A Review on Face Recognition with Artificial Neural Network and Particle Swarm Optimization

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***Abstract*— Face recognition is the technique for detecting and validating the human face. Face recognition could be from digital images, images from database and sensor images. It becomes a challenging task because of vast distinctions in face appearances, brightness effect and the intricacies involved in the background of an image. Face recognition is the most prominent, significant, reliable and relevant applications of biometric and image processing schemes. In this paper, we present a review which entails a discussion of facial recognition by using artificial neural network (ANN) and particle swarm optimization (PSO) comparing both algorithms and analysing which of the them gives the optimum outcomes. Recommendations are also been engaged for further research works.**

***Index Terms*— Face Recognition, Artificial Neural Network, Particle Swarm Optimization.**

I. Introduction

It is an individual's consideration and interpretation relation to the linked information processing in the brain about the face, particularly the human face. The proportions and expressions of the human face are significant to recognize origin, emotional inclinations, health potentials, and some social information. Faces are significant in the person's social interaction, since from birth. Face perceptions are extremely intricated as the recognition of facial expressions comprises diverse wide-ranging areas in the brain. Damaged parts of the brain can cause specific impairments in understanding faces or prosopagnosia, sometimes. Face recognition has been a vital research topic in the pattern recognition field primarily due to ever surging security demands and its potential commercial and law administrative applications. The last decade has revealed dramatic advancement in this area, with prominence on such applications as Robotics, Human-Computer Interaction (HCI), Biometric Analysis, Content-Based Coding of surveillance of images and videos. An Artificial Neural Network (ANN), generally called neural network (NN), is a computational mathematical model that is enthused by the structure and/or functional features of biological neural networks. A neural network embraces of an interconnected group of artificial neurons, and it processes information using a connectionist method for calculation. In several cases, an ANN is an adaptive system that arranges and amends its structure according to external or internal informational data that comes out from the network throughout the learning phase. This paper reviews on Neural Network based efficient and robust face recognition algorithm. Here, a general technique is used for face recognition in which the entire face of the person is taken as the data for input. This algorithm uses the concept of mean image which attempts to include all the prospects of the subject's images on database. The only pre-processing of the training images is the calculation of mean image on the database. The mean image of a subject is taken as an input to the neural network and the network trains itself according to the target image of the subject. After the network has been trained the weight vectors for individual subjects have been updated and stored in database and then on basis of these weight vectors in the database, recognition of any new test image is achieved.

II. Particle Swarm Optimization

Particle Swarm Optimization i.e. PSO is one of the most lately advanced evolutionary method, and it is centred on an appropriate model of social interface between particles (independent agents) and it uses social information in directive to discover the global minimum or maximum of a generic function. Even though for the GA, the enhancement in the population fitness is guaranteed by pseudo biological operators, likewise mutation, selection and crossover. the core PSO operator is the updation of velocity that receipts into account the superlative position discovered with the process of iterations, ensuing in a relocation of the swarm to the global optimal.

In the PSO the term swarm intelligence i.e. the experience gathered during the development is used to explore the constraint space by monitoring the trajectories of a group of particles likewise swarm like set of rules. The location of each & every particle is used to calculate the optimized value of the function. Subsequently, each position is a specific solution of the problem optimization. Each & every particle traverses the problematic hyper space and are fascinated by both the location of the global finest performance of the whole swarm and the location of their finest past performance. Particles are moving in the field of problem with varying speeds and every location they reach signifies a specific configuration for variable set, which is then assessed in directive for getting score.

As for Genetic Algorithm (GA), the initial point for PSO is the description for random population of particles. In the PSO method every particle i^{th} is demarcated by its position vectors X_i in the space of the constraints to be optimized but contrarily than GA, such a particle also has arbitrary velocity in the space parameter. At every iteration the particle moves to its velocity accordingly and the optimization of cost function $f(X)$ is assessed for each & every particle with their existing position. The value of the cost function is then equated with the finest

value attained during the earlier iterations. Also, the finest value ever attained for every particle is kept stored and the adjacent position P_i is stored & kept too. The particle's velocity is then stochastically updated ensuing the updating rules according to the attraction of the position P_i of its individual optimal and the position P_g, i.e. the global optimal. Memorizing that the global optimal is the finest fitness value ever reached by all the swarm algorithms, equation illustrates the renowned standard PSO updating rule for velocities of particles:

$$V_{i+1} = \omega V_i + \varphi_1 \eta_1 (P_i - X_i) + \varphi_2 \eta_2 (P_g - X_i)$$

Where ω denotes friction factor that inclines to stop the particle and prevents oscillations nearby the optimum value, efficiently accelerating up convergence. φ_1 & φ_2 are constant coefficients, whereas η1 & η2 are arbitrary positive numbers with an even distribution between 0 and 1. The existence of arbitrary weights in the pull relations engendered by the particles best position P_i and the global swarm finest position origins wide oscillations and a random exploration in the complete space parameter. Such oscillations are valuable however they widen the exploration of every particle but they have some downsides as they can yield continuous oscillation nearby the optimum point. Such oscillation can be reduced, and so that convergence improved with an efficient use of the ω parameter.

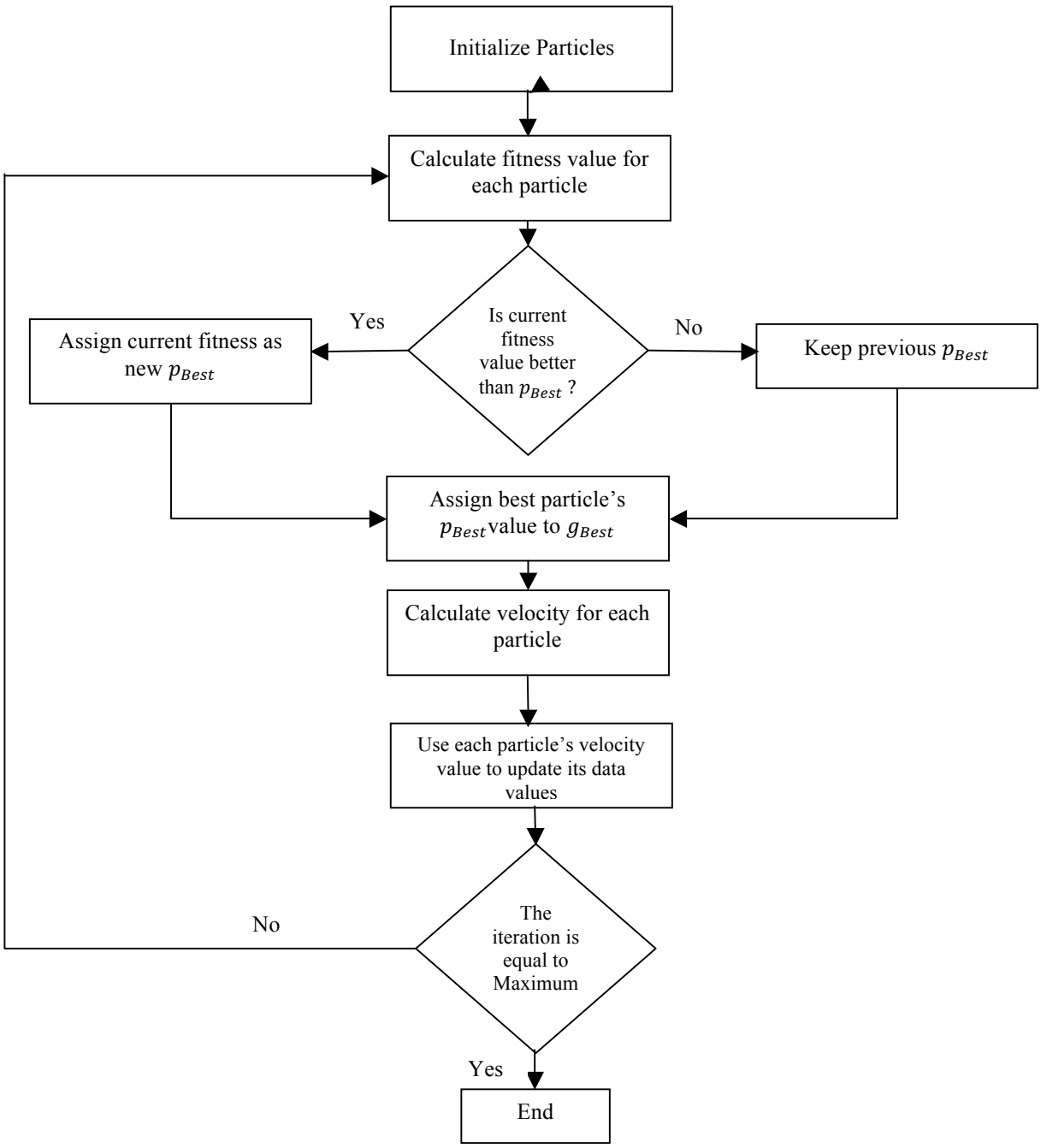

Figure 1: Flowchart of PSO

III. CLASSIFICATION OF FACE RECOGNITION

Face recognition states can be divided into two phases, Face verification i.e. authentication and Face identification i.e. recognition.

1) Face verification: It is a one-to-one match that equates a query face image against a reference face image whose identity is being requested. To assess the authentication performance, the authentication rate, the rate at which legitimate users are granted access versus false accepts rate i.e. rate at which imposters are granted access is plotted, called ROC curve. A good verification system should set equilibrium these two rates based on operational requirements.

2) *Face identification:* It is a one-to-many matching procedure that compares a query face image against all the reference images in a face database to evaluate the identity of the query face. The identification of the test image is achieved by tracing the image in the database that has the highest resemblance with the test image. The identification procedure is a "closed" test, which means the sensor takes an observation of an individual that is acknowledged to be in the database. The test subject's normalized features are equated with the other features in the system's database and a resemblance score is found for each evaluation. These resemblance scores are then statistically ranked in a descending order. The percentage of times that the highest resemblance score is the accurate match for all individuals is stated as the "top match score".

IV. LITERATURE REVIEW

Brunelli and Paggio [1] presented a paper based on assessment of two simple but general approaches on a common database. Database comprises of frontal images of faces of 47 people out of which 26 are of males and rest 21 are of females, contains four images per person. The research work developed and implemented two novel algorithms, the first one is calculation based on set of geometrical features such as nose length and width, chin and mouth shape and the second one is based almost on grey-level reference matching. The outcome attained on the testing sets, was about 90% accurate cognition using the geometrical feature, and perfect recognition using reference matching technique.

Thai [2] introduced some innovative models for all phases of a face recognition system. It projected a hybrid model merging Ada Boost and Artificial Neural Network (ABANN). It defines a methodology for improving the efficiency by the association of two methods: Independent Component Analysis technique and geometric feature-based technique. The model links many Neural Networks together, so termed as Multi Artificial Neural Network. Finally, the experimental results of all steps on CallTech database demonstrate the viability of his proposed model.

Garro and Vázquez [3] Presented a technique that automatically designs an ANN using particle swarm optimization algorithms such as basic PSO, SGPSO, and NMPSO. The methodology is compared with those designed manually using the renowned Levenberg-Marquardt Learning algorithm and Back-Propagation algorithms. Finally, the precision of the technique is tested with different nonlinear pattern classification problems with result attained.

Marami and Tefas [4] outlined a face detection technique that uses Particle Swarm Optimization (PSO) for finding the image is proposed. The algorithm uses a linear Support Vector Machine (SVM) as a accurate and fast classifier in order to find a face in the 2D solution space. Using PSO, the comprehensive search in all possible combinations of the 2D coordinates can be sidestepped to save time and lessening the computational complexity. Moreover, linear SVMs have confirmed their efficiency in classification of problems, especially in challenging applications. Investigational results based on real recording conditions from the Bio ID database are very promising and backing the potential use of the proposed method for real applications.

Ranawade [5] introduced a simple method for identification of human faces in disarrayed scenes based on neural nets. In detection phase, neural nets are used to examine whether a window of 18x27 pixels comprises a face or not. A foremost difficulty in learning process comes from the large database essential for face/non-face images. We resolve this problem by separating these data into two groups. Such partition outcomes in decreasing of computational complexity and thus lessening the time and memory needed during the test of an image. The planned face recognition method entails of three parts; pre-processing, feature extraction, and recognition phases**.** Gradient Vector technique is used for facial feature extraction. A face recognition system based on recent technique which concerned with both representation and recognition using artificial neural networks is revealed. It then assesses the performance of the system by implementing two photometric normalization methods: histogram equalization and homomorphic filtering. The structure yields promising outcomes for face verification and face recognition.

Kasar *et al*. [6] Deliberated numerous face recognition algorithm using ANN which are successfully been useful in the field of image processing and pattern recognition. It also comprises wide analysis of face recognition system and studies based on diverse ANN methods and techniques. The strengths and restrictions were also encompassed. Performance outcomes of different ANN were examined.

Ramadan and Abdel–Kader [7] engrossed on PSO, It also reveals a innovative feature selection algorithm based on particle swarm optimization PSO, an algorithm applied to coefficients derived from by two feature abstraction methods: DCT i.e. the discrete cosine transforms and DWT i.e. the discrete wavelet transform. The PSO based feature selection system is applied to

examine the feature space. The Investigational outcomes demonstrates that the PSO-based feature selection algorithm was found to engender excellent recognition outcomes of selected features with the minimal set.

Seyedali Mirjalili et.al. [8] introduced a novel hybrid population based algorithm (PSOGSA) is projected with the amalgamation of Gravitational Search Algorithm (GSA) and Particle Swarm Optimization (PSO). The key idea is to assimilate the capability of exploitation in PSO with the capability of examination in GSA to use both algorithms' assets. Some standard test functions were used in this paper to compare the hybrid algorithm with both the standard GSA and PSO algorithms in simulating optimum solution. The outcomes illustrated that hybrid algorithm owns a improved ability to escape from local ideal situation with quicker convergence than the standard GSA and PSO.

CONCLUSION

In this review paper, we reviewed various algorithms used so far for face recognition. Hybrid algorithm likewise with amalgamation of strengths of PSO and GSA were used, outcomes revealed that the convergence speed of PSOGSA is faster than PSO and GSA individually. Howbeit, strengths of PSO and ANN has not been used, hitherto for face recognition. Which will further be useful in security system and can be better than current biometric security system.

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