ISSN:2249-5789

Face Recognition using LBP and LVQ Classifier

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Abstract
From the past decades, Face recognition is a challenging problem in the area of computer vision, pattern recognition and image analysis. It is a biometric technique used to identify and verify the human face. Face has many different characteristic due to which face of one person very form other. The variation in the human face mostly include lightning change effect, pose variation, facial expression variation, direction at different situation. Each human face has different features, through which each human is identified individually. Researchers have proposed various mechanisms for face detection and recognition. This paper presents a face recognition method, using a Local Binary Pattern, which is a static approach for feature extraction and Combined Learning Vector Quantization Classifier approach is used for face classification. The localization of face component and segmentation are applied using the Hough Circular Transform. The proposed recognition mechanism is robust to handle inputs from varying sources, and to detect and recognize faces rapidly.

Keywords-*Face recognition, Linear binary patter and Linear Vector Quantization (LVQ)*

1. Introduction

From the past decades, Face recognition [2][4] is a challenging problem in the area of computer vision, image analysis and pattern recognition[10]. It has received a great deal of attraction and attention over the last few years. Due to wide potential applications in the different areas such as human–computer interaction, video surveillance, face image database management, face detection, face recognition etc. It is a user-friendly system that can protect our privacy [8] and secure our assets without losing our identity in a sea of numbers is obvious. In the present scenario, PIN is needed to get cash from an ATM, to login in a computer we need password, similarly various numbers of others to access the Internet, and so on. In spite of all these traditional methods, another biometric personal identification [3] exist, through which we can identify a human very easily. There are various other biometric methods, among all those methods face recognition is a most preferable method. It doesn't give any harm to the human body. Face recognition acquired an outdoor environment for the problem of pose variation and lighting illumination [6][11]. Recognition consist of various face processing related tasks which includes detection of a pattern as a face, tracking of face components, verification[3] of face and face recognition. The two famous mechanism of face detection [9] includes the frame based detection and integrated detection approach. Here in the frame based detection is to take an image detect face in each frame of face available, here the frames are contiguous in the sequence.

Biometric identification [3] categorized into two main classes, which are physiological and behavioural. Physiological are related to the shape of the body such as hand geometry, fingerprint, face and iris recognition. Behavioural are relevant to the behaviour of a person such as voice and signature [8]. The face recognition is considered as the most important ways of providing security in government buildings, airports, and research laboratories without providing manual security [10]. Face image contains various face components, which includes eyes, nose, mouth, forehead, chin, and skin. Noise in the face include concentration of light on the face image, pose in which face is present, and the nature of face also plays an important role here.

In face detection process, the aim is to initially check whether the input image has face or not, if the face is available in the given image, locate the face in the image. The main concern is to detect the face block from the given image. Firstly as soon as face is detected, we need to draw a blob over the detected part of the face. The face region need a lot of preprocessing in order to detect face and removes the unwanted noise and remaining region from the image. Normalize the face image to a specific size for the proper detection. Output of the face detection is to train the module, determine and decide whether the given image belongs to the face class or not and finally we need to provide the

information of the recognition rate.

Image per-processing module has various steps, image may be a blur image or distorted image, so in order to enhance the image quality, histogram equalization of the input image is need to be obtained. Histogram equalization is then followed by the edge detection process. Which is important to detect the points in the image, it might also be possible that image brightness may or may not change. Sobel edge detection and pewit edge detection mechanism are used for the implementation work [5]. After this process thinning is used to degrade the width of edge to single line. Thinning is now followed by division of dataset to the small subcomponent. The small subcomponents are then processed.

2. Background

Face detection is the first stage in the face recognition system; firstly face is located in the given image before it is recognized. Earlier efforts have been focused on matched filtering, correlation, subspace methods, template matching, deformable templates [4],[1]. For comprehensive surveys of these early methods, see [4], [12]. Latest approaches mostly emphasize on data-driven based techniques like statistical modeling methods.

In the face recognition arrangement, there are various blocks. Each block has its own functionality. There are two methods to input/take an image. Static and dynamic, in static method we can input an image from the available images. But at the same time, in dynamic method image is obtained though the web-cam installed in the computer. The web-cam captures the image, which is input to the face detection block which can detect the face from the captured image. Face recognition perform two main tasks which include verification and identification of the human face. The verification is a one-to-one matching process, where we present the image of an unknown person, a claim of identity and verifying whether the individual is one who claims to be. In case of Identification, it is a one-to-multiple matching. Here we have an image of a unknown individual and a dataset of images, where we compare the claim identity with the database images. There are various application areas where face recognition is used for these two purposes which include Image database investigations, Surveillance, Security, General identity verification, Smart Card, Criminal justice systems [8], video indexing, Multi-media environments with adaptive human computer interfaces, Witness face reconstruction.

Various face detection algorithms are been based on correlation methods [5], filters matching [4] and these methods has a poor performance. In order to increases the performance of face detection data driven methods are used. These methods provide a lot of success in detecting faces from the normal images. These methods include Bayesian classifiers, artificial neural networks, clustering methods [2] and SVM [8]. These algorithms use Harr wavelet [4], Gabor filter [5], image gradient, and entropy measurement as features to improve the classification. For the efficient face detection most distinctive and discernment features are extracted In order to detect face from the environment. In this paper both texture analysis and matching of texture representation will be used with the aid of combined classifier learning vector quantization (LVQ) and a comparative evaluation with other methods using different iris datasets will be presented.

2.1. Face localization

Cyrille Baptiste presents an algorithm to localize the face image with a series of steps,

Step 1: Determine mean intensity of an image.

Step 2: Calculate the Cut off part of an image.

Step 3: Apply Binarization of the interest part.

The threshold is determined using following equation:

$$threshold = 0.52\left[\frac{1}{size_{map}}\sum Intensity_{pixels}\right] \quad (1-a)$$

Step 4: Using Hough Circle Transform (HTC) [13] in order to localize face image. Equation 2, 3 and 4 can be used to detect the projection point as follows: Equation (2 and 3) calculates first, second projection in the vertical and horizontal direction. • Equation (4) determines Xp3 and Yp3, Where Xp3 and Yp3 are the average values of Xp1 and Xp2, and Yp1 and Yp2 respectively.

$$X_p{}^1 = \arg\min_x \left(\sum I(x,y)\right)$$
$$Y_p{}^1 = \arg\min_y \left(\sum I(x,y)\right) \quad (2)$$
$$X_p{}^2 = \arg\min_x \left(\sum I(x,y)\right)$$
$$Y_p{}^2 = \arg\min_y \left(\sum I(x,y)\right) \quad (3)$$
$$X_p{}^3 = 0.5.(X_p{}^1 + X_p{}^2)$$
$$Y_p{}^3 = 0.5.(Y_p{}^1 + Y_p{}^2) \quad (4)$$

Step 5: Apply Binarization of the original image by multiplying equation (1-a) * 0.6.

Step 6: Determine threshold approximation as shown

$$threshold = 0.6.\left\{0.52\left[\frac{1}{size_{map}}\sum Intensity_{pixels}\right]\right\} \quad (1-b)$$

2.2 Face Segmentation

The face segmentation is the mechanism of separating the input face image into various face components. Which is an important step of image preprocessing and it is used in description and recognition of image. The CHT is the best ways to separate the face components from the whole

Image, in order to find the circle of the different face components. To analyze and determine the image intensity its edges are detected from the binary image using a predefined suitable threshold.

3. Proposed Work

Objective of our proposed approach is to extract distinctive and discriminate facial features from the whole image as well as local regions. These features are extracted using the Local Binary Pattern and Histogram properties. All the extracted local features as well as global discriminate face features are combined to made a new feature vector and if needed the dimensionality of the newly designed feature vector is reduced. During reduction of facial feature we need to keeping its discriminate information same. In order to combine all the facial information the face images are segmented into S sub-images in such a way that that they cannot overlap with each other, where each sub-images will represents a local facial changes due to the variation of illumination condition, facial expression and pose etc.

In face detection method, the images in the data base are of almost identical environment of distance, various images of different peoples are under consideration, some of them are identical, some with the variation at different angles, pose variation, some of them are with the different nature of facial expressions of images such as sad, happy, anger and people laughing etc. other are with the different backgrounds etc. For creating database some images are used for training and some for testing, both of these training and testing contain images with all kinds of variations.

A Local Binary Pattern [14] is called uniform if the transactions between “0” and “1” are less than or equal to two. A transition is evaluated when there is a change of value from 0 to 1 and vice-versa. For example: 11011111, 01110000 are patterns, the patterns 00000000 has all zeros and no one is there so there is zero transition, 11000111 (2 transitions) 01111000 (2 transitions) these pattern are uniform transitions. If the transitions are more than two then theses transitions are not considered as a uniform transitions. The histogram of uniform patterns in the whole image is used as the feature vector [2]. Uniform pattern are extended from the original operator which is used to reduce the length of the feature vector and implement a simple rotation-invariant descriptor.

For classification purpose we use Learning vector Quantization LVQ [15] classifier as a neural network approach for classification. Firstly features are extracted using Histogram properties and LBP. Transformed the face image into a feature vector which is applied to classifier. LVQ is a pattern classification method; each and every output node of the LVQ is represented as a class. The weight vector is considered as a reference. It adjusts the output of weight vector in order to approximate a theoretical neural network classifier. The resultant classification is based on the majority voting algorithm. This is a strong classifier. There are two layers in LVQ, among them the first layer is the input layer and second layer is the output layer. Input layer contains the input neurons, and the output layer contains output neurons. In LVQ the output is calculated using Euclidean distance in order to determine the winner neuron for the input vectors as well as weight vectors.

In this paper, there are four stages of proposed system which are face detection, preprocessing of the face image, Local Binary patter, Linear Vector Quantization (LVQ) and classification as shown in Figure.

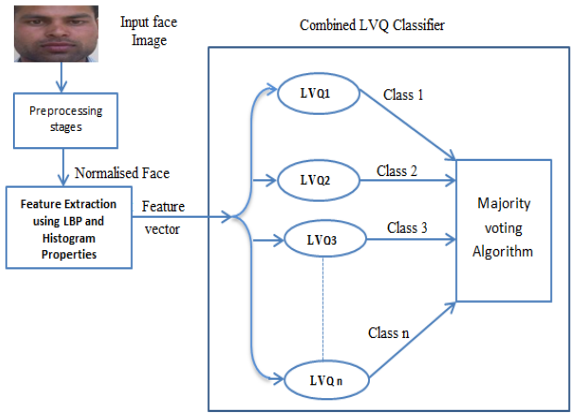

Figure: Proposed system diagram

4. Proposed Face recognition Algorithm

Step 1: Input Face images.
Step 2: Apply Preprocessing steps:
a. Apply canny edge detection for face localization.
b. Apply Daugman sheet model for segmentation
c. Normalization of a face image.
Step 3: Extract the face features using both LBP in order to obtain the feature vector.
Step 4: Newly obtained Feature vector is uploaded to Combined LVQ Classifier.
a. Set the number of Classifier (Nc) = 5.
b. Determine the Minimum Acceptable Classifier Performance.
Step 5: Training and testing each LVQ Classifier by selecting a suitable learning rate, number of hidden neuron, a training epoch number. Repeat number of classifier for each LVQ Classifier (Nc=5).
Step 6: Results are determine based on majority of classifiers voting and it is given as;

For m = 1 to N (N is no. of image for testing)
For n = 1 to M (M is the no. of classes)
Counter [n] = 0;
End for;
For C = 1 to N : N is the no. of Classifier
K= Recognition result [c, m];
Counter [K] = Counter [K] + 1;
End for;
Winner Class = Max (Counter);
End for.

5. Experiments and Results

Experiments were performed in the Yale and Olivetti Research Laboratory (OLR) face databases. Yale database contains 165 face images in total, each subject has 15 images and OLR database has 400 face images in total, these images are of 40 different peoples. These Yale and ORL are classical databases, in the face recognition and present various characteristics of images which include facial expression, variations in illumination and facial details. The facial expression contains images with smiling face, non-smiling face, and open eyes, closed eyes, happy, surprised, and sad. variations in illumination contains images with variation of light on the face image some images contain high intensity of light, some images with the low light intensity and facial details which contains images with glass and without glasses. We used 10 training images and remaining are the test images for each class. In the Yale database, there are 90 test face images and 75 training images. Similarly the OLR database contains 200 test images and 200 training images. The images are selected in the random order without overlapping between test and the training images. In experiment the number of eigenvectors used is same as the number of classes [1]. The Gabor wavelet also gives very interesting results without correspondence. It captures structure regarding the spatial localization, partial frequency, and orientation [9]. By taking small databases for training the PCA can outperform Fisher faces and also that Eigen faces is less sensitive to different training data sets [2]. Gabor filters also enhance the low concentration features which include valleys, peak and ridges. In order to enhance the distinct and discernment facial features. Gabor wavelet gives the 94.20% accuracy with the images of face variations in face images of Yale database. Variation includes the characteristics of position of eyes, distance between the eyes with different poses, forehead line, the nose, the mouth among other.

Proposed approach presented good results in Yale and ORL on database. The method of Combining face features includes global as well as local feature, obtained discriminate face features even in the presence of poses variation, illumination, size variations and noise. Images transformations are used to perform the verification of classifier robustness. In ORL data base we resize images to 50% of the original, in order to verify the performance of classifier in pose variation and size variation. Up to some instance image illumination is also changed which may decrease up to 40%. In Yale database, the image transformation result is beyond the crop of face image. Here we need to analyses and verify the signature of the nose, mouth and eyes in the class discrimination. Illumination alteration in images does not have much effect in classification. They can be easily classifiable. The accuracy in the Yale database is 96.56%. On applying the resizing on the original image and as well as local features and global features, the performance of LVQ was 89.55% of accuracy which decrease of 10 percent points in the classifier performance. The influence of mouth, eyes, nose, forehead, and hairstyle and skin color is also verified by using Yale database images.

6. Conclusion

This paper proposes a face recognition method based on LBP and Combined LVQ Classifier. The LVQ classifier is further enhancing the uniqueness and robustness of recognition system, which has more strong expression capability. This paper proposes the algorithm based on LVQ classifier. Through the recognition experiments using Yale and ORL face image database, the validity of the algorithm has been verified in the interference factors which include lightning change and facial expression, it shows a good robustness and stability.

7. References

[1]Bashyal, Shishir, and Ganesh K.Venayagamoorthy. Recognition of facial expressions using Gabor wavelets and learning vector quantization. *"Engineering Applications of Artificial Intelligence* 21, no. 7 (2008): 1056-1064.

[2]Yella, Siril, Narendra K. Gupta, and Mark S. Dougherty. "Comparison of pattern recognition techniques for the classification of impact acoustic emissions."*Transportation Research Part C: Emerging Technologies* 15, no. 6 (2007): 345-360.

[3]Ellis, Hadyn D., John W. Shepherd, and Graham M. Davies. "Identification of familiar and unfamiliar faces from internal and external features: some implications for theories of face recognition." *Perception* 8 (1979): 431-9.

[4]Samal, Ashok, and Prasana A. Iyengar. "Automatic recognition and analysis of human faces and facial expressions: A survey." *Pattern recognition* 25, no. 1 (1992): 65-77.

[5] M. Turk and A. Pent land. Eigen faces for recognition. J.of Cognitive Neur science, 3:71–86, 1991

[6] Peng hui. 2007. People face automatic recognition based on K-L transform method. Journal of Tsinghua University (Science and Technology),37(3.2007),67-71.

[7] B. Peixoto, C. Michelassi, and A. Rocha, "Face liveness detection under bad illumination conditions," in Proc. IEEE 18th Int. Conf. Image Process. , Sep. 2011, pp. 3557–3560.

[8] S. Prabhakar, S. Pankanti, and A. K. Jain, “Biometric recognition: Security and privacy concerns,” IEEE Security Privacy, vol. 1, no. 2, pp. 33–42, Mar./Apr. 2003

[9] T. de Freitas Pereira et al “Face liveness detection using dynamic texture,” EURASIP J. Image Video Process. , vol. 2014, no. 1, pp. 1–15, 2014.

[10] A. R. Rivera, R. Castillo, and O. Chae, “Local directional number pattern for face analysis: Face and expression recognition,” IEEE Trans. Image Process. , vol. 22, no. 5, pp. 1740–1752, May 2013

[11] M. R. Faraji and X. Qi, “Face recognition under varying illumination based on adaptive homomorphic eight local directional patterns,” IET Comput. Vis., pp. 1–10, Nov. 2014

[12] A. Anjos and S. Marcel, “Counter-measures to photo attacks in face recognition: A public database and a baseline,” in Proc. Int. Joint Conf. Biometrics, Oct. 2011, pp. 1–7.

[13] Kawaguchi, Tsuyoshi, Mohamed Rizon, and Daisuke Hidaka. "Detection of eyes from human faces by Hough transform and separability filter." *Electronics and Communications in Japan (Part II: Electronics)* 88, no. 5 (2005): 29-39.

[14] Ahonen, Timo, Abdenour Hadid, and Matti Pietikainen. "Face description with local binary patterns: Application to face recognition." *Pattern Analysis and Machine Intelligence, IEEE Transactions on* 28, no. 12 (2006): 2037-2041.

[15] Bashyal, Shishir, and Ganesh K. Venayagamoorthy. "Recognition of facial expressions using Gabor wavelets and learning vector quantization."*Engineering Applications of Artificial Intelligence* 21, no. 7 (2008): 1056-1064.