

Gender Classification using OpenCV and Feature Extraction

Gender Classifier

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Abstract - Face detection [1] is not an easy task for machines like it is for humans. The machines need to be trained thoroughly with many data, because the machines cannot understand by its own. When we the humans look at someone's face, we may decode much information about the person just by looking at the face such as gender, age and sometimes behavior or calmness also. Our brain is also trained for recognizing gender from a face. The aim of this project is to appropriately train the machine using algorithms so that it can identify and detect the differences between male and female faces. The pixel and the data of the image are together known as the picture element. It is the compact most element of an image. Both the processes face recognition and face detection, mainly deal with the pixels and their respective picture elements. The attributes of the image or based upon the features extracted [2] from each image can be used for the face recognition.

Keywords: Gender Classification, OpenCV, Face Detection, Image, Feature Extraction.

I. INTRODUCTION

The prevailing prominent feature in machine learning [3] and computer vision system [4] is the human face. Gender, age, ethnicity, etc are the various information's conveyed by the human face. Sectors like biometric authentication [5] and intelligent human computer interface [6] applies face information. It is also used in law enforcement identifications, banking authentication, security system access and also personal identification. According to neurophysiologist David Hubel and Torstel Wiesel, there are specialized nerve cells in our brain which responds to specific local characteristics of a scene like lines, angles, edges and movements. The visual cortex combines these information sources to combine them into one frame or pattern. Automatic face recognition deals with deracinating those meaningful pieces and merging them into one picture. The main concern for gender classification is detecting skin region and hence selecting colour space is required. This whole process can be classified into three major

steps. Firstly, giving a common gray filter to the image to detect facial features. To detect the skin regions from the facial image, the proposed algorithm converts the image to YCbCr [7] colour space from RGB. The next step is detecting the face from the scattered pieces and hence dividing the face into 3 parts as nose, forehead and eyes, mouth and jaw. These pieces are hence used to detect the male or female classifications and finally the detected image in the image database is used to the face recognizer to test it with the image it has been trained.

II. LITERATURE REVIEW

Our paper deals with the agenda to classify the gender of a person using the features from the photo. This technology is pushed with greater accuracy in the paper so as to make computers much more user friendly and for security purposes also. Shervin EMAMI in his paper Facial Recognition using OpenCV has found a way to recognize a face and match with the face in the database using OpenCV, but has not pushed the limits to classify the gender of the face hence recognized. Object detection using Haar-cascade Classifier by Sander Soo and Rapid Object Detection using a Boosted Cascade of Simple Features by Paul Viola has found ways to detect the object from a still image or from live streaming respectively. The object thus detected is used to detect the face and thus recognizing it. The process of object detection is done by Haar Cascade classifier algorithm.

In this paper, the face is first preprocessed in which the face is divided into 3 parts- forehead, nose and below nose. Features or characteristics are extracted from them and hence checked with the ones in the database. Also a common light filter is given to the pictures which remove the extra illumination and effects from it. The features hence extracted are also checked for gender classification. Unlike the other papers, this paper extracts features from the face after dividing it into 3 parts. This process of preprocessing is done by Haar cascade classifier and OpenCV.

III. TOOLS USED

3.1 OpenCV

OpenCV [8] (open source computer vision library) is a software library used for machine learning. It focuses on processing any image fetched from real time. It increases the use of machine learning or perception of machines in commercial products. It can be used for any kind of image related processes, such as: detect faces, differentiate human movements, track moving objects, find alike images from database, recognize scenery and differentiate them with other situations. It was initially made in C interface, which makes it easily available, making it having a wider range of customers or users. But, using it in C had some disadvantages like: more lines of code, more probability of errors. To eradicate these problems it was summed up with C++ leading to less memory leaks. But in this case providing wrappers are becoming a difficult task as compared to C code. So, most of the wrappers of other languages are deficit of the features present in the recent updates.

3.2 Haar features

The haar features [9] are used for extracting features from the face to be trained. During the process of face detection, each face may have a huge number of features. The features with low number of sub features or iterations are used to train the classifier. This process can be done rapidly using Adaboost algorithm [10]. For the features, the number of iterations contained in it can be calculated. Amongst all the features, the one with the lowest iterations is needed and hence it is used to train the classifier with haar features. The features hence achieved from the face the used to train and also modified to produce the template.

The haar features are depicted as rectangular blocks, as described in Viola's paper [11]. The paper described that the black areas of the rectangular boxes depicts a group of pixels, which describes the features. This paper also describes that the black areas and the white areas sums up the total block. That is, the black areas subtract the full block to achieve the uncolored areas.

This promotes a better hit rate in the basic set of haar features. There haar features are not exactly the haar ones but the ones that are similar to the haar, which in turn are used to train the classifier and to extract the features. The rectangular boxes may have more than one group of black groups. These black areas depict each sub feature under each feature. A block having only one partition is one feature block, whereas the one ones having two partitions are 2 features block and so on.

IV. METHODOLOGY

4.1 Preprocessing

The real world is a complicated illuminated environment for which the eradication of non standard illumination is necessary. The lighting condition hampers the accuracy of the skin colour which complicates the face recognition and gender discrimination process. The environment creates a yellow biased colour or effect into the image. Contradicting the earlier researches the present research shows that the skin colour depends non-linearly on the luminance of the environment. In the process of lowering the environment luminance, takes into account each pixel at a time. If the value of luma (non linear gamma corrected luminance) of each pixel is into any kind of extremes the chrominance value is adjusted using top 5% of luma as reference white. The images which are taken in varying colors with different brightness can be restored to natural lights using the light compensation (LC) algorithm [12] as used in the paper.

The algorithm can be stated as follows:

//template equation

$$\hat{R} = \gamma_0 + \gamma_1\beta_1 + \gamma_2\beta_2 + \gamma_3\beta_3 + \gamma_4\beta_4 + \epsilon_i$$

The object created by face recognition has Face Recognizer [13] train for training the machine and Face Recognizer predict for recognizing the face. The detect Multi Scale [14] function in OpenCV uses the viola-Jones algorithm for detecting faces on images. The above process is done by segmenting the face into different parts from which features are to be extracted to check for similarity with the trained image.

The face detector studies each of the images and classifies it as face or not a face, coming from any image or video. In the process of classifying the image, it assumes a fixed scale. The classifier divides the face into smaller scales to search for the image. On detecting a face the face detector creates a sub image such that the face comes in the middle with appropriate scale.

4.2 Face Detection

The face detection process comprises of steps like detecting the image, extracting the features, forming face image template, comparing the templates, declaring the matching template with the image. High pixel density and resolution is accommodated to the real time image using any type of image sensor. This process can also be done by can also be done by real time Ethernet connectivity. The real time

image is divided on smaller image parts and then simpler patterns are searched onto it.

OpenCV does the work of feature extraction. It uses boosting techniques like Discrete Adaboost [15], Real Adaboost [16], Gentle Adaboost [17] and Logitboost [18] of every stage cascade classifiers, which are themselves complex, built by basic classifiers. Haar classifier method locates and scans the image in real time, whereas the OpenCV scans still images. It deals with the geometry of the image and gives rise to differential features taking data or information from geometry of face. The result thus obtained is compared to each section of the face from the data trained, thus the result of the comparison gives rise to the various decisions to be taken based of security and management purposes.

The purpose of image training is achieved by a function which takes the path to the database of the image, which contains the image which is to be trained with the arguments that are returned from the function are- the located images in the image or video stream and the respective template. To correctly obtain the face, live video streams or still images are used, which is then scaled onto different scales to identify or locate the face which was present in the trained image. This training function is achieved by the OpenCV from haar characteristics. A particular part of the image is selected and sent to the haar classifier to check for a face in the image, which is defines by its own template. Thus each portion of the images are checked and compared with the templates by the help of haar classifier. Each of the image searches for an origin from where to start the checking as referenced from the templates. During the checking process, each of the features are tested with that of the detected face, if all the features are present then it turns out to be true, else the image or template next in the stack is taken into account for checking. This process also consists of hard testers, which checks all the sub features of each of the features. If results of any of the hard testing fail then again the next template of the stack is taken into account for checking and testing and the current template which has failed in hard testing is not checked further.

4.3 Gender Classification

The gender classification for human is much easier as they use the methodology to divide the face into three parts- forehead eyes, nose and jaw. This process is used can also be used to determine the gender of the face, hence this is the main parameter used. Processing of each part is done with the help of 2D Gabor filter [19] which is used for 2D image processing of Gabor wavelength highlight and to extract local features of the image, also its change of tolerance in shape, size and light, in which Gabor wavelength has a planar sinusoid multiplied by

a two dimension Gussion [20]. The formula for space domain Gabor wavelength is given below:

$$g(x, y) = \frac{1}{2\pi\sigma_x\sigma_y} \exp \left[-\frac{1}{2} \left(\frac{x^2}{\sigma_x^2} + \frac{y^2}{\sigma_y^2} \right) + j2\pi x \right]$$

The formula of frequency domain is as follows:

$$g(u, v) = \exp \left\{ -\frac{1}{2} \left(\frac{(u-w)^2}{\sigma_u^2} + \frac{v^2}{\sigma_v^2} \right) \right\}$$

The Gabor wavelet transformation used in this project is:

$$F(x, y) = a^{scale - scaleindex} g(x', y')$$

$$x' = (x \cos \theta + y \sin \theta)$$

$$y' = (-x \sin \theta + y \cos \theta)$$

(x, y) Represents single pixels in the image while *scale* is a parameter of spatial frequency and is an orientation angle.

$$\theta = \frac{n\pi}{k}, n = (0, 1, 2, \dots, k-1)$$

Here, k represents the number of operations. 8 operations (n = 0, -7) and 5 spatial frequencies (scale = 1, 2, 3, 4, 5) can be used with this wavelength. A single image is broken into 40 smaller images with 5 scales and 8 orientations, the features hence deduced are the individual Gabor filter coefficients. To avoid the complexity and slow process in the spatial domain, FFT [21] in frequency domain followed by IFFT is used to get the output in the spatial domain itself.

4.4 Feature Vector Generation

To train the Haar Cascade [22] file feature vector machine is used from the OpenCV, which assigns the features identified from the image to a feature vector location of feature space. Various groups of images are found distributed along the feature space while plotting the feature vectors and analyzing the results. Thus, the two main classes of the feature vector are male and female, which can be determined in various ways. The way of using the whole image is avoided as it needs a lot of computational; complexity, so the process of taking into account the important values from the image as extracted from each filter is used, resulting a value of feature vector for each image.

4.5 Support Vector Machine

For classification, the learning algorithm used is the support vector machine, which reduces the expected classification error for unseen patterns by finding an optimal

separating hyper plane. A hyper plane separates the input which is mapped on to high dimensional feature space, in case of linearly non-separable data. Kernels efficiently perform the work of high dimensional projection into the space. For a set of training samples x_i and their respective values of decision, $y_i \in \{-1, 1\}$, the best separating hyper plane calculated by the equation $w^T x + b$ is found out by SVM[23], which increases the difference between the classes.

The main task training SVM is to solve the following quadratic equation:

$$\min L = \frac{1}{2} \sum_{i,j} a_i a_j y_i y_j K(x_i, x_j) - \sum_{i=1}^L a_i$$

Subjected to-

$$0 \leq a_i, \leq C, \sum_i a_i y_i = 0$$

Where, C signifies the penalty parameter [24] and K is kernel function [25].

The problem can be stated as the input data which are projected to a higher dimensional plane where they are again separated using parallel hyper planes. The polynomial kernel function used for this problem is given below.

$$K(x_i, x_j) = (1 + x_i^T x_j)^p$$

And the radial basis function is given by-

$$K(x_i, x_j) = \exp(-\gamma \|x_j + x_i\|^2)$$

By the correct choice of kernel, the SVM can function perfectly. There has been a lot of experiment for the correct choice of kernel for a given set of data, but there has not been any standardized solution to this. Hence, the choice of kernel has been reduced to hit and trial method.

4.6 Combing the Result

The respective probabilities of being male and female for an image have been found out. These probabilities now need to be averaged to get the final result, which done by the SAT technique [26]. This technique calculated the percentage of the probabilities of the male and female chances.

V. RESULTS AND DISCUSSION

A database is formed by combining both male and female images from different nationality and ethnicity. Frontal images with slight expression and illumination variation has been taken to highlight the aim of gender recognition. For training purpose, 515 male and 480 female images, giving a total of

995 images, has been taken into account, wherein the male faces are indexed as +1 and the female ones as -1.

5.1 Results

TABLE 4.1.1
Details of the mixed Database

Database	No. of male face images	No. of female face images
CMU PIE	66	56
AR	156	168
Indian Face	150	132
Chinese Face	80	62
FERET	79	62
Total (995)	515	480

TABLE 4.1.2
Comparison results of different algorithms

Methods	Male Detection Rate (%)	Female Detection Rate (%)
Neural Network	62.31	65.2
Threshold Adaboost	75.26	72.45
LUT Adaboost	75.78	76.71
Mean Adaboost	71.84	73.23
LSVM	78.2	75.8
SVM+Pol	86.72	84.51
SVM+RBF	87	85.5
Our data	87.6	85.9

TABLE 4.1.3
Gender Classification Result with different frequencies

Frequency	Male	Female
0.1~0.4	76.12%	78.5%
0.1~1.0	89.5%	87.9%

Table 4.1.1 provides the composition of the database which contains images from the CMU PIE [27], AR [28], FERET [29] face databases. The results are compared and tested of different algorithms and our methods are shown in Table 4.1.2. The frequency of the Gabor filter bank are also changed and experimented, the results are shown in Table 4.1.3. A GUI has been designed by the help of MATLAB-2008a.

VI. CONCLUSION

In this paper, a color model conversion algorithm is presented based on chrominance color information which is used for detection of face region. The face area is detected from color image by applying the threshold measurements in pixel which gives great accuracy. Input to the gender classifier is served by the cropped output of the face detector. The SVM classifier is learned by Gabor features. The approach is tested on random images from internet, picture taken by digital camera and achieved accuracy of about 88%.

Conventional gender classification methods can only detect the gender of the given face image, most of them can not

automatically detect face from the image. But this method, detect the face area automatically within the color image and also detect the gender of the face. It can be concluded that the experimental results of that the proposed method is much better in terms of varied circumstance. The proposed solution can be used for surveillance system, forensic applications, access control, face recognition problems etc. Finally, we conclude that there is still room for improvement in gender classification methods.

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