Volume 6, Issue 4, April 2016 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

A MATLAB based Face Recognition System using Image Processing and Neural Networks

Ashok Kumar, Manisha
BITS, Bhiwani, Haryana,
India

Abstract— Automatic recognition of people is a challenging problem which has received much attention during recent years due to its many applications in different fields. Face recognition is one of those challenging problems and up to date, there is no technique that provides a robust solution to all situations. This paper presents a new technique for human face recognition. This technique uses an image-based approach towards artificial intelligence by removing redundant data from face images through image compression using the two-dimensional discrete cosine transform (2D-DCT). The DCT extracts features from face images based on skin color. Featurevectors are constructed by computing DCT coefficients. A self-organizing map (SOM) using an unsupervised learning technique is used to classify DCT-based feature vectors into groups to identify if the subject in the input image is "present" or "not present" in the image database. Face recognition with SOM is carried out by classifying intensity values of grayscale pixels into different groups. Evaluation was performed in MATLAB using an image database of 25 face images, containing five subjects and each subject having 5 images with different facial expressions. After training for approximately 850 epochs the system achieved a recognition rate of 81.36% for 10 consecutive trials. The main advantage of this technique is its high-speed processing capability and low computational requirements, in terms of both speed and memory utilization.

Keywords— Face recognition, discrete cosine transform, self-organizing map, neural network, artificial intelligence.

I. INTRODUCTION

ACE recognition has become a very active area of research in recent years mainly due to increasing security demands and its potential commercial and law enforcement applications. The last decade has shown dramatic progress in this area, with emphasis on such applications as human-computer interaction (HCI), biometric analysis, content-based coding of images and videos, and surveillance[2]. Although a trivial task for the human brain, face recognition has proved to be extremely difficult to imitate artificially, since although commonalities do exist betweenfaces, they vary considerably in terms of age, skin, color and gender. The problem is further complicated by differing image qualities, facial expressions, facial furniture, background, and illumination conditions[3]. A generic representation of a face recognition system is shown in Fig. 1. This paper presents a novel approach for face recognition that derives from an idea suggested by Hjelmås and Low[1]. In their survey, they describe a preprocessing step that attempts to identify pixels associated with skin independently of facerelated features. This approach represents a dramatic reduction in computational requirements over previous methods.

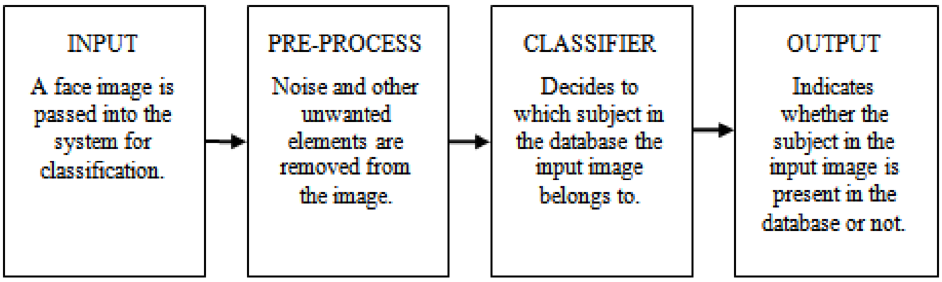


Fig. 1. Generic representation of a face recognition system

Since skin color in humans varies by individual, research has revealed that intensity rather than chrominance is the main distinguishing characteristic. The recognition stage typically uses an intensity (grayscale) representation of the image compressed by the 2D-DCT for further processing[2]. This grayscale version contains intensity values for skin pixels.
A block diagram of the proposed technique of the face recognition system is presented in Fig. 2. In the first stage, the 2D-DCT for each face image is computed, and feature vectors are formed from the discrete cosine transform (DCT) coefficients. The second stage uses a self-organizing map (SOM) with an unsupervised learning technique to classify vectors into groups to recognize if the subject in the input image is "present" or "not present" in the image database. If the subject is classified as present, the best match image found in the training database is displayed as the result, else the

result displays that the subject is not found in the image database. The rest of this paper is organized as follows: Section II discusses DCT computation on face images. Section III describes the design and architecture of the SOM neural network. Section IV shows experimental results, and discusses possible modifications and improvements to the system.Section V presents concluding remarks.

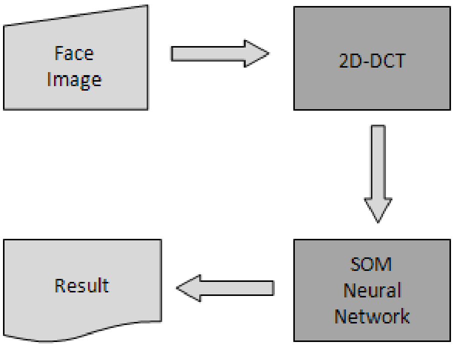


Fig. 2. Proposed technique for face recognition system

DISCRETE COSINE TRANSFORM

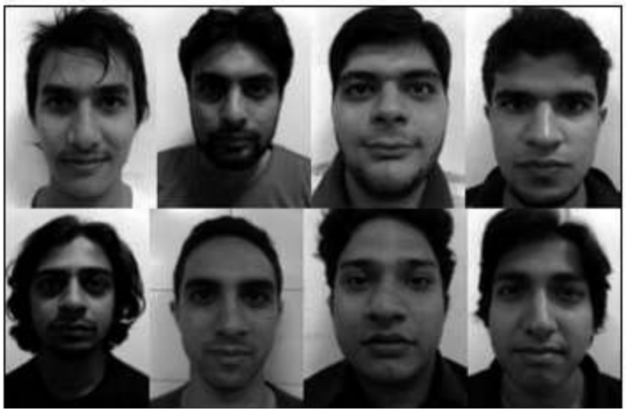
Overview

The discrete cosine transform is an algorithm widely used in different applications. The most popular use of the DCT is for data compression, as it forms the basis for the international standard loss image compression algorithm known as JPEG[5]. The DCT has the property that, for a typical image, most of the visually significant information about the image is concentrated in just a few coefficients. Extracted DCT coefficients can be used as a type of signature that is useful for recognition tasks, such as face recognition[6,7]. Face images have high correlation and redundant information which causes computational burden in terms of processing speed and memory utilization. The DCT transforms images from the spatial domain to the frequency domain. Since lower frequencies are more visually significant in an image than higher frequencies, the DCT discards high-frequency coefficients and quantizes the remaining coefficients. This reduces data volume without sacrificing too much image
quality[3].

Face Image Preprocessing

Face images of different candidates with different facial expressions are taken with a Canon Powershot S3 IS 6.0 megapixel digital camera in the size of 1200 × 1600 pixels (2.0 megapixels). All face images taken resemble the following
General features:

- Uniform illumination conditions
- Light color background
- Faces in upright and frontal position
- Tolerance for tilting and rotation up to 20 degrees



(a)

(b)

Fig. 3. Face images of candidates. (a) Face images of different subjects. (b) Face image of a single subject with 5 different facial expressions

Face images are preprocessed in Adobe Photoshop CS2. The face image fabrication process is shown in Fig. 4. Image preprocessing includes the following steps:

- Auto adjusting hue and saturation levels
- Adjusting brightness and contrast to fixed scale
- Desaturating 24 bit RGB color into 8 bit grayscale
- Downsizing images to 512 × 512 pixels
- Saving images in jpeg format

II. PROBLEM STATEMENT

Face recognition has become a popular area of research in computer vision, mainly due to increasing security demands and its potential, commercial and law enforcement applications. It is a very challenging problem and up to date and there is no technique that provides a robust solution to all situations and different applications that face recognition may encounter. Hence, this dissertation focuses on developing a technique that provides a solution for an efficient high-speed face recognition system in different applications.

III. SYSTEM MODEL

MATLAB and SIMULINK

Introduction

MATLAB is a high-performance language for technical computing created by The MathWorks in 1984. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:

- Math and computation
- Algorithm development
- Data acquisition
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including graphical user interface building

MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis. [22]

MATLAB is a numerical computing environment and programming language. It allows easy matrix manipulation, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs in other languages. Although it specializes in numerical computing, an optional toolbox interfaces with the Maple symbolic engine, allows it to be part of a full computer algebra system. Besides dealing with explicit matrices in linear algebra, it can handle differential equations, polynomials, signal processing, and other applications. Results can be made available both numerically and as excellent graphics. [22]

MATLAB solves many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non-interactive language such as C or Fortran.

The name MATLAB stands for Matrix Laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects. Today, MATLAB engines incorporate the LAPACK and BLAS libraries, embedding the state of the art in software for matrix computation.

MATLAB features a family of add-on application-specific solutions called Toolboxes. Toolboxes allow learning and applying specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others. As of 2004, MATLAB was reported to be used by more than one million people in industry and academia.

The MATLAB System

The MATLAB system consists of the following five parts:

- Desktop Tools and Development Environment
- MATLAB Mathematical Function Library
- MATLAB Language
- MATLAB Graphics
- MATLAB External Interfaces/API

What Is Simulink

Simulink is a software bundled with MATLAB for modeling, simulating, and analyzing dynamic systems. It supports linear and nonlinear systems, modeled in continuous time, sampled time, or a hybrid of the two. Systems can also be multi-rate, i.e., have different parts that are sampled or updated at different rates. Simulink enables users to pose a question about a system, model it, and see what happens. With Simulink, models can be built easily from scratch, existing models can be taken and be added to it. Thousands of engineers around the world use Simulink to model and solve real problems in a variety of industries. [22]

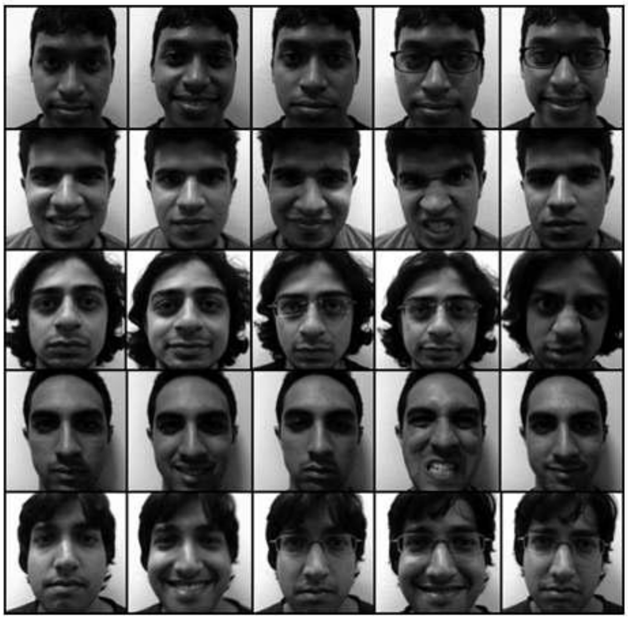
IV. PROPOSED IMPLEMENTATION

The technique to be applied for the design and implementation of the face recognition system is as follows:

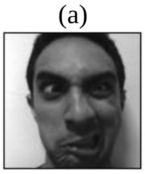
- Data gathering of face images of subjects from a digital camera.
- Importing face images into MATLAB.
- Discrete Cosine Transform (DCT) image compression of face images.
- Design of a Neural Network in MATLAB.
- Input face images into Artificial Neural Network (ANN).
- Training the neural network and simulating it for different input images.
- Discrete Wavelet Transform (DWT) image compression of face images.
- Design of a Neural Network in MATLAB.
- Input face images into Artificial Neural Network (ANN).
- Training the neural network and simulating it for different input images
- Creating a user-friendly program in MATLAB from the source code
- Accuracy Comparison between DCT & DWT.

V. RESULT

Face image database was created for the purpose of benchmarking the face recognition system. The image database is divided into two subsets, for separate training and testing purposes. During SOM training, 25 images were used, containing five subjects and each subject having 5 images with different facial expressions. Fig. 7 shows the training and testing image database constructed.



(a)



(b)

Fig. 7. Training and testing image database. (a) Image database for training. (b) Untrained image for testing

The face recognition system presented in this paper was developed, trained, and tested using MATLAB™ 7.2. The computer was a Windows XP machine with a 3.00 GHz Intel Pentium 4 processor and 1 GB of RAM.

VI. CONCLUSION

This paper has presented a novel face recognition technique that uses features derived from DCT coefficients, along with a SOM-based classifier. The system was evaluated in MATLAB using an image database of 25 face images, containing five subjects and each subject having 5 images with different facial expressions. After training for approximately 850 epochs the system achieved a recognition rate of 81.36% for 10 consecutive trials. A reduced feature space, described for experiment 2 above, dramatically reduces the computational requirements of the method as compared with standard

DCTfeature extraction methods. This makes our system well suited for low-cost, real-time hardware implementation. Commercial implementations of this technique do not currently exist. However, it is conceivable that a practical SOM-based face recognition system may be possible in the future.

REFERENCES

[1] E. Hjelmås, and B. K. Low, "Face detection: A survey", Computer Vision and Image Understanding, Vol. 83, No. 3, Sept. 2001, pp. 236-274.

[2] A. Abdallah, M. Abou El-Nasr, and A. Lynn Abbott, "A New Face Detection Technique using 2D DCT and Self Organizing Feature Map" in Proc. of World Academy of Science, Engineering and Technology, Vol. 21, May 2007, pp. 15-19.

[3] J. Nagi, "Design of an Efficient High-speed Face Recognition System", Department of Electrical and Electronics Engineering, College of Engineering, Universiti Tenaga Nasional, March 2007.

[4] D. Kumar, C.S. Rai, and S. Kumar, "Face Recognition using Self- Organizing Map and Principal Component Analysis" in Proc. on Neural Networks and Brain, ICNNB 2005, Vol. 3, Oct 2005, pp. 1469-1473.

[5] E. Ifeachor and B. Jervis, Digital Signal Processing: A Practical Approach. Prentice Hall, 2001.

[6] L. Ma, Y. Xiao, and K. Khorasani, "A new facial expression recognition technique using 2D DCT and k-means algorithm", in Proc. International Conference on Image Processing, Oct. 2004, pp. 1269-1272.

[7] L. Ma and K. Khorasani, "Facial expression recognition using constructive feedforward neural networks", IEEE Transactions on Systems, Man and Cybernetics, Part B, Vol. 34, No. 3, June 2004, pp. 1588-1595.

[8] Y. Zi Lu and Z. You Wei, "Facial Expression Recognition Based on Wavelet Transform and MLP Neural Network", in Proc. 7th International Conference on Signal Processing, ICSP 2004, Vol. 2, Aug 2004, pp. 1340-1343.

