ISSN : 2347 - 8446 (Online)
ISSN : 2347 - 9817 (Print)
Vol. 3, Issue 1 (Jan. - Mar. 2015)
International Journal of Advanced Research in Computer Science & Technology (IJARCST 2015)

Advanced Face Recognition Using Reconstruction of 2-D Frontal Face Images From Multi Angled Images

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Abstract
Most of the presently available Face Recognition Algorithms shows better performance only when they are provided with front facing Mug shot faces Images. But in Real time applications it is not much possible to obtain clear 2D face images. Here proposing an Algorithm for Face Recognition using Side facing or multi angles Images of a person. Primary Task is to obtain Facial landmarks like Eyebrow, Nose tip and Mouth corners after converting the image to a gray scale image. Firstly an automatic eye-brow detection algorithm is used to detect the eye-brow along with its position i.e. left or right. By this result it is easier to detect whether the given image is left- or right profile view of a face. After that an automatic face cropping algorithm is used to extract the facial areas and then alignment mechanism using eye-brow leveling is used to mosaic them to construct the frontal face image. Lastly eyes are shifted using geometrical transformation to make it almost perfect frontal view of the face. Also an approximation of the frontal face from a single side-view image can be generated by cutting it according to the previous method and copying the same half into the second half. Then the obtained image is used as a query image for Face Recognition Step. From the generated 2D image, different facial Objects like Nose, Mouth, Eyes, Mouth Corners etc. and then each object are converted into small patches.
Gray-Level Co-Occurrence Matrix (GLCM) based features are considered along with Local Binary Pattern features which extracted from each patches to form a feature vector. Multi Class SVM classifier can be used to classify the image and to get details of the person as I stored in the Trained Database.

Keywords
Eye-Brow Detection, Eye Shift, Face Mosaicing, LBP Features SVM Classifier.

I. Introduction

Face recognition is a biometric method with many applications for its nature of being non-intrusive, natural, and passive. Especially, in applications such as surveillance systems, smart homes or any application that dealing with identifying people from videos [1]. However, it is very much challenging task to identify, detect and recognize faces from real-time scenarios where the environment is susceptible to expression, occlusion, or even pose variations [2]. Among many applications, possible implementation areas for face recognition techniques are home safety applications, Security surveillance, etc. Therefore, face recognition can be used to increase the situational awareness, to prevent the factors that may cause further accidents, or to detect an emergency in time [3]. From 2D frontal face images, it is much easier to extract various features without much error and face recognition by using such system will be very accurate [4]. But the case while I have to deal with face identification using side view or multi angled images is much difficult. There might not be every facial components like eyes, nose mouth corners etc in a single side image of a person [5]. If I use a system using only one side view image it might result in false positives [4]. So taking on one image per person is not suitable for an efficient face identification system [5].
Here in this paper I introduce a novel method for side-view face recognition to be used in many applications. Two or more different side views are taken per person to implement the recognition task. Our goal is to identify people even with their multi angled profile views. The paper describes, a fully automatic and efficient framework is proposed for frontal face construction from two profile face images.

II. Current Trend in Face Recognition System

Face recognition approach is quite critical issue in real world applications with certain outcome of illumination, occlusion, and imaging condition on the survive images [6]. These objects image can have several notorious properties like; facial feature components, and similar eye alignment, occlusion, overlapping etc. Recognition applications uses standard images and detection algorithms detect the faces and extract face images which include eyes, eyebrows, nose, and mouth [7]. Popular approach is either it create specific angle face image [2] or it may create frontal face image based on side image [8].

III. Proposed Work

The methodology of proposed work is shown below. It starts with face detection followed by eye selection for face splitting that reference to face creation.

A. Pre- processing

Inputs of the 2D face modeling are the profile images of the person under interest. The primary task is the acquisition of the profile views images [9]. The Right and Left profile images are loaded separately. There may be a chance to have noises in the image. So I use a median filter to the input images to eliminate these unwanted salt and pepper noises [10].

B. ROI (Region of Interest) Selection

Since the Side images are of different sizes and alignment of face is not in a uniform size [11], I need to crop the Image which contains only the profile image. This will improve the efficiency of the system by avoiding the noises and errors caused by the unwanted elements from the image [12]. ROI is manually selected by using a cropping tool. The Both left and Right profile view images are cropped in order to remove unwanted objects outside the face area.

C. Face Objects detection

The next task is to find the Face objects from the face area of each input images. Viola-Jones Algorithm [18] is an efficient tool to obtain the face objects like nose, eyes, mouth etc. But since the Images are only representing the profile view of the image,

ISSN : 2347 - 8446 (Online)
ISSN : 2347 - 9817 (Print)

sometimes the algorithm fails to localize the facial objects. So I chose an alternative method to obtain the left half region of the face from left profile view image and right face area from the right profile image. For that first I point the left eye in the left profile image and right eye from right profile image. So the cropping automatically happens according to the position of left and right eye [13]. Each image is then split into two parts. The separating boarder is the column with which contains a few pixels from the eyes. Each part has equal number of rows but number of columns varies according to the position of eye [14, 15]. After these steps there are four images. Two from the right profile image and two from the left profile image. Left part of the Right profile and Right part of left profile view are passed to the next steps.

D. Face Region Alignment

The two extracted regions from each input images have to be merged with minimum distortion. So the obtained cropped images (Left part of the Right profile and Right part of left profile view) have to affine transformed. Here I use a horizontal shearing of shear factor 0.6 on each half face [16]. For the sake of selecting a good 2D face, the system produces two outputs by merging the face halves in different ways [17]. One combines the left side image with a mirror transformed image of the left section itself. Similarly a second image is formed by combining the right section with a mirror transformed image of the right section [18, 19].
By providing a provision for the user to select the best image manually, the best output is transformed to the next section. The obtained image may have distortions due to the unnatural distance between the eyes, and due to the improper alignment of hair style. It needs to be rectified and will go to that section on further research that I can see in Figure.

E. Face Image Recognition

The next step is the Recognition of the Obtained 2-D image. The features used for the Recognition are GLCM based features and Local Binary pattern features [1] from patches of facial objects [3].
Gray level co-occurrence matrix (GLCM) comes under second order feature extraction technique. GLCM is a powerful tool of feature extraction and it gives joint probability occurrence of gray level of two pixels. It is a matrix that gives the frequency of one gray level appearing in a specified spatial relationship with another gray level within the area of investigation. The co-occurrence matrix is computed based on two parameters, which are the relative distance between the pixels measured in pixels and their relative orientation It is a tabulation of how often different combinations of pixels brightness values occur in an image [20, 21]. The GLCM is a square matrix where the number of rows and columns are equal to total number of gray levels in the image. Consider I as an image and it has N number of gray levels. Let P be the gray level co-occurrence matrix of order N. The element (i,j) of the matrix P can be defined as number of times a pixel with intensity value i is adjacent to a pixel with intensity vale j.Let N be the number of gray level used. The adjacency can be horizontal, vertical, left and right diagonal. The image in the gray scaled version is used for extracting the features. Various features can be extracted from the GLCM matrix P.
Let p(i,j) be the (i,j)th entry in a normalized GLCM. The mean and standard deviations for the rows and columns of the matrix are:

$$\mu_x = \Sigma_i \Sigma_j i.p(i,j)$$

$$\mu_y = \Sigma_i \Sigma_j j.p(i,j)$$

$$\sigma_x = \Sigma_i \Sigma_j (i-\mu_x)^2 p(i,j)$$

$$\sigma_y = \Sigma_i \Sigma_j (i-\mu_y)^2 p(i,j)$$

1) Energy:

$$f_1 = \Sigma_i \Sigma_j p^2(i,j)$$

2) Contrast:

$$f_2 = \Sigma_i \Sigma_j |i-j|^2 p(i,j)$$

3) Homogeneity:

$$f_3 = \Sigma_i \Sigma_j \frac{p(i,j)}{1+|i-j|}$$

4) Correlation:

$$f_4 = \Sigma_i \Sigma_j \frac{(i,j)p(i,j) - \mu_x \mu_y}{\sigma_x \sigma_y}$$

5) Entropy:

$$f_5 = \Sigma_i \Sigma_j p(i,j) \log\left(p(i,j)\right)$$

6) Skewness:

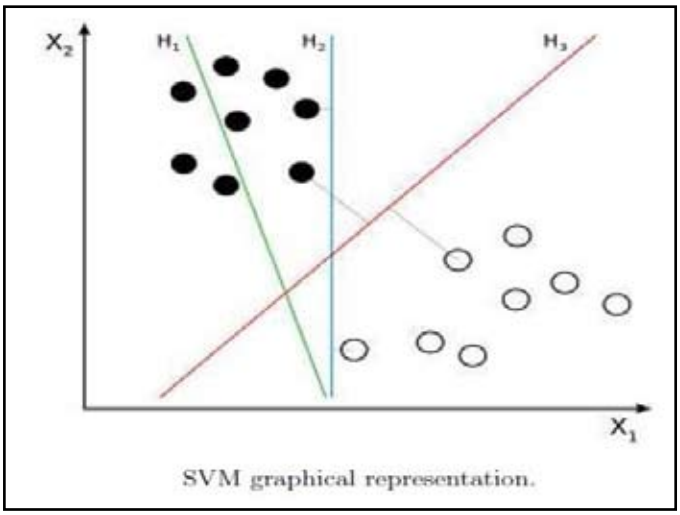
$$f_6 = \frac{1}{\sigma_x^3 \sigma y^3} \Sigma_i \Sigma j (i-\mu_x)^3 (i-\mu_y)^3 p(i,j)$$

7) Kurtosis:

$$f_7 = \frac{1}{\sigma_x^4 \sigma y^4} \Sigma_i \Sigma j (i-\mu_x)^4 (i-\mu_y)^4 p(i,j) - 3$$

Facial objects- Left Eye, Right Eye, Nose, Left Mouth corner and Right mouth corner are separated from the image and then converted to gray scale. Then the above features are obtained from the GLCM matrix .
Also another set of LBP features are also considered, for each detected facial component, I will extract 7x5 grids, where each grid is a square patch. In total I have 175 grids from five components including two eyes, nose tip, and two mouth corners. On the aligned image using similar methods proposed in [4]. From each grid, I extract an image patch and compute uniform LBP feature descriptor as our local feature.
These two feature vectors are combined and used for the classification of faces. MultiSVM [5] classifier is used as the classifier. The SVM is a supervised learning algorithm that infers from a set of labeled examples a function that takes new examples as input, and produces predicted labels as output. As such the output of the algorithm is a mathematical function that is defined on the space from which our examples are taken, and takes on one of two values at all points in the space, corresponding to the two class labels that are considered in binary classification. Classifying is a common task in machine learning. Support vector machines (SVMs) are a set of related supervised learning methods used for classification and regression. They belong to a family of generalized linear classifiers. In another terms, Support Vector Machine (SVM) is a classification and regression prediction tool that uses machine learning theory to maximize predictive accuracy

while automatically avoiding over-fit to the data. Suppose some given data points each belong to one of two classes, and the goal is to decide which class a new data point will be in. In the case of support vector machines, a data point is viewed as a p-dimensional vector (a list of p numbers), and I want to know whether I can separate such points with a (p − 1) dimensional hyper plane. This is called a linear classifier. There are many hyper planes that might classify the data. One reasonable choice as the best hyper plane is the one that represents the largest separation, or margin, between the two classes. Margin means the maximal width of the slab parallel to the hyper plane that has no interior data points. So I choose the hyper plane so that the distance from it to the nearest data point on each side is maximized. If such a hyper plane exists, it is known as the maximum-margin hyper plane and the linear classifier it defines is known as a maximum margin classifier.



SVM graphical representation.

IV. Conclusion

In this paper, I presented approach for face recognition techniques. As it is very important task to recognize human from single side view image, particularly images fetched by surveillance systems that deals with identification of humans. There should be proper mechanism to adjust appropriate angle and orientation while capturing side view image so that all the facial features like eyes, nose and lips are clearly and completely visible. An effective mechanism that generates frontal face images from side view but with prior detection of presence of any defect on the either side and thereby maximizing the resemblance of both views in comparison to original one. Our method is useful for 2D face creation that increase success rate to match with reference image for human recognition from human face side view.

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