ISSN:2348 9510
International Journal Of Core Engineering & Management(IJCEM)
Volume 1, Issue 2, May 2014

# Image–Based Face Detection and Recognition using MATLAB

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***Abstract***- Face detection is a computer technology that determines the locations and sizes of human faces in arbitrary images. It detects facial features and ignores anything else, such as buildings, trees and bodies. We have implemented an efficient system to recognize faces from images with some near real-time variations. Our approach essentially was to implement and verify the algorithm. This method consist on weighting the difference between a given face image and a mean image, which is obtained by averaging a predefined set of faces. The training set is a group of face images from which the mean face is calculated. Face detection takes place by linearly projecting the image to a low dimensional image space and weighting the difference with respect to a set of eigenvectors.

***Keywords***— Circular Hough Transform, Covariance matrix, Eigenvalues, Elliptical Hough Transform, Face segmentation, Raster
Scan Algorithm.

## I. INTRODUCTION

Face detection is used in biometrics, often as a part of (or together with) a facial recognition system. It is also used in video surveillance, human computer interface and image database management. Some recent digital cameras use face detection for auto focus. Face detection can be applied for a wide variety of problems like image and film processing, human-computer interaction, criminal identification etc. This has motivated researchers to develop computational models to identify the faces, which are relatively simple and easy to implement. Our goal is to implement the model for a set of training images and find a mean image of all the images so as to compute the difference between it and the input image for proper detection.

"Facial recognition is a form of computer vision that uses faces to identify a person or verify a person's claimed identity". A **facial recognition** *device* is one that views an image or video of a person and compares it to one that is in the database. It does this by comparing structure, shape and proportions of the face; distance between the eyes, nose, mouth and jaw; upper outlines of the eye sockets; the sides of the mouth; location of the nose and eyes; and the area surrounding the check bones.

Upon enrolment in a **facial recognition** program, several pictures are taken of the subject at different angles and with different facial expressions. At time of verification and identification the subject stands in front of the camera for a few seconds, and then the image is compared to those that have been previously recorded. A 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. One of the ways to do this is by comparing selected facial features from the image and a facial database.

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

To prevent a subject from using a picture or mask when being scanned in a **facial recognition** program, some security measures have been put into place. When the user is being scanned, they may be asked to blink, smile *or* nod their head. Another security feature would be the use of facial thermograph to record the heat in the face.

The main **facial recognition** methods are:
**Feature analysis, neural network, eigenfaces, automatic face processing.**

Some facial recognition software algorithms identify faces by extracting features from an image of a subject's face. Other algorithms normalize a gallery of face images and then compress the face data, only saving the data in the image that can be used for facial recognition. A probe image is then compared with the face data.
A fairly new method on the market is three-dimensional **facial recognition**. This method uses 3-D sensors to capture information about the shape of a face. This information is

ISSN:2348 9510
International Journal Of Core Engineering & Management(IJCEM)
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then used to identify distinctive features on the face, such as the contour of eye sockets, nose and chin.

The advantages of 3-D facial recognition are that it is not affected by changes in lighting, and it can identify a face from a variety of angles, including profile view.

Another new technique in **facial recognition** uses the visual details of the skin, as captured in standard digital or scanned images. This technique is called skin texture analysis, turns the unique lines, patterns, and spots apparent in a person's skin into a mathematical space. Preliminary tests have shown that using skin texture analysis in facial recognition can increase performance in identification by 20 to 25 percent.

Regardless of specific method used, the facial recognition is accomplished in a five step process-

***(Step 1) Acquiring the Image of an Individuals Face***

2 ways to acquire image

1) Digitally scan an existing photograph

2) Acquire a live picture of a subject

***(Step 2) Locate Image of Face***

MATLAB (image processing toolbox)is used to locate the image that has been used.

**(Step 3)Analysis of Facial Image**

-software measures face according to is peaks and valleys (nodal points)

-nodal points are used to make a face print

**(Step 4) Comparison**

-the face print created by the software is compared to all face prints the system has stored in its database.

**(Step 5)-Match Or No Match**

-software decides whether or not any comparisons from step 4 are close enough to declare a possible match

**FACE RECOGNITION TECHNOLOGY WITH EIGEN VALUES**

**1. Eigenfaces Initialization**

Acquire an initial set of face images (the training set)

**2. Eigenfaces Algorithm**

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

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

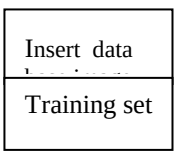
In this project we will make the program to identify the face or any image using MATLAB. In this there will be photographs in our database. Software will check the photo graph we want to check is in database or not. If not then it will display image is not in database. If yes then it will display, image is available in database.

Previous mathematicians have theorized that certain cognitive processes, such as face recognition, can be emulated through the use of principal component analysis. we have attempted to use techniques of principal component analysis, more specifically, eigen-vector analysis, to develop a computer program capable of face recognition. Specifically, the goal of our project was to investigate a mathematical basis and model for face recognition using principal component analysis with eigenvectors, and then implement a working model in the form of a computer program.

The fundamental idea behind principal component analysis with eigenvectors has its basis in linear algebra. Put simply, if there are a series of multi-dimensional vectors representing objects which have similarities, it is possible to use a transformation matrix and eigenvectors to orient a space which requires fewer dimensions to accurately describe these multidimensional vectors.

For instance, if in three dimensional space, there was a cloud of particles that lied in a two dimensional plane skewed from the axes (Fig 1), it would be possible to orient a new space with a new origin and new unit vectors such that the cloud which previously required a three dimensional representation could now easily be represented in only two dimensions.

**FLOW DIAGRAM**



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| |
|---|
| Normalized the training set |
| Taking mean image |
| Getting eigen faces |
| Giving input |

***STEPS***

1. The first step is to obtain a set S with M face images. Each image is transformed into a vector of size N and placed into the set.
2. After you have obtained your set, you will obtain the mean image Ψ
3. Then you will find the difference Φ between the input image and the mean image
4. Next we seek a set of M ortho normal vectors, $u_n$, which best describes the distribution of the data. The $k^{th}$ vector, $u_k$, is chosen such that is a maximum, subject to

Note: $u_k$ and $\lambda_k$ are the eigenvectors and eigenvalues of the covariance matrix C

We obtain the covariance matrix C in the following manner

5. $A^T$
6. Now we have to find the eigenvectors, $v_l$, $u_l$

**RECOGNITION PROCEDURE**

1. A new face is transformed into its Eigen face components. First we compare our input image with our mean image and multiply their difference with each eigenvector of the L matrix. Each value would represent a weight and would be saved on a vector Ω.

2. We now determine which face class provides the best description for the input image. This is done by minimizing the Euclidean distance

3. The input face is considered to belong to a class if $\varepsilon_k$ is bellow an established threshold $\theta_\varepsilon$. Then the face image is considered to be a known face. If the difference is above the given threshold, but bellow a second threshold, the image can be determined as a unknown face. If the input image is above these two thresholds, the image is determined NOT to be a face.

4. If the image is found to be an unknown face, you could decide whether or not you want to add the image to your training set for future recognitions. You would have to repeat steps 1 trough 7 to incorporate this new face image.

TWO MAIN USES
1) IDENTFICATION
-figure out "Who is X?"
-accomplished by system performing a "one-to-many" search

2) VERIFICATION
-answer the question "Is this X?"
-accomplished by the system performing a "one-to-one" search

***BENEFITS***

The benefits of facial recognition are that it is not intrusive, can be done from a distance even without the user being aware they are being scanned. (i.e.: bank or government office)

What sets apart **facial recognition** from other biometric techniques is that it can be used for surveillance purposes; as in searching for wanted criminals, suspected terrorists, and missing children. Facial recognition can be done from far away so with no contact with the subject so they are unaware they are being scanned.

**Facial recognition** is most beneficial to use for facial authentication than for identification purposes, as it is too easy for someone to alter their face, features with a disguise or mask, etc. Environment is also a consideration as well as subject motion and focus on the camera.

Facial recognition, when used in combination with another biometric method, can improve verification and identification results dramatically.

***APPLICATION DOMAIN***

As one of the most successful applications of image analysis and understanding, face recognition has recently gained significant attention image analysis and understanding face especially during the past several years. There are at least two reasons for such a trend: the first is the wide range of commercial and law enforcement applications and the second is the availability of feasible technologies after 35

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years of research. Moreover recent significant advances in multimedia processing have also helped to advance the applications of face recognition technology. Among the diverse contents of multimedia face objects are particularly important for e.g.- database software capable of searching for ace objects or a particular face object is very useful.
Another example is a security system that is able to automatically track human objects and report their IDs.Though tracking and recognizing face objects is a routine task for humans building such system is still an active research. Among many proposed face recognition
Schemes image based approaches are possibly the most promising ones. However the 2D images/patterns of 3D face objects can dramatically change due to lighting and viewing variations. Hence, illumination and pose problems present significant
Obstacles for wide applications of this type of approaches. In this we review existing methods extensively. And then we propose using a generic 3D model to enhance existing system. More specifically we use the 3D model to synthesize the so-called prototype image from a given image acquired under different lighting and viewing condition. The advantages of this approach are computational simplicity and system robustness which are essential for any real applications.

Some other attempts at facial recognition by machine have allowed for little or no variability in these quantities. Yet the method of correlation (or pattern matching) of unprocessed optical data, which is often used by some researchers, is certain to fail

Low-resolution images of faces can be enhanced using face hallucination. Further improvements in high resolution, mega pixel cameras in the last few years have helped to resolve the issue of insufficient resolution.

This recognition problem is made difficult by the great variability in head rotation and tilt, lighting intensity and angle, facial expression, aging, etc. in cases where the variability is great. In particular, the correlation is very low between two pictures of the same person with two different head rotations.

In this paper we discussed an efficient and accurate method or human face identification and segmentation in gray scale images. This method utilizes the inherently elliptical nature of the human head and fits an ellipse to the head. The resultant information about the ellipse is then used to mask out unwanted feature points in the recognition phase of the identification system. When compared to other methods, the proposed hybrid method has the advantage of eigenvaluesapproach, CHT and Raster Scan Algorithm. It does not use the tangent of edge points to extract the ellipses and avoids false alarms. The amount of data required for ellipse detection and parameters estimation using the proposed method is minimal, since it uses only eigenvalues of covariance matrix. When compared to the conventional face space methods, the main strengths of our method are its less computational time, low memory requirements and accuracy of face detection and segmentation.. The proposed method was tested on images with uniform background, cluttered and noisy
Conditions.

## *CONCLUSION*

In 2006, the performance of the latest face recognition algorithms was evaluated in the Face Recognition Grand Challenge (FRGC). High-resolution face images, 3-D face scans, and iris images were used in the tests. The results indicated that the new algorithms are 10 times more accurate than the face recognition algorithms of 2002 and 100 times more accurate than those of 1995. Some of the algorithms were able to outperform human participants in recognizing faces and could uniquely identify identical twins.

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