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Hybrid Face Recognition Technique Based on SVM and Cuckoo Search Optimization

A Thesis

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

نحن خلقناهم وشددنا أسرهم وإذا

شئنا بدلنا أمثالهم تبديلاً



﴿ الآية ٢٨ سورة الانسان ﴾

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Dedication to

This work is dedicated to my family, whose assistance, forbearance, and continues encouragement during the whole period of time, made it possible to finish this work. Also dedicated to giving the effort to my parents, may God have mercy on them? I wish to express my love and gratitude to my beloved family members



With My love

Suhad

Abstract

Face image recognition becomes an effective research area over last two decades, and it is considered as a challenging research topic. It covers a wide range of activities from many aspects of life such as authentication and identification, airport security, inmate tracking, e-commerce and facebook's automatic tag. The aim of face image recognition is to recognize the face of a person depending on the features extracted from his face.

In this thesis, two proposed systems are developed .The first step in this work is the preprocessing of images for all training and testing images. The second step is detecting the accuracy of the face by using Viola - Jones algorithm. The third step is features extraction and selection by using Linear Discernment Analysis (LDA). In the final step, the Support Vector Machine (SVM) is applied to reorganize the face as face or non-face face. In the hybrid proposed system all the steps applied in the first proposal system are applied on hybrid system in addition, a the second selection feature method is added by applying the Cuckoo Search Algorithm in order to select the best features which are stored as a features vector.

The proposed hybrid system has been implemented by using a datasets Marlboro University of Cape Town (MUCT). This dataset is considered as taking the processing of faces for frontal position. The results show that the SVM classifier recognition provides an accuracy rate of 99.25% with cuckoo search algorithm, and 96% without cuckoo search algorithm for the same test images.

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List of Symbol

Symbol	Meaning
$d(x, y)$	Distance Measure
$d_S(x, y)$	Statistical Distance
S_B	Between – Class Scatter Matrix.
S_w	Within – Class Scatter Matrix
σ_i^2	Variance
W	Projection Matrix.
μ_i	Mean
$(c - 1)$	Vector Feature
D_i	Distance Metric
λ	Values Features
p_α	Probability of The Nests
V_{mean}^c	Mean Vectors
YC_bC_r	YC _b C _r Color Space
#	Number Person of Image

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List of abbreviation

Abbreviation	
BA	Bat Algorithm
BMP	Bitmap Picture
CMU PIE	CMU Pose, Illumination, and Expression (PIE) Database
CSA	Cuckoo Search Algorithm
FAR	False Alarm Rate
FLD	Fisher's Linear Discriminant
FR	Face Recognition
FS	Feature Selection
GA	Genetic Algorithm
HCI	Human Computer Interface
HMM	Hyper-Plane Margins
HVS	Humane Vision System
ICA	Independent Component Analysis
JPG	Joint Photographic

KFA	Kernel Feature Analysis
KPCA	Kernel Principle Component Analysis
LBP	Local Binary Pattern
LDA	Linear Discernment Analysis
MUCT	Marlboro University of Cape Town
Open CV	Open Source Computer Vision Library'
ORL	Olivetti Research Lab Database
PC	Personal Computer
PCA	Principle Component Analysis
PGM	Portable Gray Map
PIN	Postal Index Number
PSO	Particle Swarm Optimization
RGB	Red, Green and Blue
RR	Recognition Rate
SIFT	Scale-Invariant Feature Transform
SURF	Speeded-Up Robust Features
SVM	Support Vector Machine

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Chapter One

General Introduction

Chapter One

General Introduction

1.1 Introduction

Face image is the availability of that consists of numerous and appropriate representative patterns which an essential part of any face image recognition. The invasion of face image data and the creation of the database have been very significant to computer engineers and scientists for several years. The accuracy rate of the results of face recognition work is highly depended on the presence of moderately important representative samples from the database used [1].

To identify the human face, the first step is to extract the related features from facial images. So for the research which intends to generate sufficient which acceptable and militaries of human faces therefore another human can correctly and essay identify the face [2].

Recently, face image recognition is a rapid increasing field for its several uses in the several field applications such as security, biometric authentication and numerous other areas. There are numerous problems that appear because to the exactness of several factors that affects the feature of image. When processing images one must take into account the variations in light, image quality, the persons pose and facial expressions along with others. Due to its significant applications, face recognition is taking more attention in last years. The face image recognition is an essential ability of human, but it is hard for face image recognition systems to perform as well as human under different conditions, including illumination, variation of poses, expressions, occlusion and etc [3].

The face image recognition mainly consists of four steps. The first step is the face detection which finds the interest area in the image that contains the face. The second is the face extraction features which positions the face detected into an estimate pose, usually represented by a target face or model. The third step is face representation which describes the face with certain aspects of interest, the finally step is face classification which decides whether the representation belongs to a model or target face [4].

1.2 Face Recognition Approaches

There are three approaches of face recognition. The first feature based approach which depends on facial characteristics, the second one deals with the holistic view of the face recognition , and the third one is a hybrid approaches which is included in the first and the second approaches [5][6].

1.2.1 Featured-based

In feature based approach, certain face features such as nose, mouth, or eyes would be determined, and position will be segmented more than one computing process that can be carried out. The results are to be used as input data feed into certain classifier. The most common feature is the middle of the eyes, mouth width, nose size, the space between the eyes, the eye sockets depth, the cheekbones shape and the jaw line length noticeable land marks have an alternative term that can be defined as “nodal points”, and several codes can be created by their measurements, (features vector or face print), which will represent the face in the database [7] [8].

1.2.2 Holistic Based Approach

The face clip is completely used to identify the face. In Holistic based approach the face image recognition depends on the entire face clip instead of face local features determination and computing the distance between them. The most common approaches that are used: Moment Invariants, Fisher Faces ,

Independent Component Analysis and (ICA) Principle Components Analysis (PCA) [8] [9].

1.2.3 Hybrid Based Approach

This approach is considered as combination of the two above mentioned approaches. In Hybrid based approach, specific face region can be determined and extracted to be used as an input for the step of dimensional reduction. This concept came from which both holistic face and the local characteristics are perceived by human vision system (HVS) [8].

1.3 Challenges in Face Recognition

Many issues hinder research efforts in the field of face recognition. Variation exists in every imaging modality used, and finding fast, simple algorithms that are robust to variation is difficult (as evidenced by years of research). Categorizing the variation may be helpful in the development of effective face recognition algorithms.

There are many sources of variability in the face recognition problem, as follows: [10][11]

- 1. Pose Variations:** The images of a face vary due to the relative in data set pose (frontal, 30-degree, profile, upside down, wearing class and smile), and some facial features such as an eyes , mouth , face and nose segments may become partially wholly.
- 2. Light and Texture Variation:** Up to now, the described variations due to the position and orientation of the object in dataset are caused by the face and its environment, specifically the face's surface properties and the light sources. Changes the light source in particular can radically change a face's appearance.

- 3. Background Variation:** The border of the face itself is the most important feature, and its shape varies from person to person. Thus the boundary is not predictable, so the background cannot be simply masked off and is ignored.
- 4. Shape Variation:** This type of variation includes facial expression, whether the mouth and eyes are open or closed and with or without glasses, beards and mustaches.
- 5. Image Conditions:** When the image is formed, factors such as lighting (spectra, source distribution and intensity) and dataset characteristic affect the appearance of a face.

1.4 Face recognition: advantages and disadvantages

The face image recognition has used many robust advantages the following :

Advantages: Face image recognition relates to a wide range of applications in the biometric approaches such as voice recognition, iris and fingerprint. In general, the face image recognition approach includes identifying individuals through their unique physical characteristics. Usually, PINs and passwords have been used to identify person formally, but the problems of these approaches are that someone else has used them or can be simple forgotten. But, the defect of voice recognition, fingerprints and iris is that they need the efficient cooperation of persons. Face image recognition is therefore the best method of biometric due to its variety uses that the individuals are recognized effectively via facing the negatively, or scanner face, as they walk in front of the scanner face [12].

There are types of problems using face image recognition. The faces are dynamic and can greatly vary in their recognition facial expression, size,

lighting and aging. So, face image recognition is a difficult problem to be solved. Because of these problems, many researchers have proposed a range of disciplines, including computer vision, artificial intelligence and pattern recognition, to solve many of these difficulties, as well as improving the robustness and accuracy of these methods [13]

1.5 Related works

To this search, it is easy to provide an outline of present processes within the face recognition literature. Many researches have attempted to find the results of the problem of face recognition; something that even little boys can do so effects, simply and obviously, from that time they may be born. Scientists and engineers were anxious with increasing face image recognition systems. This research has been performed on the sight for the singularity of faces and the participating factors which human help beings in recognizing faces, even though results propose that detection of faces is firstly based on special features, permanent proof indicates that faces have recognized to be identified as an essential stimulus [14].

Following are some of the former manipulations related to the subject:-

Fahim M., (2010) [15]: presented face image classification depend on facial images using the database consists of full frontal face. In the pre-processing step, the image intensities are normalized and the images were cropped by removing hair and background. After that, performed the images histogram equalization. Using the dimensionality reduction methods which are Independent Component Analysis (ICA) and Principal Component Analysis (PCA) to extract feature image that used as input to the Support Vector Machine (SVM) classifier.

Pal and Foody (2010) [16]: They present an approach which emphasizes on a need for dimensionality reduction as a preprocessing classification stage.

The experimental and results of study shows that the accuracy rat recognition of SVM algorithm can be increased when reducing the dimensionality of the data. So, the results show that the dimensionality reduction is the basic preprocessing step for SVM algorithm classification. Though, such relation was valid for a large dimensionality reduction, large training dataset are important. The experimental and results show that dimensionality reduction and the SVM algorithm classification accuracy are important correlated. The result when the feature dimensions considered is 55 and 65, the recognition accuracy rate is 92.24% and 91.76% respectively.

Hanane. B and Abdelaziz. B (2011) [17]: Introduce approach which deals with the non-trivial issue of human face image recognition. In fact, approach is depending on two main stages. The first one stage is to provide a providing prototype representative for each detected class and an unsupervised fuzzy learning algorithm, which used to detects the classes supposed present in the learning database. The next stage is an artificial neural network, which used the proprieties from the first step to determine the separating boundaries of classes in the data space.

Tiwari, V., (2012) [18]: In this study, demonstrated the advantages of use of features selection by noisy and extra data, removing non-relevant thus driving to the more accurate detection of face image from the database, in this work was used the Cuckoo-algorithm based feature selection algorithm , The algorithm is utilized to arranging of merit vectors taken away by 2D Discreet Cosine Transform of an image(DCT). The algorithm is applied to search the feature space for the optimum feature subset. At that time, the classifier discovers the most matching image from the database using Euclidean Distance.

Maodong, Shen, Cao Jiangtao, and Ping Li. (2012) [19]: Introduced a new approach that is a face image recognition system which is depending on matrix symmetrical image of the person face. Independent Components Analysis (ICA) is used to inspect the effect of brightness on face recognition and multi-dimensional data can be found in a small traditional ICA. The system implies neural network properties with face mirror property and Principal Component Analysis (PCA) is used to eliminate the second-class-related and decrease the dimensions, by using the ICA the features of the samples are extracted.

Yuan L., et al.,(2013) [20]: They introduced more versatile techniques in face recognition during preprocessing stage of the image by adopting eight eyes segmentation, geometry normalization and energy normalization. Then to attract the global features of the complete expression image as well as the local texture feature of mouth, by using Local Binary Pattern (LBP) and PCA. After the two kinds of feature ultimate recognition and expression classification, the SVM algorithm is used. For the experiment, from total samples of training images, half of the images are poor condition of illumination while half are clear condition. Seven recognition expressions are involved in experiment out of six expressions (happy, surprise, sadness, anger, fear, and disgust) and the result of the average recognition rate is 94%.

Isra'a Abdul-Jabbar (2014) [21]: This study aims to present the improvement of the face recognition rate by image enhancement process. The peculiarity of this work concentrates on improving of the face recognition in the light of face image enhancement, the image file format, the combine of Principle Component Analysis (PCA), Linear Discernment Analysis (LDA), Kernel Principle Component Analysis (KPCA) and Kernel Feature Analysis (KFA) feature extraction and feature reduction dimension. In the initial step,

faces images are adjusted with the image the adjustment, after that point, the images are presented with histogram equalization, then the face image is converted over from PGM to BMP and JPG to get two face databases with great quality, each of them 400 face images database. To decrease the dimension of face images, the PCA algorithm is used with measurement of two distance; Mahcos distance and Euclidean distance, while the Mahcos distance utilizes the remaining three techniques KPCA ,LDAand KFA. The output gained by the use of this approach show clearer metrics, sharp edges as well as provides more points of interest that prompted the predominant execution than the original PGM AT&T ORL database. The highest recognition rate reached by this research is 97%.

Barnoti Nawaf, et al., (2016) [22]: They presented face image recognition system , the initial phase in this system is face detection by using Viola-Jones algorithm, the subsequent step was feature extraction and feature reduction of dimension by LDA and PCA techniques. Square Euclidean Distance is utilized to find the distance between two consecutive images, which prompts to detect image similarity. The outcomes accomplished through the use of the proposed framework to three databases (Face94, MUCT, and Grimace) are (100%, 87.5% and 100%) separately.

Nishu R. and Rajan S. (2016) [23]: In this work, the Scale-Invariant feature transform (SIFT) is used to get the features extracted, the optimized Features are gathered from the extracted features by the use of Cuckoo Search Algorithm. This work exhibits a method for the user authentication system in depending on the combine acquisition of face and fingerprint. Feature level fusion is used as it is used to enhance and provide the optimal results of identification. The accuracy rate of the proposed system is 0.97% .