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Face Recognition System Concepts Using Complex Wavelet with Hidden Markov Model

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Abstract: This paper focuses on concept of face identification method, for recognition of individual face image from face database. Face identification method is a means of identifying different faces against several stored pattern faces. It takes image of a human face as input and searches for a match in the stored face images. If there is a match, the user can see the result as the face recognized or not recognized. User cannot generate any kind of modification in the stored image files, i.e. a user is not allowed to insert, delete, update or modify images from the storage data. The administrator of the system has validation to make modifications in the storage data or face image database. The intention of this research is to develop an original, correct and efficient face recognition system. This system concept we uses the wavelet filter to extract the sequence of informative wavelet features from the given facial image. The extracted features are again subjected to form a sequence of feature vectors from an image. Then, the system developed uses the Hidden Markov Model (HMM) to match a test facial image with an accurate reference image. Viterbi algorithm is used to find the highest possibility of the surveillance and analysis order.

Keywords: CWT, HMM,DRT, DT-CWT, ORL, YALE, SPACEK, JAFFE, and FERET.

I. INTRODUCTION

Biometrics consists of strategies for unambiguously recognizing humans, primarily based upon one or additional intrinsic physical or behavioral traits. The word springs from the Greek word bios (life) and metrikos (measure).In technology, particularly, biometrics is employed as a variety of management and access management. It"s additionally used to identify persons in crowd that are in . The biometric need for security systems is going up, hence recognition of a human being every day based on fully automated personal identification and authentication has been attracting extensively over the past two decades. Some of the biometric system applications areas listed below.

1. The biometric systems have a wide range of applications in different areas such as human-computer interaction, image processing, film processing, security applications, computer access control, criminal screening, and surveillance etc.
2. Banking systems.
3. Regular attendance monitoring and authentication of the employees using any of the biometric traits.
4. Airport checking for personal authentication.
5. Home security applications.
6. Electronic voting system.
7. Military force to authenticate refugee. (viii)Using a pre-stored image database, the biometric recognition system is able to verify and authenticate one or more persons in the database.
8. Biometric is one of the major research topics in the current fields such as neural networks, man, and machine intelligence system, robotics and computational vision, computer graphics, image processing and psychological study.

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A bio-metric system will operate within the following two modes:

1. Verification – it"s one to at least one comparison of a captured biometric with a accumulate pattern to verify that the individual is that the one he claims to be. It can be performed with a smart card, username or ID number.
2. Identification – It is one too many comparisons of the captured biometric against a biometric database in an attempt to identify an unknown individual. The identification solely succeeds in distinguishing the individual if the comparison of the biometric sample to a model within the information falls at intervals antecedently set threshold. Figure 1 shows a general block diagram of a biometric system. In enrollment section, the biometric database is enrolled and features are extracted in this section. The enrollment stage performs operations such as preprocessing and feature extraction on database biometrics.

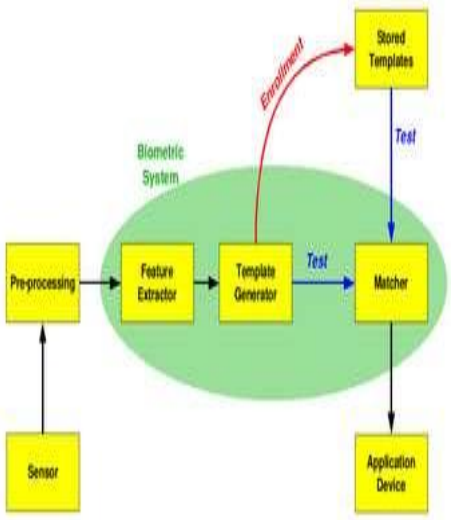

Figure 1: The basic block diagram of a biometric system. (Jain et al., 2008)

In biometrics Face recognition holds an important place. It has recently received attention, especially during the past few years. Face recognition is the process of identifying one or more people in images by analyzing and comparing patterns. Algorithms for face recognition typically extract facial features and compare them to a database to find the best match. Face recognition is a vital a part of several biometric, security, and supervision systems. Face recognition is one among the foremost sure-fire applications of image analysis and understanding. Face recognition is a task that human performs activities and effortlessly in day to day.

In computer vision face recognition extracts info from facial pictures, and pattern recognition to model the looks of faces and to prepare them. We are able to use computer image techniques to perform feature extraction to write in code the discriminative info needed for face recognition. A face recognition system is accepted to spot faces present in images by design. It will operate in two modes

(1) Face verification and

(2) Face identification.

Face verification involves a one to one match that compares a question face image against a model face image whose identity is being claimed. Face identification involves one - to- several matches that compares a question face pictures against all the examples pictures within the information images in the record to decide the identity of the query face. The comparison of the check face sample with a sample in the database falls within a predefined threshold then it succeeds in characteristic a person's face. The face database is created and preprocessed on each face data to device good quality and appropriate image for processing. The feature vectors are extracted from each face data and are developed on whole face database.

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The performance of face recognition system has improved significantly wherever illumination, expression, occlusion etc vary a lot. Face recognition is a visual pattern recognition problem. The faces as an object subject to vary illumination, pose, expression and so on is to be identified on the basis of its two- dimensional image. A face recognition system typically consists of four modules as represented in figure 2: input frame, detection, feature extraction and matching.

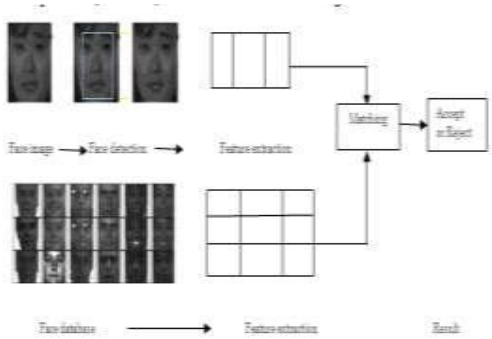

Figure 2: Face recognition process flow.

In this thesis on Face recognition I have used two methods: (1) Complex Wavelet Transform (CWT) and (2) Hidden Markov Model (HMM). A Hidden Markov Model (HMM) is a statistical Markov model in which the system being modeled to be Markov process with unobserved (hidden) states. In a Hidden Markov Model, the states don"t seem to be directly visible, but output, obsessed with the state, is visible. In this thesis Hidden Markov Model is used to match a test facial image with an appropriate reference image and wavelet filter to extract the sequence of informative wavelet features from the given facial image.

It is also shown in this research that the HMM-based system performs better than a typical human being. Existing techniques utilize features that are fundamentally very diverse from those used in this thesis. This is especially the case for the HMM-based system. This means it"s extremely expected that a mixture of any existing system and therefore the HMM-based system developed during this study can end in a superior integrated system (Auckenthaler et al., 2000).

In this thesis, I have concentrated only on static face image verification. Two systems can be used for this purpose, a DTW-based system and an HMM-based system (Auckenthaler et al., 2000). The system is classified into two stages:

1. Face detection.
2. Recognition.

These stages can be further divided into two steps:

1. Features extraction: where main information about data is saved.
2. Features matching: where recognition result is given with the help of an extracted database.

II. SYSTEM DESIGN

A) Proposed Solution

For face detection system, we have used wavelet filter bank for selecting wavelet features for face detection. A small subset of wavelet features are skilled of discriminating from other face images that are stored in the face database. In this thesis, the system developed uses the hidden Markov model (HMM) to match a test facial image with a proper reference image. This face detection system use the Gabor filter to extract the sequence of useful Gabor features from the given facial image. The extracted features are again subjected to discrete Radon transform (DRT) to extract a series of characteristic vectors from an image. The HMM-based system developed in this thesis matches the feature set (observation sequence) for a test image with an HMM of the claimed image, through Viterbi alignment. A distance measure is obtained by calculating negative log likelihood.

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B) System Design

a) Feature Extraction

Facial feature extraction is one of the methods for face recognition. We aim to intend an efficient facial feature illustration by using Dual Tree - Complex Wavelet Transform (DT- CWT). The Complex-WT face characterizes the geometrical structure of facial images by using the properties of DT-CWT such as estimated shift invariance and good directional selectivity. Dual Tree Complex Wavelet Transform along with efficient normalization and noise reduction techniques is developed. Normalization is done using discrete cosine transform and Total variation minimization approach is used as a noise reduction technique. Efficiency of the method is evaluated by FERET and Yale databases. (A Novel Design for Face Recognition System Using Dual Tree Complex Wavelet Transform)

b) Image Modeling

Two different techniques have been used in this system to model a specific facial image. In the case of the DTW-based system, each facial image is modeled by an observation sequence that represents the person most representative training image. This observation sequence acts as a pattern for the image. In the case of the HMM-based system, each facial image is modeled by an HMM of which the states are organized in a ring. HMM based system is developed in this paper. (A Calderon,1964)

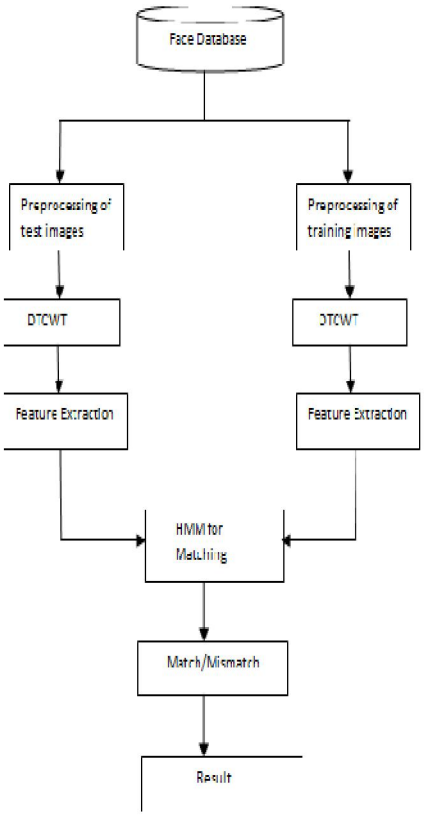

Figure 3: Face Recognition Process Flow

c) Matching

For the purpose of matching the distance between a test image and a model for the claimed image is obtained as follows. The DTW-based system matches the observation sequence for a test image with the observation sequence for the reference (template) image of the claimed facial image, by first aligning these observation sequences in an

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optimal way. This alignment is important to achieve rotation invariance and is discussed in more detail in further chapter. The average of the DTW-based distances between the aligned observations is then calculated. The HMM-based system developed in this thesis matches the feature set (observation sequence) for a test image with an HMM of the claimed image, through Viterbi alignment. A distance measure is obtained by calculating negative log likelihood.

d) Verification

A distance measure is obtained when a claim is made that a test image belongs to a specific person, the extracted observation sequence is first matched with a model of the image. This distance measure is then normalized in order to compensate for the dissimilarity in the facial image. The dissimilarity in the facial image is estimated by matching all of the training images with the image model. In this way several distance measures are obtained. Statistics of these distance measures are then used to estimate the variation in the image training set. A global threshold, that is a threshold which is the same for all images, can therefore be used. Test images, for which the normalized distance calculated is less than this threshold, are accepted – the others are rejected. Figure3 shows the process flow diagram of face recognition.

III. Proposed Method and System Architecture

A) Step Perform to Proposed Method

(a) Re-sizing the image: The size of an image is resized to required size or a Region of Interest (ROI) of an image.

(b) Feature Extraction: The first step in any face recognition system is the extraction of the feature matrix Feature extraction is the process by which the key features of the samples are selected. The process of feature extraction is depending on the set of algorithms. 4-level DT-CWT on LL subband to generate feature has been used.

(3) Output: Match/Mismatch Face Image by using Hidden Markov Model (HMM). Architecture of face recognition system

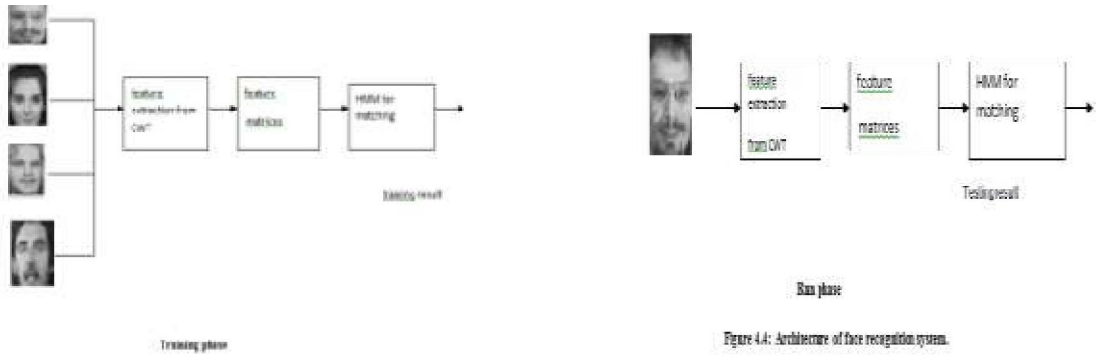

Figure 5: Architecture of face recognition system.

IV. Result

We will use above method using matlab coding in standard face databases (ORL, YALE, SPACEK, JAFFE, and FERET) and also Compare the Recognition Rate of the Proposed Algorithm with Other method

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