A Novel Approach of Face Recognition System under Uncontrolled Illumination Variation Using Principle Component Analysis Method

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Abstract: In this paper, proposed a Face Recognition System under uncontrolled illumination variation. In this Face recognition system consists of two phases, illumination-insensitive preprocessing method, Feature-extraction. In the preprocessing stage illumination sensitive image transformed into illumination-insensitive image, and then to combines multiple classifiers with complementary features instead of improving the accuracy of a single classifier. In this system demonstrated successful accuracy in face recognition under different illumination condition. Biometric tool for Face recognition is an advance implementation in many domains. Face, finger print, iris, ear are some of major biometric recognition systems. But as technology is growing parallel to that the efficiency of these biometric recognition tools also have to be on high standards. Hence the multi modal analysis of biological security systems came in to consideration. Automatic face recognition systems have currently reached high accuracy. In this paper, performance evolution of face recognition is obtained by considering various facial 2d & 3d images. The concept of principle component analysis is implemented. Here the RGB image is converted to gray scale image initially, and then by considering the orientation, frequency, band width of the image the enhanced image is obtained. Then various cropped images are considered to follow the recognition process. Principal component analysis is one among efficient approaches for the recognition systems. Person authentication, recognition can be done. This is an efficient way of multimodal analysis of biological person identity using face and ear biometrics.

Keywords: Face Recognition, Feature extraction & PCA method.

1. INTRODUCTION

The Principal Component Analysis (PCA) is one of the most successful techniques that have been used in image recognition and compression. PCA is a statistical method under the broad title of factor analysis. The purpose of PCA is to reduce the large dimensionality of the data space (observed variables) to the smaller intrinsic dimensionality of feature space (independent variables), which are needed to describe the data economically. This is the case when there is a strong correlation between observed variables. The jobs which PCA can do are prediction, feature extraction, data compression, etc. Because PCA is a classical technique which can do something in the linear domain, applications having linear models are suitable, such as image processing and communications etc. Face recognition has many applicable areas. Moreover, it can be categorized into face identification, face classification, or sex determination.

The most useful applications contain crowd surveillance, video content indexing, personal identification (ex. driver’s license), entrance security, etc. The main idea of using PCA for face recognition is to express the large 1-D vector of pixels constructed from 2-D facial image into the compact principal components of the feature space. Face is one of the most important visual objects in our life which playing a major role in conveying identity and emotion and includes rich information. Face recognition commonly includes feature extraction, feature reduction and recognition or classification. Feature extraction is to find the most representative description of the faces, making them can be most easily distinguished from others. Face reduction is to not only decompose and compress the original features but also not destroy the most important information. Because the face image is often with a high dimension, it is difficult to use the original data directly, so it is critical to choose the effectively distinguished features for extraction and reduction. In all kinds of the algorithms of face recognition, Principle Component Analysis (PCA) is effective feature extraction method based on face as a global feature. It reduces the dimension of image effectively and holds the primary information at the same time. This paper mainly focus the recognize a person's identity is important mainly for security reason, but it could also be used to obtain quick access to medical, criminal, or any type of records. Solving this problem is important because it could allow personnel to take preventive action, provide better service - in the case of a doctor's appointment, or allow a person access to a secure area.
Generic face recognition systems identify a subject by comparing the subject’s image to images in an existing face database. These systems are very useful in forensics for criminal identification and in security for biometric authentication, but are constrained by the availability and quality of subject images. The challenging problems of face identification are illumination changes, face expressions, pose variations etc. One major issue for face recognition is how to ensure recognition accuracy for a large data set captured in various conditions. In this face recognition system using successful accuracy in face recognition under uncontrolled illumination situations. The proposed system is used to match two face images of the same person under different illumination condition. It is based on two parts: the preprocessing stage and score fusion stage. In the preprocessing stage, illumination sensitive image transformed into illumination-insensitive image, and then to combines multiple classifiers with complementary features instead of improving the accuracy of a single classifier. Score fusion computes a weighted sum of scores, where the weight is a measure of the discriminating power of the component classifier. In this system demonstrated successful accuracy in face recognition under different illumination condition.

II. FACE RECOGNITION

Recently, technology became available to allow verification of “true” individual identity. This technology is based in a field called “biometrics”. Biometric access control are automated methods of verifying or recognizing the identity of a living person on the basis of some physiological characteristics such as fingerprints or facial features, or some aspects of the person’s behavior, like his/her handwriting style or keystroke patterns. Since biometric systems identify a person by biological characteristics, they are difficult to forge. Among the various biometric ID methods, the physiological methods (fingerprint, face, DNA) are more stable than methods in behavioral category (keystroke, voice print). The reason is that physiological features are often non-alterable except by severe injury. The behavioral patterns, on the other hand, may fluctuate due to stress, fatigue, or illness. However, behavioral IDs have the advantage of being no intrusive. People are more comfortable signing their names or speaking to a microphone than placing their eyes before a scanner or giving a drop of blood for DNA sequencing.

The idea for this paper came up while studying the concept of multimodal approach of biological recognition systems. As the technical aspect is on high standards there is an absolute requirement of high efficient and quick recognition systems. Then the single biological traits such as face, fingerprint, iris, signature etc can sometime leads to misclassification. This misclassification is a huge impact factor in the biological security systems or recognition systems. The main consideration in designing the biometric recognition systems is the false acceptance misclassification of the person. As the single biometric recognition system can lead to misclassification due to ageing of person, growth of hair/beard in case of face biometrics. Similarly for every other there is an absolute probability of misclassification. Hence the multimodal analysis provides an alternative to obtain the correct authentication of the person. Other issues to be considered while implementing.

III. ALGORITHM

1. Problem definition: Multimodal biometric recognition of face using principle component analysis method.

2. Objective: To obtain high efficiency recognition system by using two 2D & 3D physiological biometric subjects.

3. Advantages of using the Biometrics

The use of ear as other biometric has certain advantages. These include,
1. Unlike the fingerprint and iris, it can be easily captured from a distance without a fully cooperative subject.
2. Unlike the face, the ear is a relatively stable structure that does not change much with the age and facial expressions. The shape does not change due to emotion as the face does, and the ear is relatively constant over most of a person’s life.
3. The ear’s smaller size and more uniform color are desirable traits for pattern recognition. The uniform distribution of color means that almost all information conserved when converting the original image into gray scales.

III. PROCEDURE OF BASIC WORKING MECHANISM

Initially predefined image of either face is considered and then the features are extracted by image enhancement and cropping process. The principle component analysis algorithm checks for the nearest possible match among the available images. The diagrammatic representation of the process is shown as follows,

![Diagram of Working Mechanism](image-url)

Figure 1: Working mechanism of face recognition
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IV. IMPLEMENTATION CODE & SIMULATION RESULTS

A. Experiments and Results
The proposed system is implemented using a Matlab program where it is evaluated for compress the image. The performance of the algorithm is evaluated on several real images. These pictures are the most widely used standard test images used for face recognition algorithms. Original image get decomposed into low frequency component image and high frequency component image. Smoothing is performed on high frequency component, and normalizing is performed on low frequency component. Reconstruction is performed by combining the Processed low and high frequency component image.

B. Implementation Code
% This program uses Principal Component Analysis algorithm to reduce the number of features used in face recognition by uncontrolled illumination variation. This program allows you to set K clear all; close all;
fprintf('Principal Component Analysis used for Face Recognition\n');
t = cputime;
%% Initializing Variable
fprintf('Initialzing Variables\n');
K = 100; % Number of reduced features (principal components)
dispFaces = 12; % How many faces to display
variance = 90; % Enter a number between 1 and 99 both inclusive based on % how much variance to preserve.
topeig = 12; % Used to display the top 10 eigen vectors found
fprintf('...done\n');

% Loading and Visualizing data
fprintf('Loading and Visualizing data\n');
load('faces.mat');
displayData(X(1:dispFaces, :)); % function taken from Machine Learning course
title('Original faces') % by Prof Andrew Ng.
fprintf('...done\n');
pause(1);
%% Normalizing features
fprintf('Normalizing features\n');
[X mu stddev] = normalizeFeatures(X);
topeig = 12; % Used to display the top 10 eigen vectors found
fprintf('...done\n');

%% Perform PCA to get eigen vectors and eigen values
fprintf('Performing PCA & displaying top %d eigen vectors found\n', topeig);
[U, S] = performPCA(X);
displayData(U(:, 1:topeig));
title('Top Eigen Vecotrs found');
fprintf('...done\n');
pause(2);
%% Calculate K based on variance
fprintf('Find best value of K based on Variance\n');
K = findK(S, variance);
fprintf('...done\n');
%% Get data with reduced features
fprintf('Displaying data with reduced features\n');
reducedData = reducedFeatures(X, U, K);
fprintf('...done\n');
%% Recover Original Data
fprintf('Recovering Original Data from reduced features\n');
XRecovered = recoverData(reducedData, U, K);
fprintf('...done\n');
%% Display Original and Recovered Data
fprintf('Displaying Original and Recovered Data\n');
show(X, XRecovered, dispFaces);
fprintf('...done\n');

clc;
clear all;
fprintf('Program executed in %f seconds or %f minutes\n',
cputime-
t,
cputime-
t);

Display data.m:
function [h, display_array] = displayData(X, example_width)

% DISPLAYDATA Display 2D data in a nice grid
% [h, display_array] = DISPLAYDATA(X, example_width) displays 2D data
% stored in X in a nice grid. It returns the figure handle h and the % displayed array if requested.
% Set example_width automatically if not passed in
if ~exist('example_width', 'var') || isempty(example_width)
    example_width = round(sqrt(size(X, 2)));
end

% Gray Image
colormap(gray);
% Compute rows, cols
[m n] = size(X);
example_height = (n / example_width);
% Compute number of items to display
display_rows = floor(sqrt(m));
display_cols = ceil(m / display_rows);
% Between images padding
pad = 1;
% Setup blank display
display_array = - ones(pad + display_rows * (example_height + pad), ...
    pad + display_cols * (example_width + pad));
% Copy each example into a patch on the display array
curr_ex = 1;
for j = 1:display_rows
for i = 1:display_cols
    if curr_ex > m,
        break;
    end

    % Copy the patch
    % Get the max value of the patch
    max_val = max(abs(X(curr_ex, :)));
    display_array(pad + (j - 1) * (example_height + pad) + (1:example_height), ...)
        pad + (i - 1) * (example_width + pad) + (1:example_width)) = ...
            reshape(X(curr_ex, :), example_height, example_width) / max_val;
    curr_ex = curr_ex + 1;
end
if curr_ex > m,
    break;
end
end

% Display Image
h = imagesc(display_array, [-1 1]);

% Do not show axis
axis image off
drawnow;
end

C. Simulation Results
Principal Component Analysis used for Face Recognition
Initializing Variables...done
Loading and Visualizing data...done
Normalizing features...done
Performing PCA & displaying top 12 eigen vectors found...done
Find best value of K based on Variance...done
Displaying data with reduced features...done
Recovering Original Data from reduced features...done
Displaying Original and Recovered Data...done
Program executed in 22.947747 seconds or 0.382462 minutes

I. Whenever the code runs the below input faces will display for Authentication.

2. Whenever the program executed display original and recovered faces in database successfully

V. CONCLUSION
In this face recognition system with preprocessing, feature extraction and classifier, methods for uncontrolled illumination situations. First, a preprocessing method, a face image is transformed into an illumination-insensitive image. The hybrid Fourier-based classifiers with multi face models, which basically consist of three Fourier domains, concatenated real and imaginary components, Fourier spectrum, and phase angle. The Fourier features are extracted from each domain within its own proper frequency bands, and to gain the maximum discriminant power of the classes, each feature is projected into the PCA scheme. Face recognitions are a challenging problem in the field of image analysis and computer vision that has received a great deal of attention over the last few years because of its many applications in various domains. Research has been conducted vigorously in this area for the past four decades or so, and though huge progress has been made, encouraging results have been obtained and current face recognition systems have reached a certain degree of maturity when operating under constrained conditions; however, they are far from achieving the ideal of being able to perform adequately in all the various situations that are commonly encountered by applications utilizing these techniques in practical life. The multimodal analysis developed here can be further preceded by considering the images of ear covering with hair growth. This paper deals with the images of face. So, further study can be made on mentioned conditions.

VI. REFERENCES

