



International Journal of Emerging Technologies in Computational and Applied Sciences (IJETCAS)

www.iasir.net

Analysis and Comparison of Advanced Face Detection Using PSO and PCA

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Abstract: The objective of this paper is to provide an efficient method to find out the best algorithm in between PCA and PSO using different parameters that are used for face reorganization. Assessment for image quality is a traditional need. The conventional method for measuring quality of image is MSE & PSNR. In this paper we compared the different image enhancement techniques by using their quality parameters (MSE & PSNR) & proposed a new erosion enhancement technique. This technique gives better result than other techniques and their PSNR value is high & MSE is low. The experimental results show that the proposed enhancement method gives better results Face recognition is one of the most important biometrics which seems to be a good compromise between actuality and social reception and balances security and privacy well. It has a variety of potential applications in information security law enforcement and access controls. This paper discusses different face recognition techniques by considering different test samples. The experimentation involved the use of Eigen faces and PCA. Another method based on PSO in spectral domain has also been implemented and tested. The best method will be decided on the result of Accuracy, Elapsed time, PSNR value and MSE values of both methods.

Key Words: PCA (Principal Component Analysis), PSO (Particle Swarm Optimization), PSNR (Peak Signal-to-Noise Ratio), MSE (Mean Squared Error)

I. Introduction

Face recognition is biometric identification by scanning a person's face and matching it against a library of known faces. Face recognition is defined as the identification of a person from an image of their face. Face Recognition systems can be of two types[1]. Firstly, Face Identification: Given a face image that belongs to a person in a database and to tell whose image it is. Secondly, Face Verification: Given a face image that might not belong to the database, verify whether it is from the person it is claimed to be in the database. The main aim of most commercial face recognition is to increase the capability of security and surveillance systems. In theory, security systems involving face recognition would be impossible to hack, as the identification process involves unique identification methods, and thus only authorized users will be accepted [2]. Face recognition has N classes, where each class represents one person from N individuals that mean multi class classification (one person vs. all the others). Face recognition must discriminate between the subtle differences of human faces. Face recognition is performed in order to determine the identity of each face. Applications of face recognition are access control, face databases, face identification, human computer interaction, law enforcement, smart cards and multimedia management.

II. Related Work

Currently there are many methods of biometric identification viz., fingerprint, eye iris, retina, voice, face etc. Each of these methods has certain advantages and disadvantages, which must be considered in biometrical system developing: system reliability, price, flexibility, necessity of physical contact with scanning device and many others. Selecting the certain biometrical identification method or using the multi-biometrical system can help to support these, often discrepant, requirements. Face identification can be an important alternative for selecting and developing optimal biometrical system. Its advantage is that it does not require physical contact with image capture device (camera). Face identification system does not require any advanced hardware; it can be used with existing image capture devices like web cams, security cameras etc [3]. The PSNR block computes the peak signal-to-noise ratio, in decibels, between

two images. This ratio is often used as a quality measurement between the original and a compressed image. The higher the PSNR, the better the quality of the compressed or reconstructed image. The *Mean Square Error (MSE)* and the *Peak Signal to Noise Ratio (PSNR)* are the two error metrics used to compare image compression quality. The MSE represents the cumulative squared error between the compressed and the original image, whereas PSNR [4] represents a measure of the peak error. The lower the value of MSE, the lower the error. To compute the PSNR, the block first calculates the mean-squared error using the following equation:

$$MSE = \sum_{M,N} (I(m,n) - \hat{I}(m,n))^2 / M * N$$

In the previous equation, M and N are the number of rows and columns in the input images, respectively. Then the block computes the PSNR using the following equation:

$$PSNR = 10 \log_{10} (R^2 / MSE)$$

III. Particle Swarm Optimization

Based on the idea of collaborative behaviour and swarming in biological populations inspired by the social behaviour of bird flocking or fish. Recently PSO has been applied as an effective optimizer in many domains such as training artificial neural networks, linear constrained function optimization, wireless network optimization, data clustering, and many other areas where GA can be applied [5]. Computation in PSO is based on a population (swarm) of processing elements called particles in which each particle represent a candidate solution. The system is initialized with a population of random solutions and searches for optima by updating generations. The search process utilizes a combination of deterministic and probabilistic rules that depend on information sharing among their population members to enhance their search processes. Information sharing mechanism in PSO is considerably different. In GAs, chromosomes share information with each other, so the whole population moves like one group towards an optimal area. In PSO, the global best particle found among the swarm is the only information shared among particles. It is a one-way information sharing mechanism. Computation time in PSO is significantly less than in GAs because all the particles in PSO tend to converge to the best solution quickly.

A basic variant of the PSO algorithm works by having a population (called a swarm) of candidate solutions (called particles). These particles are moved around in the searchspace [6] according to a few simple formulae. The movements of the particles are guided by their own best known position in the search-space as well as the entire swarm's best known position. When improved positions are being discovered these will then come to guide the movements of the swarm. The process is repeated and by doing so it is hoped, but not guaranteed, that a satisfactory solution will eventually be discovered. Formally, let $f: R^n \rightarrow R$ is the fitness or cost function which must be minimized. The function takes a candidate solution as argument in the form of a vector of real numbers and produces a real number as output which indicates the fitness of the given candidate solution. The gradient of f is not known. The goal is to find a solution a for which $f(a) \leq f(b)$ for all b in the search-space, which would mean a is the global minimum. Maximization can be performed by considering the function $h = -f$ instead. Let S be the number of particles in the swarm, each having a position $x_i \in R^n$ in the search-space and a velocity $v_i \in R^n$. Let p_i be the best known position of particle i and let g be the best known position of the entire swarm. A basic PSO algorithm is then:

For each particle $i = 1, \dots, S$ do:

Initialize the particle's position with a uniformly distributed random vector: $x_i \sim U(b_{lo}, b_{up})$, where b_{lo} and b_{up} are the lower and upper boundaries of the search-space.

□ Initialize the particle's best known position to its initial position: $p_i \leftarrow x_i$

□ If $(f(p_i) < f(g))$ update the swarm's best known position: $g \leftarrow p_i$

□ Initialize the particle's velocity: $v_i \sim U(-|b_{up} - b_{lo}|, |b_{up} - b_{lo}|)$

□ Until a termination criterion is met (e.g. number of iterations performed, or adequate fitness reached), repeat:

□ For each particle $i = 1, \dots, S$ do:

□ For each dimension $d = 1, \dots, n$ do:

□ Pick random numbers: $r_p, r_g \sim U(0,1)$

□ Update the particle's velocity: $v_{i,d} \leftarrow \omega v_{i,d} + \phi_p r_p (p_{i,d} - x_{i,d}) + \phi_g r_g (g_d - x_{i,d})$

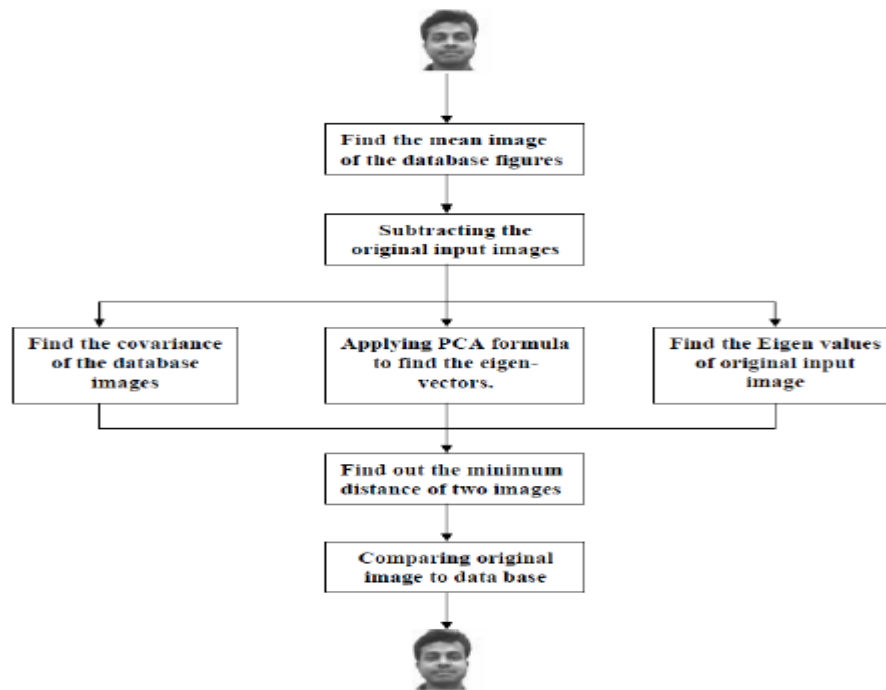
- Update the particle's position: $x_i \leftarrow x_i + v_i$
- If $(f(x_i) < f(p_i))$ do:
- Update the particle's best known position: $p_i \leftarrow x_i$
- If $(f(p_i) < f(g))$ update the swarm's best known position: $g \leftarrow p_i$
- Now g holds the best found solution.

The parameters ω , ϕ_p , and ϕ_g are selected by the practitioner and control the behaviour and efficacy of the PSO method.

IV. Principal Component Analysis

PCA also known as Karhunen Loeve projection. PCA calculates the Eigen vectors of the covariance matrix, and projects the original data onto a lower dimensional feature space, which is defined by Eigen vectors with large Eigen values. PCA has been used in face representation and recognition where the Eigen vectors calculated are referred to as Eigen faces. In gel images, even more than in human faces, the dimensionality of the original data is vast compared to the size of the dataset, suggesting PCA [7] as a useful first step in analysis. There are many approaches to face recognition ranging from the Principal Component Analysis (PCA) approach (also known as Eigen faces). Prediction through feature matching. The idea of feature selection and point matching has been used to track human motion. Eigen faces have been used to track human faces. They use a principal component analysis approach to store a set of known patterns in a compact subspace representation of the image space, where the subspace is spanned by the Eigen vectors of the training image set. PCA is a useful statistical technique that has found application in fields such as face recognition and image compression, and is a common technique for finding patterns in data of high dimension. The basic goal is to implement a simple face recognition system, based on well-studied and well-understood methods. One can choose to go into depth of one and only one of those methods. The method to be implemented is the PCA (Principle Component Analysis). It is one of the more successful techniques of face recognition and easy to understand and describe using mathematics. This method involves using Eigen faces [8]. The first step is to produce a feature detector (dimension reduction). Principal Components Analysis (PCA) was chosen because it is the most efficient technique, of dimension reduction, in terms of data compression. This allows the high dimension data, the images, to be represented by lower dimension data and so hopefully reducing the complexity of grouping the images.

Figure 1. Face reorganization system for PCA

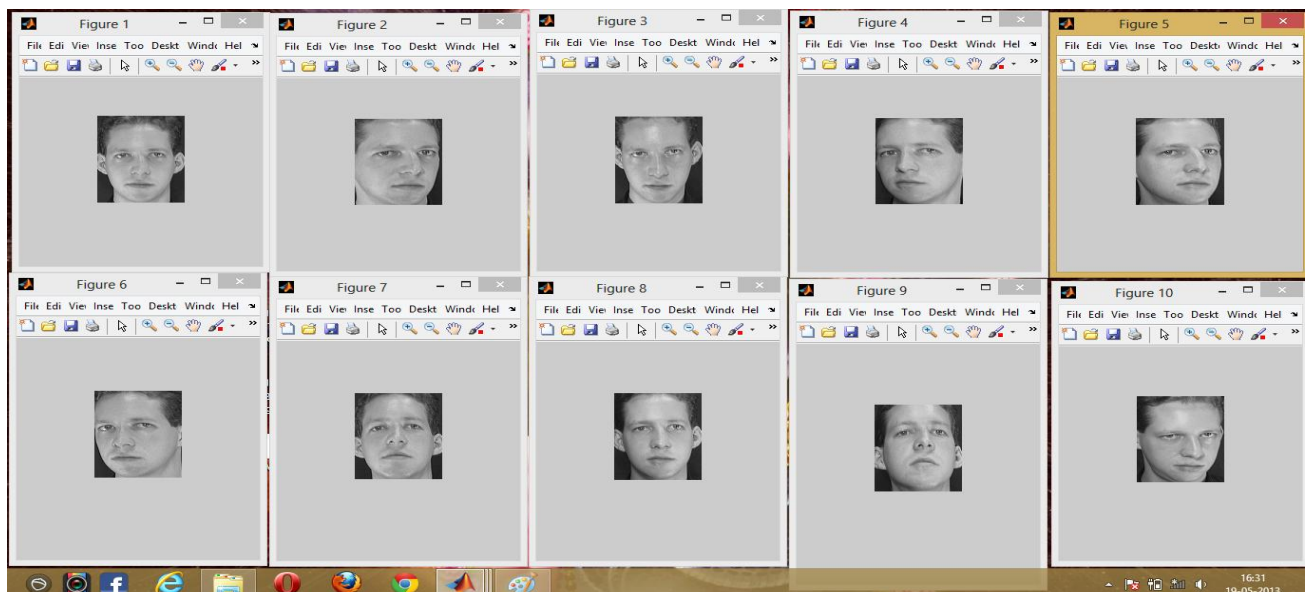


V. Methodology

A. Data Acquisition

A database of different image sets of faces was constructed. So that we can match a face of a person whose photos are taken in different angles. Because it is not possible in every time that the image of a person present in data base is always from the front view. It may be from side angle, upper angle, lower angle and any form of angle. So in this data base set we are used all the possible angle so that we can calculate the accuracy of the image using PCA and PSO.

Figure 2. Images for different angles for PSO & PCA algorithm



B. Calculation of PSNR and MSE value of the images for PSO & PCA

PSNR is most commonly used to measure the quality of reconstruction of lossy compression codes (e.g., for image compression). The signal in this case is the original data, and the noise is the error introduced by compression. When comparing compression codes, PSNR is an approximation to human perception of reconstruction quality. Although a higher PSNR generally indicates that the reconstruction is of higher quality, in some cases it may not. One has to be extremely careful with the range of validity of this metric; it is only conclusively valid when it is used to compare results from the same codec (or codec type) and same content. PSNR is most easily defined via the mean squared error [10] (MSE). Given a noise-free $m \times n$ monochrome image I and its noisy approximation K , MSE is defined as:

$$MSE = 1/mn \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} [I(i, j) - K(i, j)]^2$$

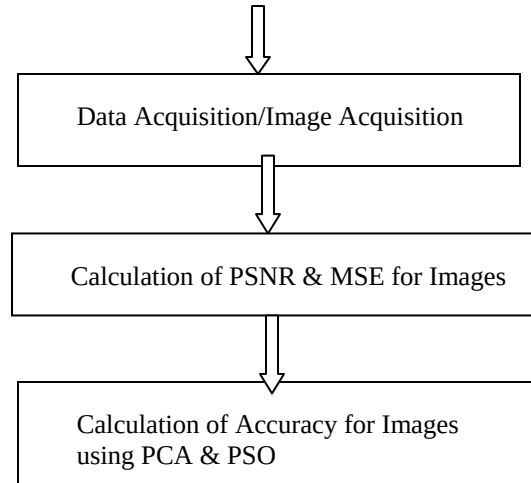
The PSNR is defined as:

$$\begin{aligned} PSNR &= 10 \cdot \log_{10} (MAX_I^2 / MSE) \\ &= 20 \cdot \log_{10} (MAX_I / \sqrt{MSE}) \\ &= 20 \cdot \log_{10} (MAX_I) - 10 \cdot \log_{10} (MSE) \end{aligned}$$

C. Calculation of Accuracy and elapsed time of PSO & PCA Algorithm

The accuracy of a classification is usually assessed by comparing the classification with some reference data that is believed to accurately reflect the true land-cover. Sources of reference data include among other things ground truth, higher resolution satellite images, and maps derived from aerial photo interpretation [11]. Note that virtually all reference data (even ground truth data) are inaccurate to some degree as well. The accuracy assessment reflects really the difference between our classification and the reference data. Consequently, if your reference data is highly inaccurate, your assessment might indicate that your classification is poor, while it really is a good classification. It is better to get fewer, but more accurate, reference data. Also be aware of temporal changes: If your satellite image was taken at a different time than when you collected your reference data, apparent errors might be due to the fact that your landscape has changed.

Flow Chart:



VI. Final Output or Result

PSO Accuracy = 90.5882

Elapsed time is 5.096668 seconds.

PSNR = +14.37 dB

MSE = +2375.29

PCA Accuracy = 85.5556

Elapsed time is 5.107210 seconds.

PSNR = +13.87 dB

MSE = +2667.40

Table 1-Comparison Table for PSO & PCA Algorithm

Algorithms	PSNR	MSE	Elapsed Time	Accuracy
PSO	+14.37 dB	+2375.29	5.096668s	90.5882
PCA	+13.87 dB	+2667.40	5.107210s	85.5556

VII. Conclusion

Image quality measurement plays an important role in various image processing applications in this paper different techniques are applied on a OLR image set having in different angle of image & among these techniques PSO method is the best method because in this PSNR has maximum value and MSE has lower value. Finally the accuracy for PSO is higher than PCA method and also the elapsed time is Minimum for PSO but it is maximum for PCA. The above comparison chart shows that PSO is better algorithm for advanced face detection method than that of PCA algorithm.

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