

# **Final Project**

**BSCS**

## **Face Recognition Data Sets**

**Submitted to:**

**Mr. Mirza Mubasher baig**

**Submitted by:**

**Majid Latif Sheikh**

**022124-019**

# University of Management & Technology



## DEDICATION

To my loving parents and respected teachers without whom knowledge, wisdom and guidance it would have not been possible.

# ACKNOWLEDGEMENT

First of all I would like to thank Almighty Allah who gave me strength, knowledge and perseverance to undertake and successfully complete this report. Secondly I would like to thank respected resource person **Mr. Mirza Mubasher Baig** for his valuable guidance and brighten our view in this course.

Besides this I would like to thank **Mr. Ilyas Ansari, Mr. Saleem Ata** for their cooperation and guidance.

My special thanks are for respondents who gave me time to take their pictures and those who directly or indirectly helped me to complete my task.

## Table of Contents

<u>Contents</u>	<u>Page Number</u>
Facial Recognition System.....	1
History.....	1
Uses.....	1
Applications.....	2
General Difficulties.....	3
Face Recognition Techniques.....	4
Project Work Scope.....	8
Conclusion.....	9
Reference.....	10

### **Facial Recognition System:**

Facial recognition system is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source.

It is typically used in security systems and can be compared to other biometrics such as fingerprint or eye iris recognition systems.

### **History of Face Recognition:**

The subject of face recognition is as old as computer vision, both because of the practical importance of the topic and theoretical interest from cognitive scientists. Despite the fact that other methods of identification (such as fingerprints, or iris scans) can be more accurate, face recognition has always remains a major focus of research because of its non-invasive nature and because it is people's primary method of person identification.

Perhaps the most famous early example of a face recognition system is due to Kohonen, who demonstrated that a simple neural net could perform face recognition for aligned and normalized face images. The type of network he employed computed a face description by approximating the eigenvectors of the face image's autocorrelation matrix; these eigenvectors are now known as 'eigenfaces.'

Kohonen's system was not a practical success, however, because of the need for precise alignment and normalization. In following years many researchers tried face recognition schemes based on edges, inter-feature distances, and other neural net approaches. While several were successful on small databases of aligned images, none successfully addressed the more realistic problem of large databases where the location and scale of the face is unknown.

Kirby and Sirovich (1989) later introduced an algebraic manipulation which made it easy to directly calculate the eigenfaces, and showed that fewer than 100 were required to accurately code carefully aligned and normalized face images. Turk and Pentland (1991) then demonstrated that the residual error when coding using the eigenfaces could be used both to detect faces in cluttered natural imagery, and to determine the precise location and scale of faces in an image. They then demonstrated that by coupling this method for detecting and localizing faces with the eigenface recognition method, one could achieve reliable, real-time recognition of faces in a minimally constrained environment. This demonstration that simple, real-time pattern recognition techniques could be combined to create a useful system sparked an explosion of interest in the topic of face recognition.

### **Why Use the Face for Recognition:**

Biometric-based techniques have emerged as the most promising option for recognizing individuals in recent years since, instead of authenticating people and granting them access to physical and virtual domains based on passwords, PINs, smart cards, plastic cards, tokens, keys and so forth, these methods examine an individual's physiological and/or behavioral characteristics in order to determine and/or ascertain his identity. Passwords and PINs are hard to remember and can be stolen or guessed; cards, tokens, keys and the like can be misplaced, forgotten, purloined or duplicated; magnetic cards can become corrupted and unreadable.

However, an individual's biological traits cannot be misplaced, forgotten, stolen or forged. Biometric-based technologies include identification based on physiological characteristics (such as face, fingerprints, finger geometry, hand geometry, hand veins, palm, iris, retina, ear and voice) and behavioral traits (such as gait, signature and keystroke dynamics). Face recognition appears to offer several advantages over other biometric methods, a few of which are outlined here: Almost all these technologies require some voluntary action by the user, i.e., the user needs to place his hand on a hand-rest for fingerprinting or hand geometry detection and has to stand in a fixed position in front of a camera for iris or retina identification.

However, face recognition can be done passively without any explicit action or participation on the part of the user since face images can be acquired from a distance by a camera. This is particularly beneficial for security and surveillance purposes. Furthermore, data acquisition in general is fraught with problems for other biometrics: techniques that rely on hands and fingers can be rendered useless if the epidermis tissue is damaged in some way (i.e., bruised or cracked). Iris and retina identification require expensive equipment and are much too sensitive to any body motion. Voice recognition is susceptible to background noises in public places and auditory fluctuations on a phone line or tape recording. Signatures can be modified or forged.

However, facial images can be easily obtained with a couple of inexpensive fixed cameras. Good face recognition algorithms and appropriate preprocessing of the images can compensate for

noise and slight variations in orientation, scale and illumination. Finally, technologies that require multiple individuals to use the same equipment to capture their biological characteristics potentially expose the user to the transmission of germs and impurities from other users. However, face recognition is totally non-intrusive and does not carry any such health risks.

## **Applications:**

Face recognition is used for two primary tasks:

1. Verification (one-to-one matching): When presented with a face image of an unknown individual along with a claim of identity, ascertaining whether the individual is who he/she claims to be.
2. Identification (one-to-many matching): Given an image of an unknown individual, determining that Person's identity by comparing (possibly after encoding) that image with a database of (possibly encoded) images of known individuals.

There are numerous application areas in which face recognition can be exploited for these two purposes, a few of which are outlined below.

- Security (access control to buildings, airports/seaports, ATM machines and border checkpoints, computer/network security, email authentication on multimedia workstations).
- Surveillance (a large number of CCTVs can be monitored to look for known criminals, drug offenders, etc. and authorities can be notified when one is located; for example, this procedure was used at the Super Bowl 2001 game at Tampa, Florida, in another instance, according to a CNN report, two cameras linked to state and national databases of sex offenders, missing children and alleged abductors have been installed recently at Royal Palm Middle School in Phoenix, Arizona).
- General identity verification (electoral registration, banking, electronic commerce, identifying newborns, national IDs, passports, drivers' licenses, employee IDs).
- Criminal justice systems (mug-shot/booking systems, post-event analysis, forensics).
- Image database investigations (searching image databases of licensed drivers, benefit recipients, missing children, immigrants and police bookings).
- "Smart Card" applications (in lieu of maintaining a database of facial images, the face-print can be stored in a smart card, bar code or magnetic stripe, authentication of which is performed by matching the live image and the stored template) .
- Multi-media environments with adaptive humancomputer interfaces (part of ubiquitous or context ware systems, behavior monitoring at childcare or old people's centers, recognizing a customer and assessing his needs).

- Video indexing (labeling faces in video).
- Witness face reconstruction.

In addition to these applications, the underlying techniques in the current face recognition technology have also been modified and used for related applications such as gender classification, expression recognition and facial feature recognition and tracking. Each of these has its utility in various domains: for instance, expression recognition can be utilized in the field of medicine for intensive care monitoring while facial feature recognition and detection can be exploited for tracking a vehicle driver's eyes and thus monitoring his fatigue, as well as for stress detection.

Face recognition is also being used in conjunction with other biometrics such as speech, iris, fingerprint, ear and gait recognition in order to enhance the recognition performance of these methods.

## General Difficulties

Face recognition is a specific and hard case of object recognition. The difficulty of this problem stems from the fact that in their most common form (i.e., the frontal view) faces appear to be roughly alike and the differences between them are quite subtle. Consequently, frontal face images form a very dense cluster in image space which makes it virtually impossible for traditional pattern recognition techniques to accurately discriminate among them with a high degree of success.

Furthermore, the human face is not a unique, rigid object. Indeed, there are numerous factors that cause the appearance of the face to vary. The sources of variation in the facial appearance can be categorized into two groups:

1. **Intrinsic factors:** are due purely to the physical nature of the face and are independent of the observer. These factors can be further divided into two classes: intrapersonal and interpersonal;
  - a. Intrapersonal factors are responsible for varying the facial appearance of the same person, some examples being age, facial expression and facial paraphernalia (facial hair, glasses, cosmetics, etc.).
  - b. Interpersonal factors, however, are responsible for the differences in the facial appearance of different people, some examples being ethnicity and gender.
2. **Extrinsic factors** cause the appearance of the face to alter via the interaction of light with the face and the observer. These factors include illumination, pose, scale and imaging parameters (e.g., resolution, focus, imaging, noise, etc.).

## Face Recognition Techniques

The method for acquiring face images depends upon the underlying application. For instance, surveillance applications may best be served by capturing face images by means of a video

camera while image database investigations may require static intensity images taken by a standard camera. Some other applications, such as access to top security domains, may even necessitate the forgoing of the nonintrusive quality of face recognition by requiring the user to stand in front of a 3D scanner or an infra-red sensor. Therefore, depending on the face data acquisition methodology, face recognition techniques can be broadly divided into following categories:

**1. Face Recognition from Intensity Images**

- a. Featured Based
- b. Holistic
  - i. Statistical
  - ii. AI
- c. Multiple Classifier System

**2. Face Recognition from Video Sequences**

**3. Face Recognition from other Sensory Inputs**

- a. 3D Model Based
- b. Infra Red

The following discussion sheds some light on the methods in each category and attempts to give an idea of some of the benefits and drawbacks of the schemes mentioned therein in general.

## **Face Recognition from Intensity Images**

Face recognition methods for intensity images fall into two main categories: feature-based and holistic. An overview of some of the well-known methods in these categories is given below.

### **Featured-based**

Feature-based approaches first process the input image to identify and extract (and measure) distinctive facial features such as the eyes, mouth, nose, etc., as well as other fiducial marks, and then compute the geometric relationships among those facial points, thus reducing the input facial image to a vector of geometric features. Standard statistical pattern recognition techniques are then employed to match faces using these measurements. Early work carried out on automated face recognition was mostly based on these techniques.

### **Advantages and Disadvantages:**

The main advantage offered by the featured-based techniques is that since the extraction of the feature points precedes the analysis done for matching the image to that of a known individual, such methods are relatively robust to position variations in the input image. In principle, feature-based schemes can be made invariant to size, orientation and/or lighting. Other benefits of these schemes include the compactness of representation of the face images and high speed matching.

The major disadvantage of these approaches is the difficulty of automatic feature detection and the fact that the implementer of any of these techniques has to make arbitrary decisions about which features are important. After all, if the feature set lacks discrimination ability, no amount of subsequent processing can compensate for that intrinsic deficiency.

### **Holistic**

Holistic approaches attempt to identify faces using global representations, i.e., descriptions based on the entire image rather than on local features of the face. These schemes can be subdivided into two groups: statistical and AI approaches. An overview of some of the methods in these categories follows.

### **Statistical**

In the simplest version of the holistic approaches, the image is represented as a 2D array of intensity values and recognition is performed by direct correlation comparisons between the input face and all the other faces in

the database. Though this approach has been shown to work under limited circumstances (i.e., equal illumination, scale, pose, etc.), it is computationally very expensive and suffers from the usual shortcomings of straightforward correlation-based approaches, such as sensitivity to face orientation, size, variable lighting conditions, background clutter, and noise.

## **AI Approach**

AI approaches utilize tools such as neural networks and machine learning techniques to recognize faces.

## **Multiple Classifier Systems**

Since the performance of any classifier is more sensitive to some factors and relatively invariant to others, a recent trend has been to combine individual classifiers in order to integrate their complementary information and thereby create a system that is more robust than any individual classifier to variables that complicate the recognition task. Such systems have been termed as multiple classifier systems (MCSs) and are a very active research area at present.

## **Advantages and Disadvantages**

The main advantage of the holistic approaches is that they do not destroy any of the information in the images by concentrating on only limited regions or points of interest. However, as mentioned above, this same property is their greatest drawback, too, since most of these approaches start out with the basic assumption that all the pixels in the image are equally important. Consequently, these techniques are not only computationally expensive but require a high degree of correlation between the test and training images, and do not perform effectively under large variations in pose, scale and illumination, etc. Nevertheless, as mentioned in the above review, several of these algorithms have been modified and/or enhanced to compensate for such variations, and dimensionality reduction techniques have been exploited (note that even though such techniques increase generalization capabilities, the downside is that they may potentially cause the loss of discriminative information), as a result of which these approaches appear to produce better recognition results than the feature-based ones in general.

In the latest comprehensive FERET evaluation, the probabilistic eigenface, the Fisherface and the EBGGM methods were ranked as the best three techniques for face recognition (Even though the EBGGM method is feature-based in general, its success depends on its application of holistic neural network methods at the feature level).

## **Face Recognition from Video Sequence:**

Since one of the major applications of face recognition is surveillance for security purposes, which involves realtime recognition of faces from an image sequence captured by a video camera, a significant amount of research has been directed towards this area in recent years. A video-based face recognition system typically consists of three modules: one for detecting the face; a second one for tracking it; and a third one for recognizing it. Most of these systems choose a few good frames and then apply one of the recognition techniques for intensity images to those frames in order to identify the individual.

## **Advantages and Disadvantages**

Dynamic face recognition schemes appear to be at a disadvantage relative to their static counterparts in general, since they are usually hampered by one or more of the following: low quality images (though image quality may be enhanced by exploiting super-resolution techniques); cluttered backgrounds (which complicate face detection); the presence of more than one face in the picture; and a large amount of data to process. Furthermore, the face image may be much smaller than the size required by most systems employed by the recognition modules.

However, dynamic schemes do have the following advantages over static techniques: the enormous abundance of data empowers the system to choose the frame with the best possible image and discard less satisfactory ones. Video provides temporal continuity, so classification information from several frames can be combined to improve recognition performance.

Moreover, video allows the tracking of face images such that variations in facial expressions and poses can be compensated for, resulting in improved recognition. Dynamic schemes also have an edge over static ones when it comes to detecting the face in a scene, since these schemes can use motion to segment a moving person's face.

## **Face Recognition from Other Sensory Inputs**

Though the bulk of the research on face recognition has been focused on identifying individuals from 2D intensity images, in recent years some attention has nevertheless been directed towards exploiting other sensing modalities, such as 3D or range data and infra-red imagery, for this purpose.

### **3D Model-based**

The main argument in favor of using 3D information for face recognition appears to be that it allows us to exploit features based on the shape and the curvature of the face (such as the shape of the forehead, jaw line, and cheeks) without being plagued by the variances caused by lighting, orientation and background clutter that affect 2D systems. Another argument for the use of depth data is that "at our current state of technology, it is the most straightforward way to input or record

complex shape information for machine analysis". The obvious drawbacks of such approaches are their complexity and computational cost.

### **Infra-red**

Since thermal infra-red imagery of faces is relatively insensitive to variations in lighting, such images can hence be used as an option for detecting and recognizing faces. Furthermore, argues that since infra-red facial images reveal the vein and tissue structure of the face which is unique to each individual (like a fingerprint), some of the face recognition techniques for the visible spectrum should therefore yield favorable results when applied to these images.