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Implementation of Face Recognition Using STASM and Matching Algorithm for Differing Pose and Brightness

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***Abstract* - A very important aspect of security is the identification of an individual. The identification techniques used may differ according to conveniences and requirements. The identification of an individual person may be carried out by traditional means like passwords, identity cards etc, but these can be easily misused. Hence a better way of identifying an individual is by using biometric verification. The biometric verification involves identification of an individual based on physiological and behavioral features. The physiological features include face, iris, finger print etc, and behavioral features include signature and voice, which are unique to a person. Human face recognition is one among the best techniques used to identify an individual person. Verification of driving license, user verification and improved human-PC collaboration all get to be conceivable just if a powerful face recognition framework can be executed. Face images have been in use for authentication since long because of their high immutability, individuality and acceptability. Immutability refers to the** consistency **of the face images over time and individuality refers to the uniqueness. Accurate face recognition system is the problem encountered in the field of biometric identification. The existing approaches called PCA (Principal Component Analysis), ICA (Independent Component Analysis) and LDA (Linear Discriminant Analysis) do not carry out the recognition to the face images captured in unprincipled settings. The proposed method uses the model-based algorithm for face recognition in unprincipled settings. STASM (Extended Active Shape Model) algorithm is utilized to position points on the face images. Using the points pose normalization is carried out. Then Matching algorithm is used for matching image with input face image and image in database. FERET database is used to train the system.**

***Index Terms* - Biometric identification, Immutability, Individuality, STASM, Matching algorithm.**

I. INTRODUCTION

Identification of an individual person is a very important aspect of the security. Biometrics refers to “the procedure of recognizing a distinctive individual in light of his behavioral or physiological characteristics”. Physiological characteristics refers to fingerprints, face, hand and eyes, where as the behavioral characteristics refers to voice, signature etc. These characteristics are used for personal authentication because of their properties such as uniqueness and persistency. Since early in the 20th century the terms “Biometrics” and “Biometry” are used for the expansion of mathematical and statistical methods which are applicable for data analysis difficulties in the field of biological sciences. Thus the technology and science of numerically analyzing and measuring biological data refers to biometrics.

The biometric system is essentially an identification system, which makes an individual identification by determining their physiological or behavioral characteristics. An important issue in building a biometric system is to find how an individual person is identified. The biometric system identifies an individual by measuring the behavioral or physiological characteristics and later comparing it with the library of characteristics belonging to many persons. The biometric devices consists of a software that converts the information into digital form, whenever analyzing of data is to be carried out . A database is created in which biometric data is stored and used for comparing with the records stored in the database. When transforming the biometric data, the software defines the data as a group of landmarks. Group of landmarks are utilized by using an algorithm into a value and matched with the data present in the database.

Face recognition carried out in unprincipled settings is still a challenge in biometrics. The images captured under different pose and brightness becomes challenge for real world face recognition entity. The smoother face recognition is possible only if the images are captured in controlled environment. There are many existing and popular methods for face analysis called PCA (principal component analysis), LDA(Linear Discriminent Analysis), ICA (Independent Component Analysis) [1] and SVM (Support Vector Machine) [2] which evaluate the attainability of authentic world face recognition only in controlled environment. A major issue with the images captured in unprincipled settings is the reduction in performance of the face recognition system concerning the pose and brightness changes. The proposed approach currently employs identification using the Matching algorithm, 1:N matching is performed. Even though the possible variations affecting face recognition, the proposed method concretely addresses pose and brightness changes. STASM (Extended Active Shape Model) [3] algorithm is utilized to find the important points on input face image. At the end, implementation of correction procedures to normalize the face images is carried out. The important points on input face image are utilized to normalize the different pose images. Once the pose normalization is done the brightness normalization is carried out by using self quotient image (SQI) [4] algorithm. Then face recognition is done by using the Matching algorithm with the images present in the database. The system contains both quality and reliability indices to show the system is adaptable. At the point when either list does not give satisfactory values, it is obliged to request another catch, when this is accessible, or the framework can utilize an alternate convention, by asking client's input. In practice the proposed system mainly consists of two modules. In the first module the image pre-processing, location of landmarks using STASM (Extended Active Shape Model) algorithm and normalization is carried out. In the second module matching is done by calculating the correlation between input images and the image in the database.

II. LITERATURE SURVEY

The current methodologies, for example, PCA, LDA, ICA [1] and SVMs [2] demonstrates that no single or hybrid strategy attempted is preferably coordinated to a typical application. The methodology of SVM and LDA routines demonstrates the consequence of 65% exactness with the high cost calculation and memory prerequisites. Later all the tried images are again trained with new image to draw out the first image. Also, the Individual PCA methodology is utilized to match the image with a genuine usage however its leads low exactness. Therefore the individual PCA draws out the full adequacy furthermore it consequently recognize the appearances from the database lastly it perceive the first focused face.

One of the methodologies of face description is texture descriptor where it is utilized to build a few nearby descriptors of the face and after that it adds them into a global description. The facial images is isolated into local regions and texture descriptors which have been extracted from every region independently. The information regarding the patterns on a pixel-level is completed by the Local Binary Pattern, the labels are gathered to small regions to deliver information of a regional level and after that regional histograms are connected to build a description of face image.

Accuracy of existing appearance-based algorithms such as PCA, ICA and LDA decreases as the pose and brightness of the face images differ significantly. The global-based approach of SVM works well only for classifying the frontal upright faces. The global-based approach is not robust against differing poses because the worldwide elements are exceptionally delicate to scaling, rotation and translation of face images. Hence model-based approach called Extended Active Shape model (STASM) is used in the proposed method which is robust against differing poses and insensitive to scaling, translation and rotation of face images.

III. PROPOSED SYSTEM

Proposed strategy exploit billow of essential points on data face image utilizing the STASM (Extended Active Shape Model) approach, which are utilized to right the pose utilizing relative changes of their comparing fields. After a pseudo frontal position has been acquired, brightness standardization is done. Found critical points permit the proposed technique to further infer essential extra data identified with the image quality achieved amid the procurement of the biometric images.

In practice, as shown in figure1 the proposed method is mainly made out of four modules. The first module performs image pre-processing, where resizing of a face image and removal of noise such as salt and pepper noise by using median filter is carried out. The second module performs face detection and location of landmarks or feature points on face images by using Extended Active Shape model (STASM)[3] algorithm. The third module performs pose and brightness normalization. The fourth module performs face recognition, 1:N matching is done with input face image and face image in database.

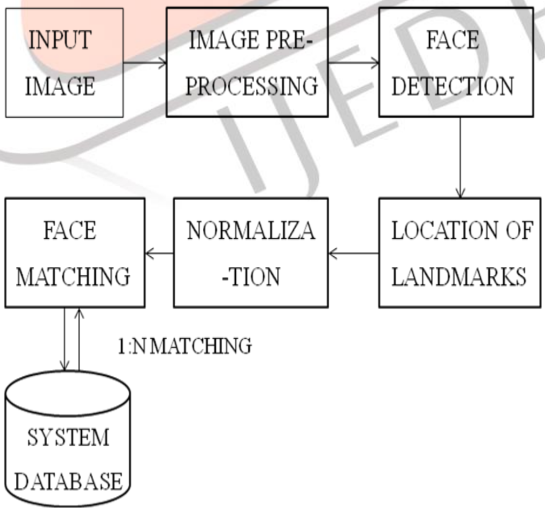

Figure 1: System architecture

Proposed method is implemented and designed for the face images captured in unprincipled settings. By Using this proposed method, we can calculate the correlation based image matching and high level image classification. By using Proposed method, it increases the image quality and transforms the image pixels

STASM algorithm

The fundamental step in the face-acknowledgment based programming is finding of one or more faces inside of a data picture. When the face image is identified utilizing worldwide Face identifier, the face image is provided as an input to the STASM (Extended Active Shape model) approach. The feature points or landmarks are located using the STASM approach. The algorithm for location of points on an input face image as referenced [3] is illustrated below.

INPUT: Input image of a face
OUTPUT: Landmarks positioned on the face image

Step 1: Produce the begin shape by finding the general position of the face
Step 2: repeat
Step 3: propose another shape by layout coordinating around every shape point
Step 4: adjust the new shape to a worldwide shape model.
Step 5: Until merging (i.e. Until no further changes in fit are conceivable)
Yield shape giving the (x, y) co ordinates of the face milestones. Conforming the new shape to global shape model is done by calculating the mahalanobis distance between two points.

$$\text{Mahalanobis distance} = (a - a')\, s^{-1} (a - a') \qquad (1)$$

Where a' is mean and s is the covariance matrix.

SQI algorithm

The Self Quotient Image (SQI) [3] is used for brightness normalization. Self Quotient image P of image R is given as

$$P = \frac{R}{R`} = \frac{R}{S \times R} \qquad (2)$$

where R` is the smoothed version of R and S is the smoothing kernel.
STEP 1: Select smoothing kernel $T_1, T_2 \ldots T_n$ and ascertain comparing weights $U_1, U_2 \ldots U_n$ as per the input image
STEP 2: Smoothing input image R by measured anisotropic channel UT_i.

$$R`_v = R \times \frac{1}{N} U\, T_v,\ v = 1, 2, \ldots, n \qquad (3)$$

STEP 3: Ascertain the self-quotient image between every input image R and its smoothing version

$$Y_v = \frac{R}{R`} \quad v = 1, 2, \ldots, n \qquad (4)$$

STEP 4: Translate self-quotient image R with nonlinear function

$$X_v = T(Y_v),\ v = 1, 2 \ldots, n \qquad (5)$$

STEP 5: Outline nonlinear transferred values

$$Y = \sum_{v=1}^{n} j_v X_v,\ v = 1, 2, \ldots, n \qquad (6)$$

The j_1, j_2, j_n are the weights for each scale of filter.

Matching algorithm

Given two face images P and Q and comparing mean estimations of their pixels, P' and Q' and their relationship C(P, Q) as given in [13] is as follows

$$C(P,Q) = \frac{\sum_{i=0}^{n-1}\sum_{j=0}^{m-1}(P(i,j)-P')(Q(i,j)-Q')}{\sqrt{\sum_{i=0}^{n-1}\sum_{j=0}^{m-1}(P(i,j)-P')^2(Q(i,j)-Q')^2}} \qquad (7)$$

Over single sub-areas in the face images P and Q, the connection is figured. The face images which are available in the database are contrasted and the information face image which is given by the client. At long last whether the match discovered or not will be shown by the framework to the client.

IV. EXPERIMENTAL RESULTS

The FERET database is used to train the system. The experiments were conducted on the face images turned to left and face images turned to right, with differing brightness of the face images.

(a)

(b)

(c)

Figure 2: Dataset of FERET database a) face images with frontal pose b) face images turned to left c) face images turned to right.

Initially face images of 100 different persons from FERET database is collected and the steps mentioned in the figure 1 is carried out. The image pre-procesing, Face detection, location of landmarks, pose and brightness normalization and Face matching steps are carried out for every input image.

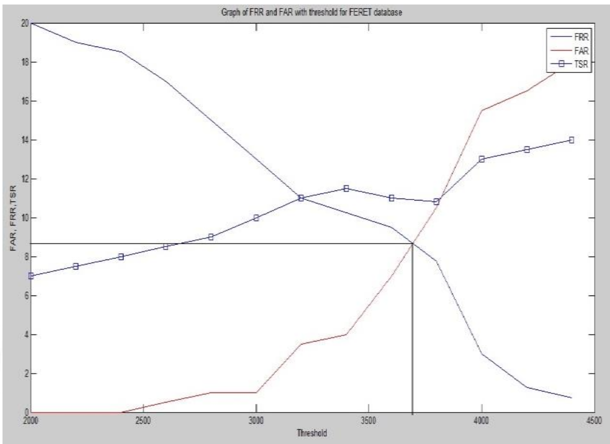

Figure 3: Graph of FRR and FAR with threshold for FERET database

From the graph shown in figure 3, we can infer that an Equal Error Rate (EER) of 8.3% is obtained at a threshold of 3600 for FERET database.

Table 1: Comparision of EER's for FERET database

Database	**Method**		
	PROPOSED IFRSMADPB	**PCA+ LDA[14]**	**PCA and Log-gabor filter [15]**
FERET	8.3%	13%	9.79%

The proposed system has less EER for FERET database when compared to other existing methods as shown in the above table 1.

CONCLUSION

The implemented system uses the model-based algorithm called Extended Active Shape Model (STASM) and pose and brightness normalization procedure, which is robust against varying poses of an input face image. The system is trained using the FERET database, in which different poses of an individual is captured i.e. 45 degree turned to left and to the right. The ERR of the proposed system is less, when compared to the existing approaches such as PCA, ICA and LDA. The future enhancement can be carried out by using the normalized cross correlation for face matching instead of using the matching algorithm. The normalized cross correlation approach is more robust for similarity measure than matching algorithm. The proposed system is tested by taking images from FERET database, in future enhancement the system can be tested using different databases.

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