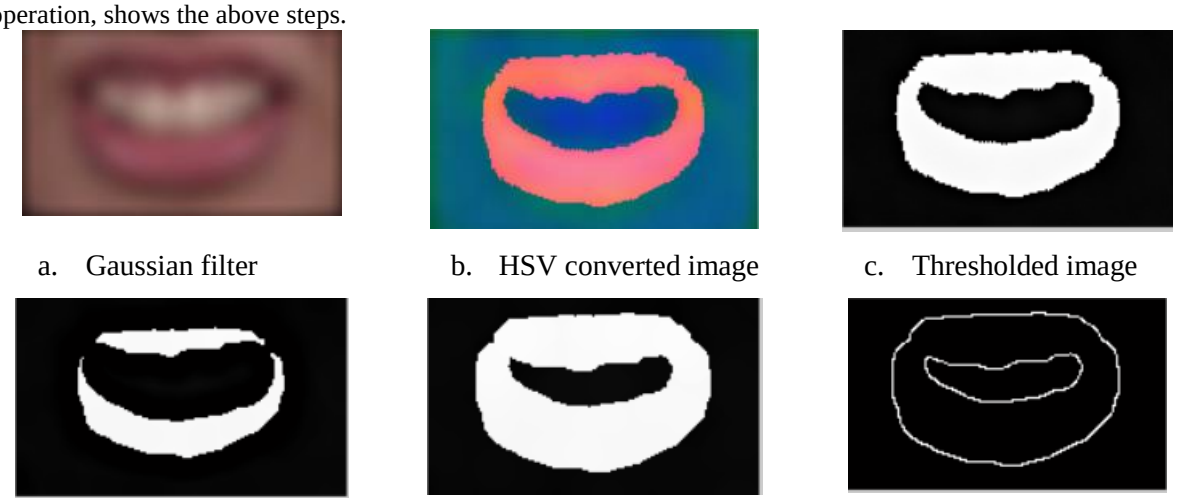
$$Y=a + bx+ cx^2 +dx^3 + ex^4 \ldots\ldots + \text{etc.} \ldots\ldots\ldots (1)$$

The goal of polynomial regression is to determine the values of the parameters that make the curve fit the data points in the best way. The order of the equation (number of coefficients) must be determined. When the number of coefficients is two, then the equation describes a line and the polynomial regression is identical to the linear regression, while when the number of coefficients is three or above the equation then Describes a curve, the more coefficients the more elastic curve it creates[16].

## 5. Proposed Technique

In order to discover the characteristics of the mouth region, attention must be paid to the diversity of the shapes of the mouth region in addition to other complications, such as the open mouth or the visible teeth between the upper and lower lip, and other expressions. The above cases make the area around the mouth contrasting between dark and bright respectively, and because of that the process of extracting the properties becomes very difficult, for the purpose of dealing with the

aforementioned problems, the Gaussian filter (2D) applied at the beginning which is basically a convolution process used for the purpose of smoothing The image thus eliminates the noise.
At first, the image was converted to the gray scale, but no good results were obtained, and accordingly the color space was chosen HSV. (hue and saturation of the value) where the color is divided into three components, which are hue (hue), saturation (x) and value (value) Then it applied opening morphological operation, after that applied thresholded to the image for search about elements related to the image and replace it (1) and ROI (mouth region) replace it with the (0) value.
After discovering the connected elements in the image, some characteristics were reached, such as the number of contiguous presses and the number of pixels for each object in the object area, then searching for the largest object that was adopted as the mouth region and canceling other areas in the object area. The following 'Figure.1' Detected mouth and preprocessing operation, shows the above steps.



a. Gaussian filter b. HSV converted image c. Thresholded image

d. Morphological processes e. Canny filter

Figure 1.Detected mouth and preprocessing operation

After applying the treatment techniques to the mouth area in the image, and for the purpose of extracting the edges, the Canny detector was used because of its ability to detect a number of more symmetrical edges with a thickness of one pixel, after finding mouth edge we drop finding edge on the original detected mouth as show in the 'Figure.2', then applied curve fitting with order (8) to fitted lower and upper outer mouth edge.

Figure 2. Dropped edge on mouth

($8^{th}$) order polynomial curve is created based on upper lips edge detected, and then the polynomial function is expressed in the format:

$$Y=a + bx + cx^2 + dx^3 + ex^4 + fx^5 + gx^6 + hx^7 + ix^8$$

a =3.70629114298727e-12
b =-2.50998868236184e-09
c =7.26666944801072e-07
d =-0.000117221915839260
e =0.0114907612517453
f =-0.698102304978560
g =25.5368818312207
h =-511.202434132737
i =4289.82557403822

when a, b, c, d, e, f, g, h are the polynomial coefficient value , the following 'Figure. 3'. show the polynomial upper lip plotted curve:

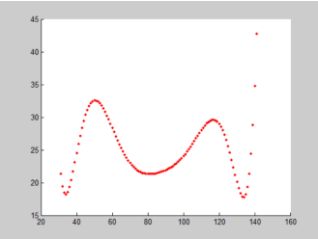


Figure 3. Curve fitting on lower edge lips detected

## 5. Conclusion

After adopting the aforementioned processing techniques for the image, and depending on the visual features extracted for the lips, the lip localization process was performed, after which a technique was used HSV for the purpose of achieving quality in the process of discovering the edges of the lips and reducing the computational complexity. The algorithm is suitable for offline applications and we have a blueprint for using the results obtained in lip reading applications.

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