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# Face Recognition Using Image Processing Techniques: A Survey

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**ABSTRACT**

Face detection is becoming one of the most interesting topics in the computer vision literature. The survey is conducted to analyze the face recognition techniques and timeline view on different methods to handle general face recognition problems. Image processing techniques focuses on two major tasks such as Improvement of pictorial information for human interpretation and processing of image data for storage, transmission and representation for autonomous machine perception. One of the common fundamental techniques that facilitate natural human-computer interaction (HCI) is face detection. In this paper, the survey is made based on a comparison of the recent advances in face detection using various image processing techniques such as Eigen faces, Hidden Markov Model(HMM), Geometric based algorithm and template matching algorithms. These techniques improve quality, removes noise, versatile in nature, and preserves original data precision of the image.

**Index Terms:** Face recognition, image processing, Eigen faces, Hidden Markov Model (HMM), geometric based algorithm, template matching algorithm.

## 1.Introduction

With the rapid growth of computational powers and accessibility of modern intellect, analysis and rendering tools and technologies, computers are becoming more and more intellectual. Face detection is the step stone to all facial analysis algorithms, including face alignment, face modeling, face relighting, face recognition, face verification/authentication, head pose tracking, facial expression tracking/recognition, gender/age recognition, etc. Image processing techniques in face recognition are used to enhance raw images received from cameras/sensors placed on satellites, space probes and aircrafts or pictures taken in normal day-to-day life for various applications. Most of the image processing techniques developed so far are mainly for enhancing images obtained from unmanned

spacecrafts, space probes and military reconnaissance flights. Image Processing systems are becoming more popular due to the easy availability of powerful personnel computers, large size memory devices, graphics software etc.

Given an arbitrary image, the aim of face detection is to find out whether or not there are any faces in the image and, if present, return the image location and scope of each face [2]. The obscurity associated with face detection can be attributed to many variations in scale, location, orientation (in-plane rotation), pose (out-of-plane rotation), facial expression, lighting conditions, and occlusions.

**1. Review of Literature**

The idea of using principal components to represent human faces was developed by Sirovich and Kirby [4] (Sirovich and Kirby 1987) and used by Turk and Pentland [5] (Turk and Pentland 1991) for face detection and recognition. Rectangular ratio is used to decide face region, mouth and eye map [6] is applied for confirmation of face. Literature studies reveal that faces can be recognized in a restricted environment with high accuracy [7, 8].

**2. Overview of face recognition methods**

We discuss and compare the different face recognition methods such as Eigen faces (or Eigen features), Hidden Markov Model (HMM), geometric based and template matching algorithms. By comparing their results, these algorithms are evaluated based on their performance.

**Eigen Faces**

Eigenfaces[3] are a set of eigenvectors used in the computer vision problem of human face recognition. Specifically, the Eigenfaces are the principal components of a distribution of faces, or equivalently, the eigenvectors of the covariance matrix of the set of face images, where an image with N x N Pixels is considered a point (or vector) in N2-dimensional space. Mathematically, it is simply finding the principal components of the distribution of faces, or the eigenvectors of the covariance matrix of the set of face images, treating an image as a point or a vector in a very high dimensional space. The eigenvectors are ordered, each one accounting for a different amount of the variations among the face images. These eigenvectors can be imagined as a set of features that together characterize the variation between face images. Each image locations contribute more or less to each eigenvector, so that we can display the eigenvector as a sort if "shadowy" face which we call an eigen face.Eigen face algorithm falls under two stages.

**Eigenfaces Initialization**

Step 1: Acquire an initial set of face images (the training set)

Step 2: Calculate the eigenfaces from the training set, keeping only the M images that correspond to the highest eigenvalues. These M images define the face space. As new faces are experienced, the eigenfaces can be updated or recalculated

Step 3: Calculate the corresponding distribution in M-dimensional weight space for each known individual, by projecting their face images onto the "face space."

**Eigenfaces Recognition**

Step 1: Calculate a set of weights based on the input image and the M eigenfaces by projecting the input image onto each of the eigenfaces.

Step 2: Determine if the image is a face at all by checking to see if the image is sufficiently close to "face space."

Step 3: If it is a face, classify the weight pattern as either a known person or as unknown.

Step 4: (Optional) Update the eigenfaces and/or weight patterns.

**Hidden Markov Model (HMM)**

In HMM-based face recognition system[3], in which a scanning strategy is employed to simulate a human-like saccadic sequence, computed on the basis of the concept of saliency. The approach converts a face image into an attention based "scan path," that is, a sequence composed of two types of information: Where information, the coordinates of the salient region in the face, and What information, local features detected in there. At the core of the scanning mechanism is the calculation of saliency. This calculation should be cheap enough that it can be applied to the whole image without significantly increasing time and space requirements, and it should be informative. With this approach, a cheap and parallel search for salient features will drive a serial and detailed analysis. The main advantage of the HMMs is that the models for each person are build independently. So every time we want to add a new person to the collection we just have to add a new model without modifying the other models.

**Geometric based Algorithm**

This is the historical way to recognize people. Geometric features can be generated by segments, perimeters and areas of some figures formed by the points. In this algorithm, facial image is initially analyzed and reduced to small set of parameters describing prominent facial features such as eyes, nose, mouth and cheekbone curvature. These features are then matched to a database. The featured set is studied to compare the recognition result. Distances in the feature space from a template image to every image in the database were calculated. Following to the FERET protocol, 5 nearest face images were derived and if there were photos of the query person then the result was considered positive. Each image was tested as a query and compared with others. The approach was robust, but it main problem is automatic point location. Some problem arises if image is of bad quality or several points are covered by hair. The major advantage of using this algorithm is that the recognition task *is not* very expensive. But, the image processing required here *is* very expensive and parameter selection must be unambiguous to match an individual's face, which becomes a major disadvantage.

**Template Matching Algorithm**

It is a statistical approach that distills an image into values and compares the values with templates to eliminate variances. It relies on the input image in the presence of light and the geometric location of different angles. The photometric transformation is implemented on the source image, does not take into account photometric changes, i.e. changes in the pixel. The main restriction in this approach is that multiple registered images of the same person is required. Since it recognizes the new image by checking that it is spanned in a linear subspace of the

multiple gallery images, it cannot handle the new images of a different person which is not included in the gallery set.

## 3. Factors affecting Face Recognition

Though all these face recognition methods solves the face recognition problem, there are some factors that affect or degrade the performance of face recognition. The reason behind these factors is in real life situation where the person's face is not always neutral (expression full). The factors affecting face recognition include expressions, occlusion, pose, illumination, facial ageing, and others.

**Facial expression:** Facial expression poses a nonlinear structure in face recognition tasks. By nature every person has expressions on his/her face used for non verbal communication. Facial expression causes a change in both transient and intransient facial features which is a form of local and global features of the face. To solve this issue, motion based, model based and muscles based algorithms are used by various researchers.

**Partial occlusion:** Partial occlusion is basically a hindrance in the view of an object. Concerning face recognition systems people cheat the implemented security systems by intentionally covering their face with hand, sunglasses or scarf etc. A graphical representation of above factors is handled. To solve this issue, part based, feature based and fractals based methods are used by various researchers.

**Pose variation:** Another more challenging case is varying head orientation of subject that varies from 90 degree to 45 or even 60-degree rotation. Feature extraction seems to be a more challenging task in this issue. When the faces are in depth rotated, geometrical normalization becomes practically impossible. To handle this issue, appearance based approaches, geometric model based algorithms, and multi view based algorithms are used by different authors.

**Illumination conditions:** Illumination greatly affects the performance of face recognition systems. Varying lighting factors cast a shadow on the face images hence making the recognition process a challenging case. Many approaches are used to solve this issue suggested by different researchers are not practical in real life situations.

**Facial aging:** Facial aging cause texture and shape changes which ultimately effect the performance of face recognition systems. Physically facial aging creates wrinkles which can also affect 3D model of the face for face recognition.

A lucrative solution to all these issues can be obtained by various Image processing techniques discussed here under.

## 4. Brief note on Image Processing

Image processing techniques in face recognition can be used to enhance raw images.

**Steps in image processing**

The various stages in image processing includes

- Image scanning
- Storing
- Enhancing
- Interpretation

**Methods of Image Processing**

There are two methods of image processing.

- Analog Image Processing
- Digital Image Processing

**Analog Image Processing**

Analog Image Processing refers to the adjustment of image through electrical means. The most popular example is the television image.

The television signal is a voltage level which varies in amplitude to represent brightness through the image. By electrically varying the signal, the displayed image appearance can be altered. The brightness and contrast controls on a TV set serve to adjust the amplitude and reference of the video signal, resulting in the brightening, darkening and alteration of the brightness range of the displayed image.

**Digital Image Processing**

In this method, digital computers are used to process the image. The image will be converted to digital form using a scanner – digitizer [6] and then process it. It is defined as the subjecting numerical representations of objects to a series of operations in order to obtain a desired result. It starts with one image and produces a modified version of the same. It is therefore a process that takes an image into another.

**Applications of Image Processing**

Image processing application areas include remote sensing, medical imaging, Non-destructive evaluation, forensic studies, textiles, material science, military, film industry, document processing, graphic arts, printing industry.

**Image Processing Techniques**

- Image Acquisition
- Image enhancement
- Image restoration
- Morphological Processing
- Segmentation
- Object Recognition
- Representation & Description
- Image Compression
- Color Image Processing

**Image Acquisition**

Image Acquisition is the action of retrieving an image from hardware based source, so that it can be passed through the processes in future. In this step, an image that is acquired is completely unprocessed and is the result of the respective hardware that was used to generate it. Here, the input operates within controlled and measured guidelines.

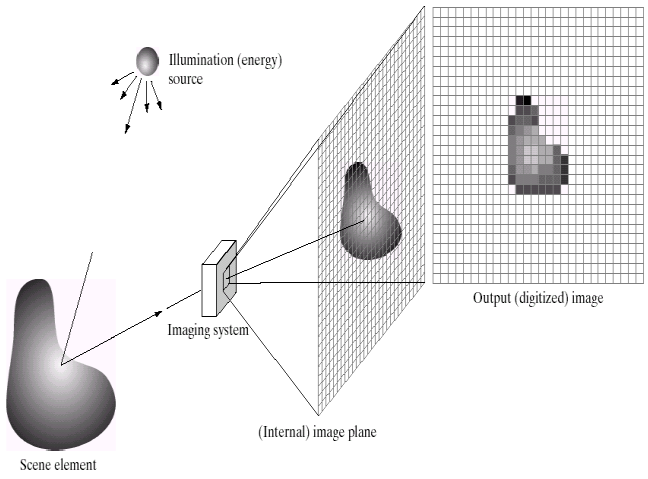
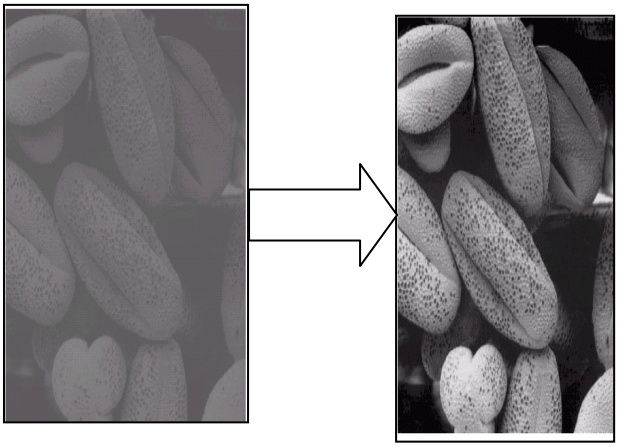
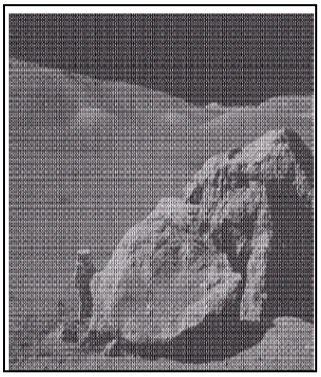


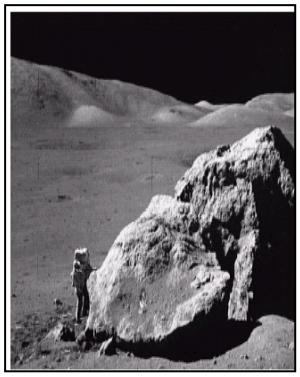

**Image enhancement**



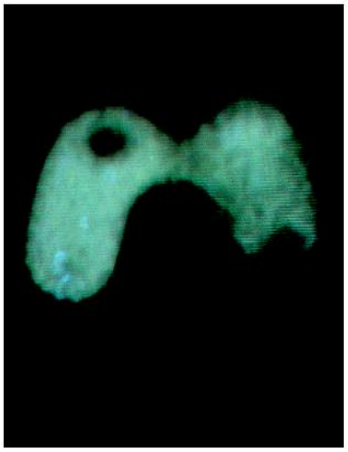
**Segmentation**

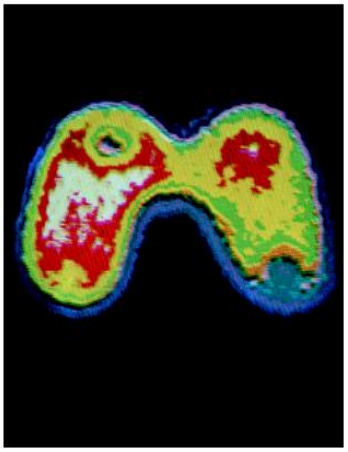
**Image restoration**



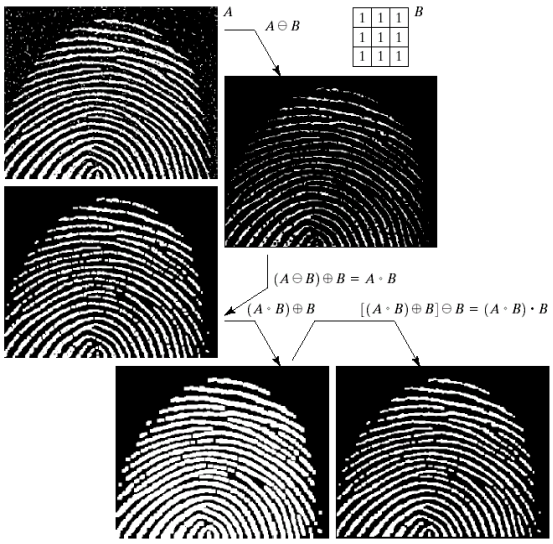


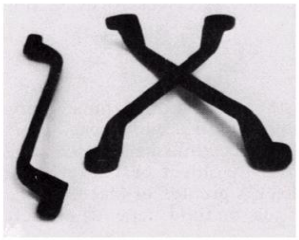
**Object Recognition**

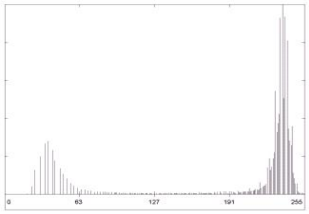


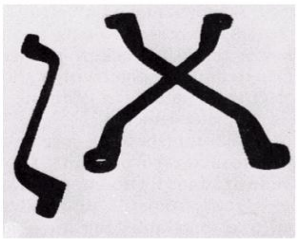


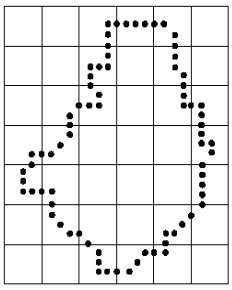
**Morphological Processing**

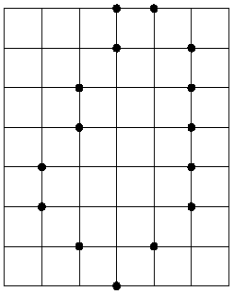


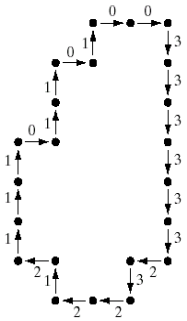



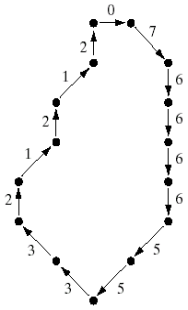




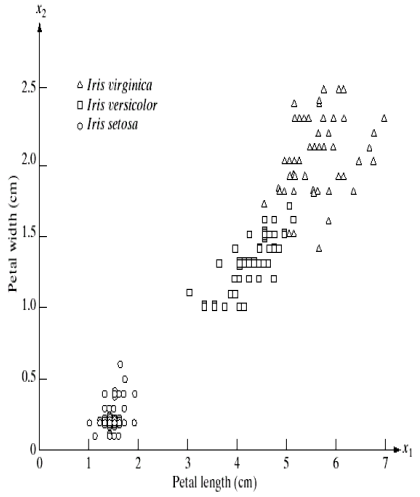






**Representation&Description**

**ImageCompression**




**Color Image Processing**

## 5.Conclusion

In this paper, we surveyed the various face recognition methods and issues faced in real life and how to overcome these issues that can be solved using various image processing techniques and their advantages. To handle issues such as facial ageing, pose, occlusion, etc. different techniques are used independently. In order to develop a high performing face recognition system, integrated approach seems to be a better choice.

## 5. Scope for future Enhancement

Face detection in completely unconstrained settings remains a very challenging task, particularly due to the significant pose and lighting variations. Enhancement in learning algorithms and features can be made in the feature to bring out the best possible outcome.

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