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Model-Based Active Appearance Model Approach For Face Recognition

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Abstract: Recently, the most user-friendly systems in the biometric world are face recognition systems. In addition, they are one of the active research fields while the researchers work to ameliorate the effectiveness and competence of biometric implementations. The major challenge to be in these implementations is to extract the useful features sets which are not disturbed caused by number of factors, including person movement, illuminations, camera's differences and other ecological and physical changes. Thus, AMM (Active Appearance Model) is one of the good population solutions which it can be used as a features extraction technique by accurate modeling under different physical and environmental situations. In this research, an AAM based face recognition system is proposed. Then, three different data sets YALEB, FERET and CASIA V5 which have been utilized for the first time in the evaluation. The experimental results showed that the performance of AAM is very powerful with face recognition.

Key words: Face biometric, human face recognition facial features, AFR, AAM, YALEB, evaluation

INTRODUCTION

Motivation: Now a days, human face recognition considers one of the active research domains from researchers in such varied fields as pattern recognition, biometrics and machine vision (Ebrahimpour *et al*., 2011; Godvarthi *et al*., 2017). Within computer vision, face recognition has become progressively relevant in community these days. The current interest in face recognition can be assigned to a wide range of applications in our daily life such as commercial, government and forensic applications needing the use of face recognition processes. The face recognition system is a computerized vision which can identify human faces from database images automatically. The problem that challenges is its require to compute for all probable appearance variation in human face because of variability in the image plane such as scaling, pose of the face with relative to the camera, shape of the face such as facial expression and lighting source, etc. Face recognition is widely used in biometric indicator which considers to be a good compromise between reality and social reception and making a good balance security and privacy (Kumar and Banerji, 2011; Patil *et al*., 2010; Shailaja and Anuradha, 2017). The face recognition system can be classified as: verification and identification. Verification processing is also called 1:1 matching which the system only compares face images against template face images whose identity is being claimed. Contrarily, identification processing is sometimes called a 1:N matching that compares the subject image against all image templates in the database. The main issues of any Automatic Face Recognition technique (AFR) can be stated as follows: facial localization, feature extraction and modeling (Ahuja and Chhabra, 2011). Since, 1990, automated face recognition has been taken into interest and the algorithms are varied, then in the recent years, there are many techniques are presented and evaluated by several researchers. As face recognition methods, the earlier one has analyzed geometry of the face (e.g., nose, eyes and mouth) r their geometric relationships between features (e.g., distance and angles) (Islam and Rahman, 2011). An "Active Appearance Model (AAM)" regards the most effective methods among several face recognition techniques.

The Active Appearance Model (AAM) explains the appearance of the face (Gao *et al*., 2011); it generates statistical model of shape and gray level appearance of any object that has given. On a large scale, it has been used for modeling human face shape and appearance (Abdulameer *et al*., 2014a; Abdullah *et al*., 2017). The model integrates constraints on both shape and texture by learning statistical generative models for the face shape and its appearance. Landmark positions represent the shape while the intensity of a pixel in the shape of face outline represent the appearance (Gao *et al*., 2011; Sauer *et al*., 2011). In training phase, the AAM algorithm takes a group of labelled images and the

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identical landmark points as an input and produces parameters of the model as an output. The power of AAM lies where it can synthesis or defines any given object's shape and appearance with compact set of parameters (Gao *et al*., 2011). This study suggested active appearance model as a stable model-based feature extraction technique to be in face recognition.

Literature review: The complexity in face recognition arises from the appearance's variability of a human face. Aforementioned while the identity is maintained, the face's appearance may change due to many elements, such as illumination, face expression or pose (Metilda and Santhanam, 2007). Different types of face recognition techniques have been developed by many researchers. Islam and Rahman (2011) have presented facial recognition system which contributes the feature and make decision in hard environment. In addition, they have examined the proposed recognition method in in exemplary conditions of office environment. Although, the "traditional Hidden Markov Model (HMM)" based face recognition technique was highly delicate to the variations of facial parameters, the proposed feature and decision maker based face recognition was set up to be stance and implements well for evolving the hardiness and simplicity of human computer-interaction. On the other hand, Hasan *et al*. (2013) have utilized "Opposition Particle Swarm Optimization (OPSO)" and "Support Vector Machine (SVM)" for face recognition. They used OPSO to find the optimal parameters for SVM. Then, they presented a novel face recognition technique which is AAPSO-SVM (Abdulameer *et al*., 2014b). And they presented a modified PSO algorithm in their new method. Recently, a combination of OPSO-SVM and AAPSO-SVM has been presented by Abdullah *et al*. (2017) and named as AOPSO-SVM. In their suggested method, they combined OPSO and AAOPSO to be AOPSO. Their new method AOPSO-SVM was outperformed OPSO-SVM and AAPSO-SVM. However, high computation time and very slow has been needed. Wawan Setiawan (Setiawan, 2016) proposed an effective method to recognize abnormal face images which containing blur or noise area. The acquired image is analyzed by using introduction of Backpropagation Neural Networks (BNN). Before using BNN approach, the pre-processing and image extraction by using zoning method through Filtering, Grayscaling, Thresholding and Zoning calls (FGTZ) were applied for segmentation purpose. To support the effectiveness of study, the input blur images were varied from level 1-5 with 10 variations which include variations of camera-face poses and lighting sources. The results pointed out that the pre-processing techniques and extraction methods can generate representative facial features whereas the overall of system containing numerous blur levels and poses can differentiate well between male and female.

MATERIALS AND METHODS

The major objective of this research is to present better face recognition technique through solving the obstacles that currently exist in the literature researches. Therefore, this research has been aimed to suggest a good way of face recognition system by using "Active Appearance Modal (AAM)". The proposed research consists of three main phases which are preprocessing phase, feature extraction phase and recognition phase. Essentially, the proposed technique will implement preprocessing on the input training face images. Thereafter this preprocessed images will be submitted into the next stage (i.e., feature extraction). In the feature extraction stage, the feature vectors will be taken out by AAM from the face images. Finally, the recognition stage is implement to recognize the face. Figure 1 shows the architecture of the proposed system.

The pre-processing stage: The performance of extraction stage and recognition stage relies massively on the quality of the input face image. Various reasons may degrade the quality of the face image such as variability in scale, location, pose and lighting conditions, …, etc. Therefore, a preprocessing stage is considered as the most fundamental stage in any established recognition model. In addition, the other reason is to make detection to the significant features in the image and to avoid detection the worthless details in the image. Some of the preprocessing steps are used for this stage.

The feature extraction stage using AAM: A set of training face images is used in this stage, I_i (x, y); x = 0, 1, …, R-1, y = 0, 1 , …, C-1 and i = 0, 1, …, C_T-1 where the size

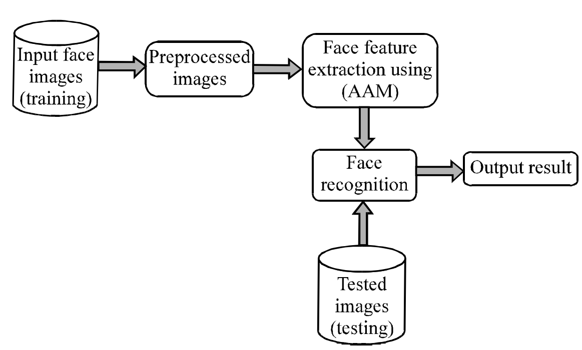

Fig. 1: The architecture of the proposed face recognition system

of I_i (x, y) is R×C. In the training images, the active parts are manually labeled to draw out the parameters of appearance and shape models. A vector of X_{ij} and Y_{ij} : j = 1, 2, …, C_p is generated where the x and y coordinates are placed. Let C_p be the active portion of an image, so that, the vectors X and Y can be calculated by using following criteria:

$$|X|_{ij} = |Y|_{ik} : j = k \quad (1)$$

$$|X|_{j} = (or) \neq |Y|_{k} : j \neq k \text{ and } k = 1, 2, ..., C_p \quad (2)$$

The grey portions of Ii are extracted using the X_i and Y_i as follows:

$$G_{ij} = \begin{cases} g_i(x, y); \text{if } x \leq X_{ij}(k) \text{ and } y \leq Y_{ij}(k) \\ 0; \quad \text{otherwise} \end{cases} \quad (3)$$

Where:

$$g_i(x, y) = 0.3I_i^R(x, y)+0.6I_i^G(x, y)+0.1I_i^B(x, y) \quad (4)$$

where, R, G and B represents color bands (Red, Green, Blue color, respectively) and then the appropriate normalization will be applied onto X, Y and G through the following Eq. 5:

$$\overline{X_j} = \frac{1}{C_I}\sum_{i=0}^{N_I-1} X_{ij}, \overline{Y_j} = \frac{1}{C_I}\sum_{i=0}^{N_I-1} Y_{ij}, \overline{G_j} = \frac{1}{C_I}\sum_{i=0}^{N_I-1} G_{ij} \quad (5)$$

Such that Eq. 6:

$$\overline{X}_j = \overline{Y}_j \quad (6)$$

Equation 7 is calculating the shape and grey parameters from X, Y and G Eq. 7:

$$A_{ij} = \begin{bmatrix} S_P^{ij} \; w_{ij} \\ G_p^{(ij)} \end{bmatrix} \text{where}$$
$$S_P^{ij} = \begin{bmatrix} (\overline{X}_j - X_{ij})\xi_j^x \\ (\overline{Y}_j - Y_{ij})\xi_j^y \end{bmatrix} \text{and } G_p^{(ij)} = (\overline{G}_j - G_{ij})\xi_j^g \quad (7)$$

where, $\overline{x_j}$ represents the normalized x and y coordinate vector value. Then as shown in Eq. 8, the achieved shape and also grey parameters are subjected to decomposition to produce a vector of appearance parameters (Eq. 8):

$$A_{ij} = Q_{ij}a_{ij} \quad (8)$$

where, the eigenvectors and vector of appearance parameters are denoted by Q_{ij} and a_{ij}.

The recognition stage: The recognition technique makes a comparison between the image parameters and the faces database for the authenticity recognition from an image. Yet, the image existence in the database makes certain that the image's validity and absence avoid providing the authenticity of person. Virtually, the tested sample is applied to faces shape and semblance parameter extraction for implementation the recognition task. The process of recognition utilizes a similarity distance measure, thus, the recognition process and making decision are done by the following formula Eq. 9:

$$N_{test} = \sqrt{\sum_{x=0}^{R-1}\sum_{y=0}^{C-1}\left(I(x, y)^{original} - I(x, y)^{model}\right.} \quad (9)$$

where, the compared between all the image and the tested sample are done by N_{test} which obtains from the test face image.

RESULTS AND DISCUSSION

The utilized face image datasets in this study were based on the human face image database which are: CASIA (Anonymous, 2007) ,YALE B (Belhumeur *et al*., 1997) and FERET (Blackburn *et al*., 2000). CASIA database Version 5.0 consist of 2,500 color face images of 500 subjects. The extended YALE B provides 16128 images of 28 subjects taken under different 9 poses and 64 illumination conditions. The FERET database was gathered between August, 1993 and July, 1996 in 15 sessions. This database consist 1564 sets of images for for an overall of of 14,126 face images that includes 1199 individuals and 365 repeated sets of images. Basically, training and testing of datasets have been distributed, to experiment, each database has images for 100 human at 5 different environments of variety in poses and lighting. Figure 2 shows some examples face images that have been utilized in this study.

The working platform MATLAB is utilized to build the proposed system. From all the over mentioned databases, 5 different datasets have been divided for experience where each dataset has images of 20 persons in five various environments of poses and changes of illumination. The system performance is analyzed by producing n-fold (for the work dataset, n = 10) come across validation over each datasets and specify the corresponding statistical performance measures. For execution of n-fold cross validation, the folding operation create 10 folds of training and testing datasets. The below Table 1-3 present the cross validation accuracy outcomes for 1:N recognition over five datasets.

Fig. 2: a) CASIA face image; b) YALE B image and c) FERET image

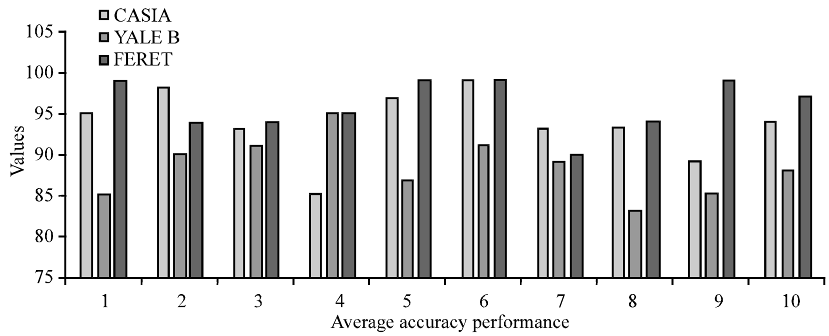

Fig. 3: Average recognition performance for CASIA, YALE B and FERET datasets

Table 1: Accuracy results for CASIA dataset

Cross validation rounds	Accuracy
1	95
2	98
3	93
4	85
5	97
6	99
7.	93
8	93
9	89
10	94

Table 2: Accuracy results for YALE B dataset

Cross validation rounds	Accuracy
1	85
2	90
3	91
4	95
5	87
6	91
7.	89
8	83
9	85
10	88

Table 3: Accuracy results for FERET dataset

Cross validation rounds	Accuracy
1	99
2	94
3	94
4	95
5	99
6	99
7.	90
8	94
9	99
10	97

The final outcome obtained ten various cross validation outcomes each dataset for showing the performance of the recognition system. Although, the procedures are similar, the recognition performance varies. Figure 3 that shows average recognition performance for the three datasets. Indirectly, this explains that in spite of that the recognition performance varies but the variation is under limitation. That mean, the reliability would be naturally high.

CONCLUSION

In this research, a face cognition system is suggested based on Active Appearance Model (AAM). The performance of this technique is analyzed in three different datasets with different circumstances which they were CASIA-face database, YALE B and FERET face datasets. The recognition is evaluated by experimenting 1:N face recognition. The experimental results have confirmed all the aforementioned features and advantages of the proposed technique with regard to accuracy measure.

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