Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X

IJCSMC, Vol. 4, Issue. 4, April 2015, pg.251 – 258

RESEARCH ARTICLE

An Illumination Robust Facial Recognition using Fisher Adaptive LDA-PCA Approach

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Abstract: Face Recognition is considered as one of the most popular and reliable biometric application that can be used as online as well as offline recognition system. The increased use of mobile cameras and high resolution camera equipments, the significance of facial recognition is increased. But this recognition system is having some criticalities in terms of illumination, pose, position, age and expression. The presented work is here defined to resolve on of such problem called illumination. The illumination is the problem occurs because of environmental light problem or the wrong camera adjustment during capturing. In this paper, A Fisher Adaptive LDA-PCA approach is defined for effective facial recognition. At the earlier stage of work, the median filter adaptive histogram equalization approach is defined to improve the facial features. Once the facial features are identified, the fisher algorithm is defined to extract these features. At the final stage, the two level LDA is applied for recognition. The work is here applied on FERET Dataset. The obtained results show the works are provided the accuracy of 92%.

Keywords: Face Recognition, Behavioral, Challenges, Application, Approaches

I. INTRODUCTION

Biometric recognition already proven its significance over other authentication system as includes the some of the human feature or feature part as the authentication key. There are number of biometric authentication methods available to perform the recognition. Over these all methods, the facial recognition is having the higher importance because of the effective extraction of face via mobile cameras and high resolution cameras. Because of this, the face can be considered as the online as well as offline vector respective to which the recognition can be performed. But, this easy capturing of facial image also increases the recognition challenge. These challenges includes the lack of expertise, illumination, pose variation, environmental disturbance etc. It is very difficult to achieve high recognition rate under these all problems. In this paper, one of such problem is been covered called illumination robust recognition. To cover this problem, the median filter and histogram equalization is applied to improve the facial features. The basic face recognition model is shown in figure 1.

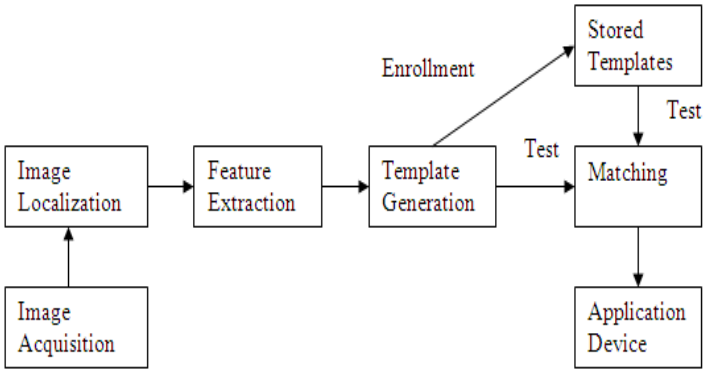

Figure 1 : Face Recognition Model

As shown in the model, the facial recognition begins with the acquisition of image. This acquisition can be performed either online by connecting the application to web cam or some camera device. In case of offline recognition system, the acquisition is considered in the form of facial file acceptance to the system. Once the image is taken, the next work is to identify the facial area over the image; this stage is defined as the localization of face over the image. This localization includes the identification of facial object by separating the background from the image. Once the actual facial object is identified, the next work is to extract the facial features. These features can be statistical, object based on algorithm specific. To extract these features, there are number of existing approaches such as gabor filter, fisher algorithm etc. Based on these facial features, the actual template will be generated that will be used to perform the recognition of face over the database. At the final stage, the facial feature object will be compared over the facial feature dataset. This recognition can be performed under some classification algorithm such as PCA, LDA, neural network etc. There are number of such supersized as well as unsupervised learning methods to perform the recognition. Once the facial object will be recognized, the authentication will be performed and the person will be connected to the actual application[4][5][6].

In this paper, an illumination robust approach is defined to perform the facial recognition. The work is here defined as the three stage model. The recognition is here been defined using two level LDA-PCA approach. In this section, the significance of biometric recognition and facial recognition is defined. Here the basic facial recognition model is explained. In second section of this paper, the challenges associated with facial recognition are explored. In section III, the work defined by earlier researchers on facial recognition is presented. In section IV, the proposed research model for facial recognition is shown. In section V, the results obtained from the work are discussed. In section V, the conclusion obtained from the work is presented.

II. CHALLENGES

The facial recognition is equally important as well as challenging. The easy and cost effective facial image acquisition also increased the use of facial recognition as the online and offline recognition system. Now the facial recognition has become the key recognition system for many web, operating system and mobile applications. But this also increased the associated challenges. Some of these challenges that does not provide the effective accuracy over the recognition system are discussed here

A) Aging :-

One of the core challenges for facial recognition system is the effect of age in facial recognition system. According to this, the continuous updation of face is required in the dataset. The facial aging changes the facial features so that high recognition cannot be obtained on older database. The age having the effect on face in terms of complexion, shape, wrinkles etc. Most of the available recognition system are not able to resolve the aging problem. They requires the updation in dataset enrollment. The aging is having its significance in some other applications such as age identification, gender recognition etc. The aging robust recognition system increases the probabilistic estimation so that same software system will be applicable for number of years[4][5].

B) Image Quality:-

Another important factor that effects the recognition accuracy is the quality of image. As the available cameras such as phone camera, web cams etc provided the easy for facial capturing but the equality of these cameras is also an issue. Some low resolution

cameras are not able to provide the effective image capturing so that low recognition rate is obtained over the image. To improve the recognition rate, some high resolution cameras are required. The quality of image can be identified in different aspects such as resolution of image, illumination, contrast distortion, correlation loss etc. This image quality problem is required to resolve while performing the recognition. For this, most of recognition model uses the pre-processing stage as the prior process stage to resolve such integrated problem. There are number of approaches available to quantify the approaches and to provide the resolvement so that effective recognition to the system will be obtained. There is the requirement to remove these irregularities so that the accuracy of the recognition system will be improved[2][3].

C) Face Expression:

Face expression is another diversion generated over the facial image that changes the accuracy of recognition process. This recognition vector is identified as emotional change in the facial structure. As the expression increases, the criticality of facial recognition is also increases. This actually change the geometric features of image in terms of pixel displacement, angular change etc. Most of the available algorithms are not robust against the facial expression[2][3][4][5].

III. EXISTING WORK

Lot of work is already defined by different researchers to improve the recognition ration under various challenges of facial dataset. Some of the work defined by the researchers is given in this section.

Zixuan Wang[1] has defined the facial recognition under the location robustness. This facial recognition system is defined as a framework applied on the mobile system to provide the online authentication system. The author has defined the recognition under location robustness and reduces the search face so that the recognition accuracy is been increased. Lijun Yan[2] has defined the facial recognition using improved PCA approach. Author has defined the directional metric specification to generate the principal component model for each facial image. Based on this model, the metric level analysis is been performed and high recognition ratio is obtained over the facial image. Jun-Bao Li[3] has defined a work on the dimensional reduction based approach to extract the facial feature and applied NDA (Nonparameteric Discriminant Analysis) to perform the recognition. Author has applied this novel feature extraction approach on different datasets including the FERET, YALE and obtained the high recognition rate. Yong Ma[4] author has defined an age sensitive approach of facial recognition for age estimation. Author has presented a framework to generate a ranking mechanism so that effective ranking the person age will be identified and based on this model, the recognition of face will be done. Author has defined comparative estimation program for age estimator and define some experiments so that the actual identification of facial features will be done.

Real time facial image processing and recognition is also a challenge. Che-Hua Yeh[5] has presented a work on home photos to represents the real time recognition. The capturing of images is done using mobile cameras and the clustered approach is defined for recognition and classification. For feature extraction local binary pattern approach was used by the author. Author obtained the high recognition rate for different photosets. Yang Zhang[6] defined another work using LBP approach and its integration to the DCT approach to provide the robustness against different variation over the raw image. These variations include the pose, age and the illumination. Author defined a block analysis approach to explore the facial features so that the effective facial will be obtained. Author applied work on Yale and FERET datasets and obtained high recognition rates. Weisheng Li[7] has presented another work on LBP approach with dynamic thresholding to perform effective recognition. Author has adjusted the image under neighborhood pixel analysis respective to the distance of pixel from central pixel. Author has defined statistical histogram analysis for effective recognition of facial image. Seiji TAKEDA[8] has defined context driven approach for effective recognition of face. Author has defined the context sensitive model under real time environment to analyze the camera position and relative vectors to identify the change at the early stage. Based on this change estimation the recognition is performed over the face. Kanchan Singh[9] has presented a wavelet predictive facial recognition model for effective facial recognition under color robustness. Author has presented a model in which the feature vectors are generated using wavelet decomposition. Later on the parametric coefficients are identified over the images and the recognition is performed based on the eigen value analysis. Naveen N. Murthy[10] has defined a work on DWT thresholding and feature extraction under wavelet decomposition approach. Author has combined two methods for feature generation called DWT and laplacian gradient masking. Author has defined the recognition system under the variation analysis so that the effective coefficient vectors will be obtained and the feature features will be improved. The recognition is performed on these improved features so that the recognition ratio will be improved.

IV. RESEARCH METHODOLOGY

In this present work, a three stage model is been defined to perform the effective recognition of facial image. The work is defined to achieve the robustness against the illumination variation over the facial dataset. The proposed model is divided in three main stages. In very first stage, all the deficiencies over the image will be identified and resolved. This stage will include the median filter and histogram equalization approach. In second stage, the feature extraction is defined using fisher algorithm. In final stage, the two stage LDA-PCA approach is defined for the recognition. This three stage model is shown in figure 2.

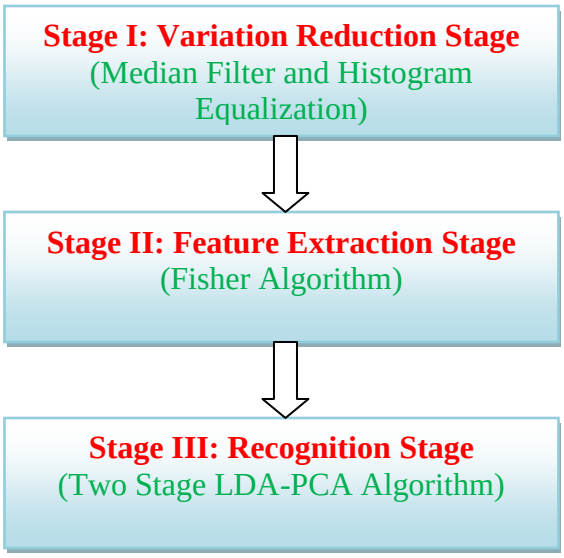

Figure 2 : Proposed Model

A) Variation Reduction Stage

One of the major problem to the facial image extraction is illumination specific variation. This variation can occur because of bad light, environment vector or the camera alignment problem. If the raw input image is not normalized against illumination vector, the accuracy ratio will be affected. To improve the facial features against illumination, the median filter can be used. This filter is a non linear filter that is able to improve the image features. These will be able to assign the rank ordering the pixel level analysis respective to the centralized pixel specification. The filter is based on the neighbourhood analysis so that the effective improvement to the image can be obtained. This filter is able to reduce the noise as well as improve the capability by normalizing the illumination vector. Once the normalization will be done, the exploration to the facial features be done using histogram equalization. The algorithm for this model is shown in Figure 3.

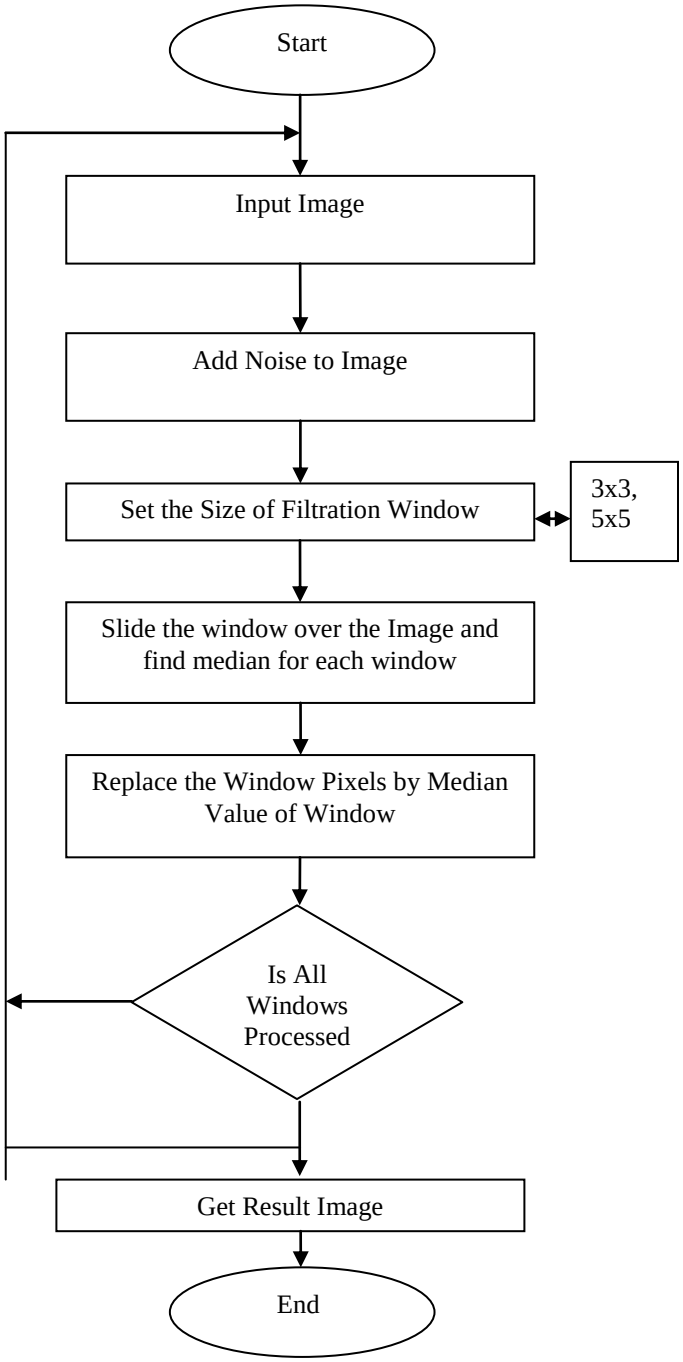

Figure 3 : Illumination Adjustment

B) Fisher Algorithm

The fisherface algorithm is here been used to generate the feature set so that recognition robustness will be improved. Here the algorithm is defined to identify the ratio between the variation of the input face and the facial dataset. This recognition is here performed to identify the class by generating the scatter matrix. The determination of this scatter class is here based on the coefficient analysis. This determination of the class is given with the specification of probability class Pr and the mean value to all the classes. The scatter value respective to class C is gen here under

ScatterMat = $\sum_{i=1}^{c} \Pr(Class(i)) \sum_i$

Here c represents number of classes

Pr is the probability of class acceptance

And

$$\sum_i = 1/N \sum (xi - Mean)(xi - Mean)\, T$$

Based on this scatter matrix, the difference between the input face and the class faces will be obtained an the match to the actual face can be performed based on class level analysis. This matrix is defined as the singular vector respective to which feature set over the dataset is obtained[11][12].

C) LDA

Once the feature set is obtained, the final step is to perform the recognition. In this work, two level recognition is using LDA PCA approach. Here LDA is applied to perform high level class identification and PCA for low level recognition. Here LDA is applied on the fisher based obtained featureset instead of raw image. LDA is here applied on feature space that actually represent the feature pattern over the facial image. These feature vectors are combined in the form of complex vector based on which the dimension map is performed. The dimensional map is required to obtain the effective recognition over the facial image. The space defined here is based on the unitary space. The scatter matrix obtained from the fisher algorithm is here taken as the probability class based on which the training samples are compared. The semi positive map are considered as the possible map. Based on which the optimal projection will be obtained and the actual recognition will be performed. The algorithmic approach for the recognition at high level is given in table 1[11][12][13].

Table 1: LDA

LDA(Featureset) /*featureset is the fisher obtained feaure set on which recognition is performed) {
1. Obtain the tranformed matrix over the featureset called WHSwW=I. Generate the diagonal matrix to generate the eigen values so taht effective optimal projection to the axis will be obtained.
2. Obtain the classProb=WHSbW based on orthonormal eigenvectors
3. Obtain the largest eigen value as the corresponding vector.
4. Map the vector over the set and identify the maximum mapped objects.
5. The objects that full fill the threshold criteria are identify the high level classification vectors.
}

D) PCA

PCA calculates the Eigen vectors of the covariance matrix, and projects the original data onto a lower dimensional feature space, which is defined by Eigen vectors with large Eigen values. PCA has been used in face representation and recognition where the Eigen vectors calculated are referred to as Eigen faces. In gel images, even more than in human faces, the dimensionality of the original data is vast compared to the size of the dataset, suggesting PCA as a useful first step in analysis. Here PCA is been defined as the low level classification method. This method is based on the eigen value analysis and obtain the high recognition rate so that effective facial recognition will be obtained [11][12][13].

V. RESULTS

The work is here been tested on FERET dataset. This dataset is having the illumination problem and dataset is been collected and sponsored by DARPA program. This dataset is having about 1400 images of 200 persons. The images are having different illumination and expression variation. Here the main consideration is given on illumination dataset. The characteristics of the experimental model applied in this work are shown in table 2. The sample dataset is shown in figure 4.

Figure 4 : Sample Dataset

Table 2 : Experimental Model Characteristics

Properties	Values
Size of Training Set	100
Size of Testing Set	25
Variation	Illumination
Resolution	200x200
Type	Grayscale
Persons	25
Number of Instance	4
Recognized Successfully	23
Wrong Recognition	2
Recognition Ratio	92%

VI. Conclusion

In this paper, an illumination robust model is been defined to perform the recognition. The presented model is divided in three main stages. In first stage, the features of facial image are improved using filteration model. In second stage, the fisher algorithm is applied for feature extraction and at final stage LDA—PCA is defined to perform the recognition. The work is applied on illumination affected dataset and high recognition over the work is obtained.

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