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Face Recognition Using Neural Network Architecture

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Abstract: Face recognition algorithms often have to solve problems such as facial pose, illumination, and expression (PIE). To reduce the impacts, many researchers have been trying to find the best discriminant transformation in eigenspaces, either linear or nonlinear, to obtain better recognition results. Various researchers have also designed novel matching algorithms to reduce the PIE effects. In this study, a nearest feature space embedding (called NFS embedding) algorithm is proposed for face recognition. The distance between a point and the nearest feature line (NFL) or the NFS is embedded in the transformation through the discriminant analysis. Three factors, including class reparability, neighborhood structure preservation, and NFS measurement, were considered to find the most effective and discriminating transformation in eigenspaces. The proposed method was evaluated by several benchmark databases and compared with several state-of-the-art algorithms. According to the compared results, the proposed method outperformed the other algorithms.

Keywords: Neutral Networks, Feature Space Embedding, Nearest Feature Line (NFL).

INTRODUCTION

The need for improved information systems has become more conspicuous, since information is an essential element in decision making. One of the major problems in the design of modern information systems is automatic pattern recognition.

Recognition is regarded as a basic attribute of human beings, as well as other living organisms. A pattern is the description of an object. A human being is a very sophisticated information system, partly because he possesses a superior pattern recognition capability.

The face is our primary focus of attention in social interaction, playing a major role in conveying identity and emotion. We can recognize thousands of faces learned throughout our lifetime and identify familiar faces at a glance even after years of separation. This skill is quite robust, despite large changes in the visual stimulus due to viewing conditions, expression, aging, and distractions such as glasses, beards or changes in hair style.

Developing a computational model of face recognition is quite difficult, because faces are complex, multi-dimensional visual stimuli. Therefore, face recognition is a very high level computer vision task. The first step of human face identification is to extract the relevant features from facial images. Research in the field primarily intends to generate sufficiently reasonable familiarities of human faces so that another human can correctly identify the face.

The question naturally arises as to how well facial features can be quantized. If such a quantization if possible then a computer should be capable of recognizing a face given a set of features. Hence, an efficient neural network based face recognition system is proposed using nearest feature space embedding algorithm.

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FACE AUTHENTICATION SYSTEM

The outline of a typical face authentication system is given in Fig. 1.1. There are six main functional blocks, performing different tasks.

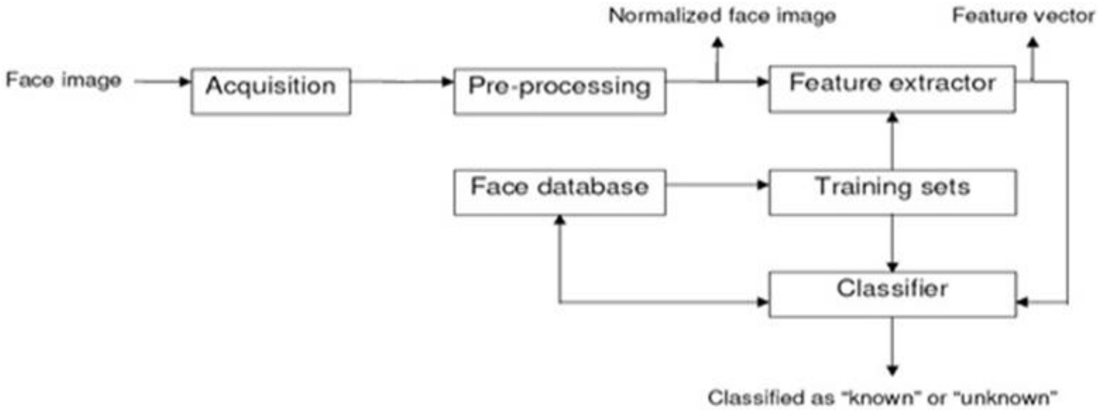

Fig. 1: Typical face authentication system

Acquisition

It is the module where the face image under consideration is presented to the system. An acquisition module can request a face image from several different environments such as the face image can be an image file that is located on a magnetic disk, it can be captured by a frame grabber or it can be scanned from paper with the help of a scanner.

Pre-processing

A pre-processing module locates the eye position and takes care of the surrounding lighting condition and color variance. First the presence of faces or face in a scene must be detected.

Once the face is detected, it must be localized and normalization process may be required to bring the dimensions of the facial sample in alignment with the one on the template. Some or all of the following pre-processing steps are implemented in a face recognition system.

Image size normalization. It is usually done to change the acquired image size to a default image size such as 128 x 128, on which the face recognition system operates.

FACE DETECTION

Face authentication system is a complex image-processing problem in real world applications with complex effects of illumination, occlusion, and imaging condition on the live images. It is a combination of face detection and recognition techniques in image analyzes.

Detection application is used to find position of the faces in a given image. Recognition algorithm is used to classify given images with known structured properties.

There are basically four different approaches to the problem of face detection:

1. Knowledge-based methods: Rules are encoded based on the human knowledge of the defining features of a human face. A majority of these rules capture the relationship between features.
2. Feature invariant methods: Algorithms designed to find structural features of a face that are invariant to the common problems of pose, occlusion, expression, image conditions and rotation.

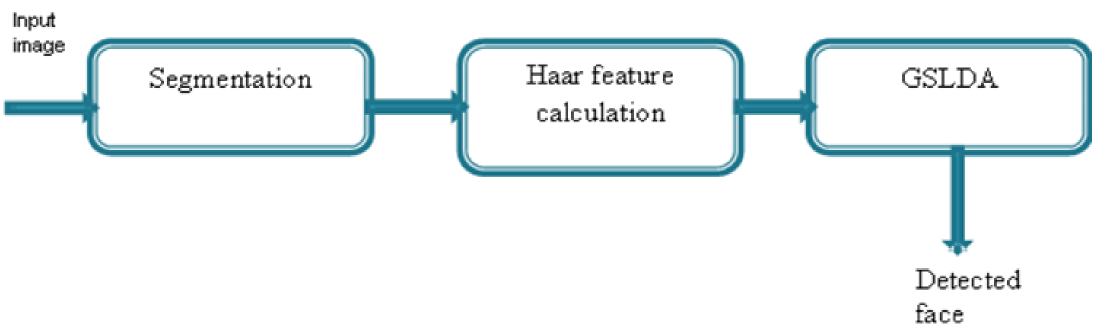

Fig. 2: Block diagram for face detection

The input image is converted into binary image to isolate the image from the background region. Segmentation is performed to localize the homogeneous parts in the image.

Haar-like features that indicate specific characteristics in an image are computed with the use of integral image and Greedy Sparse LDA is applied to detect the face region in the input image.

SEGMENTATION

Segmentation refers to the process of partitioning a digital image into multiple segments. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics.

Need for Segmentation

Segmentation is a process that partitions an image into regions. In the problem of face detection, skin segmentation helps in identifying the probable regions containing the faces as all skin segmented regions are not face regions and aids in reducing the search space.

Active Contour Model based Segmentation

A novel region-based Active Contour Model (ACM) is used for segmentation which is implemented with a special processing named Selective Binary and Gaussian Filtering Regularized Level Set (SBGFRLS) method, which first selectively penalizes the level set function to be binary, and then uses a Gaussian smoothing kernel to regularize it. The Gaussian filter can make the level set function smooth and the evolution more stable. The advantages of this method are as follows.

A new region-based Signed Pressure Force (SPF) function is proposed, which can efficiently stop the contours at weak or blurred edges. The SPF function modulates the signs of the pressure forces inside and outside the region of interest so that the contour shrinks when outside the object, or expands when inside the object.

Integral Image

In order to be successful a detection algorithm must possess two key features: accuracy and speed. Through the use of a new image representation, the integral image, Viola & Jones describe a means for the fast feature evaluation that proves to be an effective way to speed up the classification task. Rectangle features can be computed very rapidly using an intermediate representation for the image which is called as the integral image. In other words the integral image at location (x, y) is the sum of all pixel values above and left of (x, y), inclusive. Integral image ii(x,y) can be calculated as given below.

$$ii(x,y) = \sum_{x'\leq x, y'\leq y} i(x', y') \qquad (2.1)$$

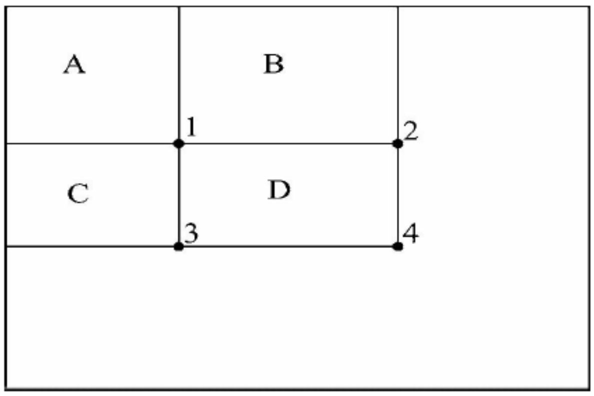

Fig. 3: Integral Image calculation

The integral image at points 1,2,3 and 4 can be calculated as

(1) = A

(2) = A + B

(3) = A + B + C

(4) = A + B + C + D

Eigen Vectors Calculation

Mean Face: Ψ=1/Mt ∑ Mt $\frac{1}{M_t}\sum_{i=1}^{M_t}\Gamma i$

Mean Subtracted Image

The difference of the training image from the mean image (size P x 1) is given by

$$\Phi = \Gamma - \Psi$$

Difference Matrix

A = [Φ1 Φ2 ... ΦM] is the matrix of all the mean subtracted training image vectors and its size is (P x Mt).

Covariance Matrix: The covariance matrix of the training image vectors of size (P x P) is given by

$$X= \quad A.AT \quad = \frac{1}{M_t}\sum_{i=1}^{M_t}\Phi i\Phi_i^T$$

$$\text{Projection: } \omega_k = v_k^T \cdot \Phi = v_k^T \cdot (\Gamma - \Psi)$$

Weight Matrix

$$\Omega = [\omega 1\ \omega 2\ \dots\ \omega M']T$$

At this point, the images are just composed of weights in the eigenface space, simply like they have pixel values in the image space. When a new test image is to be classified, it is also mean subtracted and projected onto the face space and the test image is assumed to belong to the nearest class by calculating the Euclidean distance of the test image vector to the mean of each class of the training image vectors.

The objective of LDA is to maximize the projected between-class covariance matrix (the distance between the mean of two classes) and minimize the within-class covariance matrix.

LDA takes the number of samples in each class into consideration when solving the optimization problem, i.e., the number of samples is used in calculating the between-class covariance matrix .Hence, SB is the weighted difference between class mean and sample mean. The within-class and between-class scatters are computed as follows.

SB ---- Between-class scatter

SW ---- Within-class scatter

Ni ---- Number of samples in class

N ---- Total number of samples

μi ---- Mean of a class

μ ---- Total mean

Applications of LDA

- Bankruptcy prediction
- Face recognition
- Marketing

NEURAL NETWORK ARCHITECTURE FOR THE PROPOSED SYSTEM

An artificial neural network is used for classification of face images. A feed forward back propagation neural network is used to perform classification. The number of input layers is 20 which is determined by the features extracted from the number of images in the training set.

The hidden layer use log sigmoid activation function and the number of neurons in the hidden layer is obtained by trial and error. The output layer is a competitive layer, as one of the faces is to be identified. Fig 3.8 shows the architecture of neural network for the proposed architecture.

The network training parameters are:

Input nodes : 20

Hidden nodes : 90

Output nodes : 10

Training algorithm : Gradient descent

Perform function : Mean Square Error

Training goal : 10e-5

Training epochs : 20000

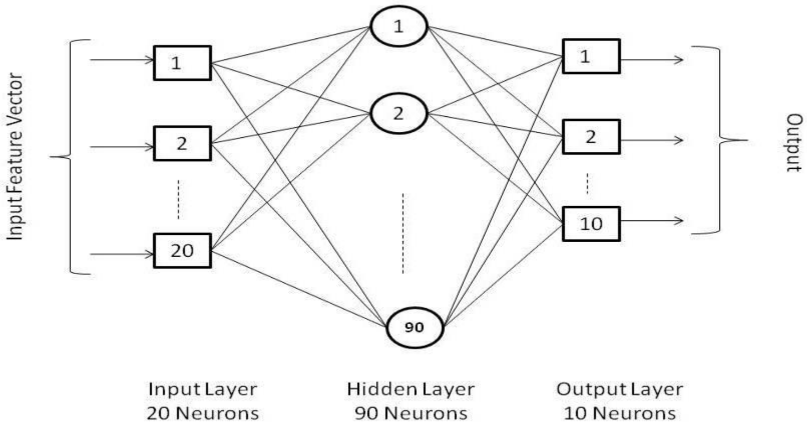

Fig. 4: Architecture of Neural Network for the proposed system

CONCLUSION

A neural network based intelligent face authentication system is proposed using Nearest Feature Space Embedding algorithm. The input face is segmented and detected using Greedy sparse LDA. The distance between the feature point and feature space is calculated and embedded in the transformation and feed forward neural networks is employed for face recognition in the proposed method. The simulation results show that the proposed scheme outperforms and is resistant to change in pose, expression and rotation. This system provides authentication insensitive to noise.

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