

A Hybrid Feature Extraction Framework for Face Recognition: HOG and Compressive Sensing

Ali K. Jaber, Electrical and Computer Engineering Department, Western Michigan University, Kalamazoo, MI, USA

Ikhlas Abdel-Qader, Electrical and Computer Engineering Department, Western Michigan University, Kalamazoo, MI, USA

ABSTRACT

A hybrid framework, that can be used in face recognition applications, to enhance system recognition efficiency and speed by extracting the most efficient features of face images is proposed. The proposed framework is based on features obtained using Histograms of Oriented Gradients (HOG) descriptor and compressive sensing (CS). The HOG feature descriptor has the advantage of extracting face feature vectors even with changes in face appearance and is fully capable of handling variations in illumination. CS is used to reduce the density of the resulting HOG face features which has a significant effect on improving the computational cost and performance of the system. For classification, the k-Nearest Neighbors (k-NN) algorithm and Probabilistic Neural Network (PNN) classifier are used. The results demonstrated that the proposed hybrid method could be implemented in a complete system for recognizing and identifying faces with varying illuminations, facial expressions and poses, and backgrounds in real time.

KEYWORDS

Compressed Sensing, Face Recognition, Histograms of Oriented Gradients

INTRODUCTION

Face recognition is one of the most important biometric systems and is still a challenging problem in the area of computer vision, pattern recognition and artificial intelligence. Face recognition has been widely used in applications such as security systems, video surveillance, access control, and human-computer interactive (HCI) (Shu, Gao, & Lu, 2010). Different feature extraction techniques have been proposed and tested for separating the classes in a lower dimensional subspace than the original image data.

The major techniques that have been used to extract holistic face features, for analyzing the global features of the whole image, are the Eigenfaces or principal components analysis (PCA), Fisher's Linear Discriminant (FLD) or Fisherfaces, and Laplacianfaces. Other approaches have been used to extract local or partial face features on relatively smaller regions such as patches around eyes or nose using the component or feature-based approach (Eleyan, Kose, & Cetin, 2014; Wright, Yang, Ganesh, & Sastry, 2009). In addition, other classification algorithms have been applied to face recognition systems using pre-extracted facial features such as the k-Nearest Neighbor (k-NN) (Kataria & Singh,

DOI: 10.4018/IJHCR.2017010101

Copyright © 2017, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

2013), Support Vector Machines (SVM) (Yang, Zhou, Ma, & Sastry, 2010), Nearest Subspace (NS), Random Forest (RF) (Salhi, Kardouchi, & Belacel, 2012) and others (Yang et al. 2010).

The selection of the type of feature representation to be used is detrimental to the success of any facial recognition system.

Eleyan et al. (2014) proposed a new technique for image feature extraction. Based on the compressive sensing (CS) method, they produced a measurement matrix which is used as projection matrix for image feature extraction. This method used the FERET and ORL Face Datasets with a recognition performance of 84.50% and 96.75%, respectively.

Salhi et al. (2012) reported a face recognition system based on Random Forest (RF) classifier and HOG feature descriptor. Using ORL dataset, the results obtained were shown to outperform, in terms of recognition rate and computational time, when compared with other methods' such as GABOR combined with RF and HOG combined with SVM.

Huang et al. (2012) proposed a feature extraction method using Pyramid histogram of oriented gradients (PHOG) combined with SVM classifier for face recognition. The results on UMIST Face Dataset have shown to have an average recognition rate of 93.66%.

Donia et al. (2014) presented a facial expression recognition method using HOG feature descriptor to extract facial expression features and combined it with SVM, which resulted in an accuracy of 95% on static images and 80% on video images.

Do and Kijak (2012) used the Co-occurrence of Oriented Gradient (CoHOG), an extension of HOG, to develop a set of weighted functions for magnitude gradient. The recognition results proved that this approach was competitive with some of the existing methods such as Eigenfaces and Fisherfaces.

Shu et al. (2010) proposed to use the amplitude projection face representation and compressive sensing method. The AT&T face database and Yale face database was used to test the proposed system. An accuracy of 92.05% on AT&T face dataset and a 91.14% on Yale face database was reported.

In this paper, the authors are expanding on their work presented at the 2016 IEEE International Conference on Electro/Information Technology (EIT 2016) (Jaber & Abdel-Qader, 2016). The authors are proposing a hybrid system framework based on HOG descriptor for feature extraction and representation, and on CS theory to reduce the dimension of the extracted feature space.

Histogram of Oriented Gradients

Histogram of Oriented Gradients (HOG) descriptor is a feature extraction method used in image processing and computer vision for the purpose of object detection. Proposed by Navneet Dalal and Bill Triggs (Dalal & Triggs, 2005), HOG gained popularity in feature detections such as other descriptors of edge orientation histograms, shape contexts, and scale-invariant feature transform (SIFT) descriptors. HOG is, however, based on the connection of regularly joint cells and allows for overlapping blocks to improve performance and accuracy. HOG has additional advantages over other methods such as allowing for the size of regions of interest (local cells) to be specified and has proven to be invariant to local geometric and photometric transformations (Dalal & Triggs, 2005).

This descriptor considers gradient orientation in small sub-regions of an image. In HOG, the local object appearance and shape in the image can be illustrated by the distribution of edge directions or intensity gradients. This descriptor divides an image into several small connected regions (cells) of size $n \times n$ pixels. The orientation of all pixels is calculated and collected in bins. The final HOG features vector is the concatenation of all cell histograms. HOG feature descriptor is derived based on the following three steps: the gradient computation, histogram generation and descriptor block and normalization (Dalal & Triggs, 2005; DO & KIJAK, 2012).

Gradient Computation

The gradient magnitude and orientation value must be determined. The 1-D centered kernel filter masks, or Sobel masks, are the most common filters that are used in the gradient computation. For example, gradient in the x and y directions are obtained using masks as given in Equation 1:

11 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the product's webpage:

www.igi-global.com/article/a-hybrid-feature-extraction-framework-for-face-recognition/181269?camid=4v1

Related Content

A Proposed Tool for Mobile Collaborative Reading

Jason T. Black and Lois Wright Hawkes (2008). *Handbook of Research on User Interface Design and Evaluation for Mobile Technology* (pp. 1068-1078).

www.igi-global.com/chapter/proposed-tool-mobile-collaborative-reading/21882?camid=4v1a

Exploring Mobile Service Business Opportunities from a Customer-Centric Perspective

Minna Pura and Kristina Heinonen (2009). *Mobile Computing: Concepts, Methodologies, Tools, and Applications* (pp. 2233-2256).

www.igi-global.com/chapter/exploring-mobile-service-business-opportunities/26662?camid=4v1a

Convex Optimization Via Jensen-Bregman Divergence for WLAN Indoor Positioning System

Osamah Ali Abdullah, Ikhlas Abdel-Qader and Bradley Bazuin (2017). *International Journal of Handheld Computing Research* (pp. 29-41).

www.igi-global.com/article/convex-optimization-via-jensen-bregman-divergence-for-wlan-indoor-positioning-system/181271?camid=4v1a

Android Applications for Lung Nodules Classification Using Convolutional Neural Network

Karthikeyan M. P., Banupriya C. V., Kowsalya R. and Jayalakshmi A. (2023). *Designing and Developing Innovative Mobile Applications* (pp. 198-215).

www.igi-global.com/chapter/android-applications-for-lung-nodules-classification-using-convolutional-neural-network/322071?camid=4v1a