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FACE RECOGNITION SYSTEM USING HMM-BASED TECHNIQUE WITH SVD PARAMETER

SUNNY SHAHDADPURI[1], BHAGWAT KAKDE[2]
[1]PG Research Scholar, [2]Assistant Professor
Department of Electronics and Communication
R.K.D.F. Institute of Science & Technology, Misrod, Bhopal, India.

SUNNY SHAHDADPURI

BHAGWAT KAKDE

ABSTRACT

An increasingly digital world, reliable personal authentication has become an important human Computer interface activity. National security, e- commerce and have access to a computer network. It is important to establish a person's identity, where some examples. Existing security measures depends on Based knowledge such as passwords, swipe cards or token -based approach and attitude to control access to physical and virtual spaces passport. Universal, such as methods, although very secure. Such as tokens, badges and access cards can be shared or stolen. Passwords and PIN Numbers can be stolen electronically. In addition, they cannot distinguish between authentic have access to or knowledge of the user and tokens.

To make a system more secure and simple with the use of biometric authentication system such as face and hand gesture recognition for personal authentication. In this paper, a new Hidden Markov Model (HMM)-based face recognition system is proposed, having approximately 99% of recognition rate. With using quantized Singular Values Decomposition (SVD) coefficients as features describing blocks of face images.

INTRODUCTION

In an increasingly digital world, reliable personal authentication has become an important human computer interface activity. National security, e-commerce, and access to computer networks are some examples where establishing a person's identity is vital. Existing security measures rely on knowledge-based approaches like passwords or token-based approaches such as swipe cards and passports to control access to physical and virtual spaces. Though ubiquitous, such methods are not very secure. Tokens such as badges and access cards may be shared or stolen. Passwords and PIN numbers may be stolen electronically. Furthermore, they cannot differentiate between authorized user and a person having access to the tokens or knowledge.

Biometrics such as fingerprint, face and voice print offers means of reliable personal authentication that can address these problems and is gaining citizen and government acceptance.

BIOMETRIC

Biometrics is the science of verifying the identity of an individual through physiological measurements or behavioural traits. Since biometric identifiers are associated permanently with the user they are more reliable than token or knowledge based authentication methods. Biometrics offers several advantages over traditional security measures. The various biometric modalities can be broadly categorized as

• **Physical biometrics**: These involve some form of physical measurement and include modalities such as face, fingerprints, iris-scans, hand geometry etc.

• **Behavioral biometrics**: These are usually temporal in nature and involve measuring the way in which a user performs certain tasks. This includes modalities such as speech, signature, gait, keystroke dynamics etc.

• **Chemical biometrics**: This is still a nascent field and involves measuring chemical cues such as odor and the chemical composition of human perspiration.

Figure 1 various biometric modalities: Fingerprints, speech, handwriting, face, hand geometry and chemical biometrics

PROPOSED ALGORITHM FOR IMAGE PROCESSING BASED AUTHENTICATION SYSTEM

Three stages of Authentication:

- Face detection
- Face recognition
- Hand gesture detection and recognition

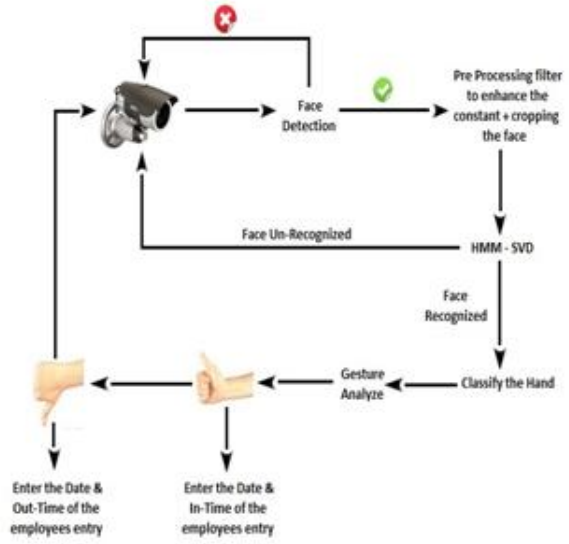

Figure 2 General block diagram of Image Processing based Authentication system.

Project will contain few phases, phase one will be to detect the face, the camera will be set on video streaming once the employee is coming it takes a snapshot after detecting the face, in phase two which will be to extract the features necessary to recognize the face, we are thinking of using Gabor features, phase three will be making the right decision based on a data-base trained models , phase four will make the system say "Welcome to Work Mr…." and then wait for the employee hand gesture, after the gesture was make the system will analyze the hand gesture and enter the date time of the employee entrance.

FACE DETECTION AND FACE RECOGNITION

Face recognition is a biometric approach that employs automated methods to verify or recognize the identity of a living person based on his/her physiological characteristics. In general, a biometric identification system makes use of either physiological characteristics (such as a fingerprint, iris pattern, or face) or behavior patterns (such as hand-writing, voice, or key-stroke pattern) to identify a person. Because of human inherent protectiveness of his/her eyes, some people are reluctant to use eye identification systems. Face recognition has the benefit of being a passive, non intrusive system to verify personal identity in a “natural” and friendly way.

In general, biometric devices can be explained with a three step procedure (1) a sensor takes an observation. The type of sensor and its observation depend on the type of biometric devices used. This observation gives us a “Biometric Signature” of the individual. (2) a computer algorithm “normalizes” the biometric signature so that it is in the same format (size, resolution, view, etc.) as the signatures on the system’s database. The normalization of the biometric signature gives us a “Normalized Signature” of the individual. (3) a matcher compares the normalized signature with the set (or sub-set) of normalized signatures on the system's database and provides a “similarity score” that compares the individual's normalized signature with each signature in the database set (or sub-set).

Face recognition starts with the detection of face patterns in sometimes cluttered scenes, proceeds by normalizing the face images to account for geometrical and illumination changes, possibly using information about the location and appearance of facial landmarks, identifies the faces using

appropriate classification algorithms, and post processes the results using model-based schemes and logistic feedback system.

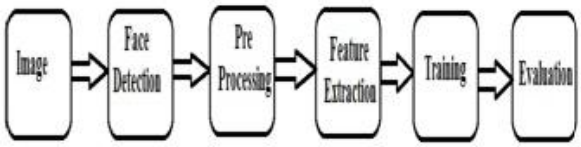

Figure 3 Generic face recognition systems

FACE DETECTION AND CROPPING BLOCK

This is the first stage of any face recognition system and the key difference between a semi-automatic and a fully automatic face recognizer. In order to make the recognition system fully automatic, the detection and extraction of faces from an image should also be automatic. Face detection also represents a very important step before face recognition, because the accuracy of the recognition process is a direct function of the accuracy of the detection process.

PRE-PROCESSING BLOCK

The face image can be treated with a series of pre-processing techniques to minimize the effect of factors that can adversely influence the face recognition algorithm. The most critical of these are facial pose and illumination.

FEATURE EXTRACTION BLOCK

In this step the features used in the recognition phase are computed. These features vary depending on the automatic face recognition system used. For example, the first and most simplistic features used in face recognition were the geometrical relations and distances between important points in a face, and the recognition 'algorithm' matched these distances the most widely used features in face recognition are KL or eigen faces, and the standard recognition 'algorithm' uses either the Euclidian or Mahalanobis distance to match features.

FACE RECOGNITION BLOCK

This consists of 2 separate stages: a training process, where the algorithm is fed samples of the subjects to be learned and a distinct model for each subject is determined; and an evaluation process where a model of a newly acquired test subject is compared against all existing models in the database and the most closely corresponding model is determined. If these are sufficiently close a recognition event is triggered.

As Table 1 shows the proposed system has a recognition rate of 99%, a high rate that can simply be approximated to 100%. The significance of this result is that such a high recognition rate is achieved using HMM+SVD parameter. [6]

Method (Learning algorithm)	**Percentage of Error (%)**
Pseudo 2D HMM + Gray tone	5%
Sliding HMM + Grey tone	13%
PDNN	5%
Eigenface	10%
Gabor filter + rank	9%
EBGM	<20%
Continuous n-tuple classifier	3%
Up-Down HMM + DCT	16%
Markov Random Fields	13%
SVM+PCA	3%
1D HMM+SVD	**1%**

Table 1 Comparative result of different methods

HMM (Hidden Markov Model)

The Hidden Markov Models are stochastic models which provide a high level of flexibility for modeling the structure of an observation sequence. They allow for recovering the (hidden) structure of a sequence of observations by pairing each observation with a (hidden) state. Hidden Markov Models (HMMs) represent a most famous statistical pattern recognition technique and can be considered as the state-of the- art in speech recognition. This is due to their excellent time warping capabilities, their effective self organizing learning capabilities and their ability to perform recognition and segmentation in one single step. They are used not only for speech and handwriting recognition but they are involved in modeling and processing images too. This is the case of their use in the face recognition field.

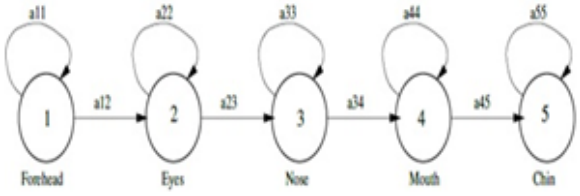

Figure 4 A one dimensional HMM for face recognition

Hidden Markov Models have been successfully used for speech recognition where data

is essentially one dimensional. Extension to a fully connected two dimensional HMM has been shown to be computationally very complex. For frontal face images, the significant facial regions (hair, forehead, eyes, nose, and mouth) come in a natural order from top to bottom, even if the images are taken under small rotations in the image plane and/or rotations in the plane perpendicular to the image plane. Each of these facial regions is assigned to a state in a left to right 1D continuous HMM.

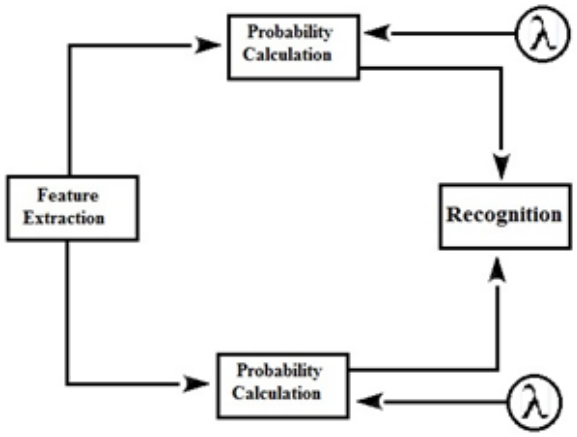

Figure 5 Face recognition

Training and Recognition algorithm

Feature extraction: In the context of face identification problem, we need to make a few image pre-processing; we need transform the face image to a uniform by level and size normalized. Then we need do fractal coding, we change face image in to matrix of fractal code. We looked upon each row of the fractal matrix as a vector. Then take these vectors clustering analysis with K-means algorithm.

SVD (SINGULAR VALUE DECOMPOSITION)

Parameter

The Singular Value Decomposition (SVD) has been an important tool in signal processing and statistical data analysis. Singular values of given data matrix contain information about the noise level, the energy, the rank of the matrix, etc. As singular vectors of a matrix are the span bases of the matrix, and orthonormal, they can exhibit some features of the patterns embedded in the signal. SVD provides a new way for extracting algebraic features from an image. A singular value decomposition of a m×n matrix X is any function of the form:

$X=UWV^T$ (1)

Where U(m×m) and V(m×m) are orthogonal matrix, and W is and m×n diagonal matrix of singular values with components $\sigma_{ij=0,}$ $i \neq j$ and $\sigma_{ii>0.}$ Furthermore, it can be shown that there exist non-unique matrices U and V such that $\sigma_1 \geq \sigma_{2...} \geq 0$. The columns of the orthogonal matrices U and V are called the left and right singular vectors respectively; an important property of U and V is that they are mutually orthogonal.

The main theoretical property of SVD relevant to face image recognition is its stability on face image. Singular values represent algebraic properties of an image. So because of these reasons and some experimental results, we find out that SVD is a robust feature extraction technique for face images.

Method	**% Recognition**	**Training Time per image**	**Recognition Time per image**
PDBNN	96	20min	≤0.1 sec.
n-tuple	86	0.90sec.	0.025 sec.
1DHMM + Wavelet	100	1.13 sec.	0.3 sec.
Pseudo-2D HMM	95	N/A	240 sec.
DCT-HMM	99.5	23.5 sec.	3.5 sec.
1D HMM +SVD	99	0.63 sec.	0.28 sec.

Table2. Comparative recognition results of some of the other methods. [6]

Table 2 shows a comparison of the different face recognition techniques. As we can see our system has a recognition rate of 99% and a low computational cost. Besides these advantages, the system has low memory space consumption because of resizing the face images.

The recognition system works as the algorithm described figure 6.

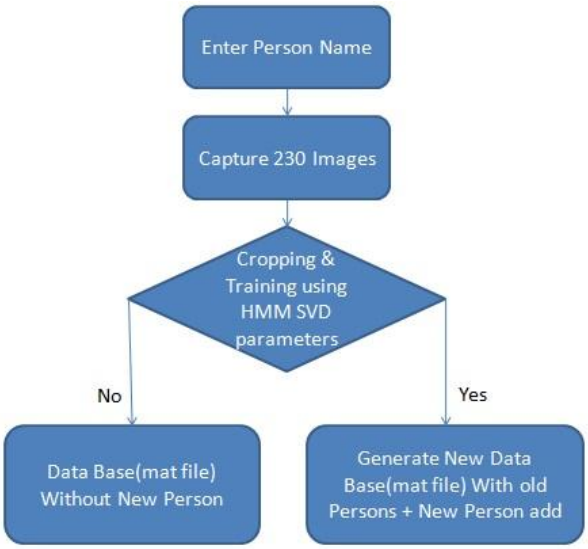

Figure 6 Process algorithm

Whole system for training the person's image is shown below.

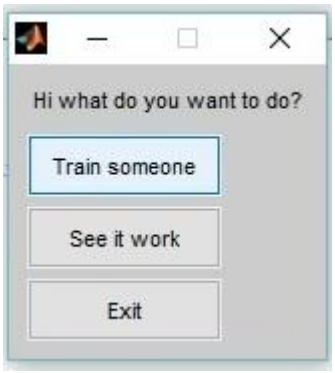

Figure7 Train Person

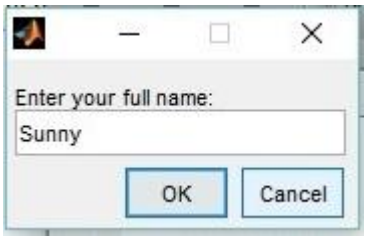

Figure 8 Enter Name of Person

Now it will take up to 230 photographs of different angles of face and ask for train the photographs. This process is shown in figure 9. Here for face detection we use Viloa Jones algorithm. It detects only faces. It will create frame towards face. It only detects face, not recognize.

Figure 9 Image Capturing

Training HMM

Train HMM by use of fact and record each HMM and cluster centers. This training process is conducted using the Baum-Welch algorithm As the detail image norms are real values, a continuous observation HMM is employed. Repeat it until all training-images are trained.

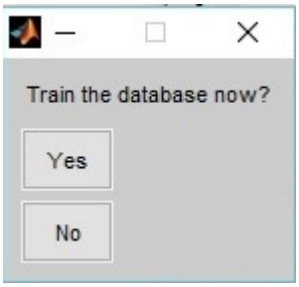

Figure 10 Train Face Images Database

As soon as training of photographs were completed, data base is ready of that employee. And it will show message of training was done. It will save all data in .mat (database file) file.

Figure 11 Training Face Images in MATLAB

Recognition algorithms: Feature extraction: A transform the face image to a uniform by level and size normalized. Then transform the face image to fractal matrix, use the matrix of fractal coding into HMM to calculate the probability. Choose the max matching probability recognition. If all of the matching probability is minor we consider as the face image can't find the matching face in this face database.

The HMM are characterized by two interrelated processes:

1) An unobservable Markov chain with a finite number of states, a state transition probability matrix and an initial state probability distribution.

2) A set of probability density functions for each state.

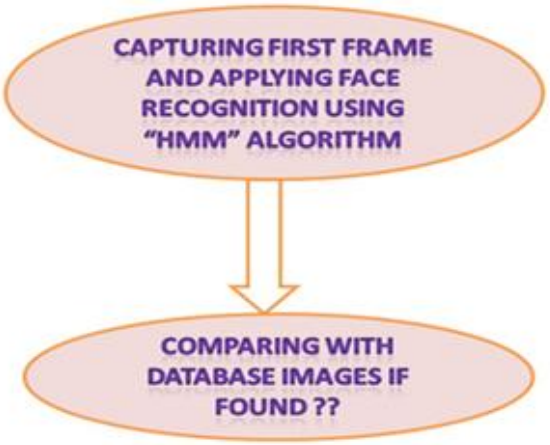

Figure 12 Face Detection and Recognition Process

RESULT

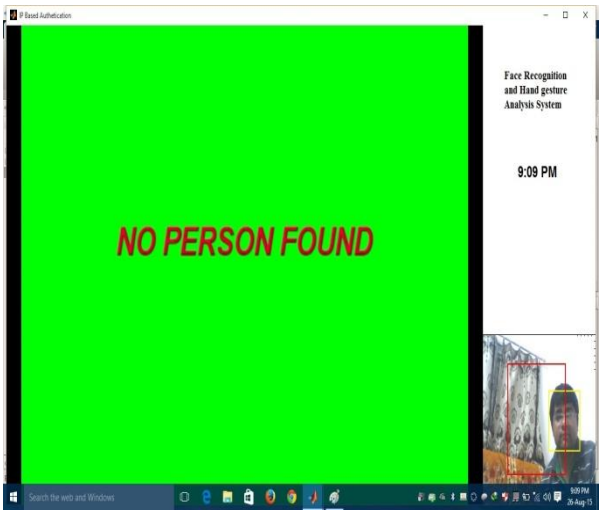

Figure 13 Face Detection and Recognition

The face images of every subject in the database is identified by a HMM face model. A dataset of image vectors representation different instances of the same face image which was trained.

When person will come in default area, camera automatically captures the image of person. If person is outside of default area or in between that it will show "No Person Found".

Here HMM recognize the face of employee & SVD parameter calculate the 5 spot of face using database .mat file and check that image of that person is available in database or not. It will take only 0.28 second. If calculation is perfect and matching with employee image it shows the message on LCD "Welcome to Work Mr..." and automatically one excels sheet will generated with date and entry time.

Figure 14 Person Recognized at IN time

Figure 15 Person Recognized at OUT time

Now at the end of day when employee leaves from office once again whole process is repeated and message will comes on LCD screen "Go Home. Drive safely. Mr…" and it will automatically update that excels sheet with leave time.

And if another person comes in that recognition area who is not employee of the company and whose database is not available in .mat file it will automatically shows message "No Person Found" message on LCD screen.

CONCLUSIONS

An increasingly digital world, security is a main important for personal authentication. Here a fast and efficient system was presented. Images of each face were converted to a sequence of blocks. Each block was featured by a few number of its SVD parameters. Each class has been associated to hidden Markov model as its classifier. In this system, approximately having a recognition rate of 99%, the system was very fast.

To make a system more secure and simple with the use of biometric authentication system such as face and hand gesture recognition for personal authentication. In the future, we will focus on the Hand gesture analysis system.

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