Journal of Engineering and Applied Sciences 14 (9): 2982-2987, 2019
ISSN: 1816-949X

Face Recognition Approach using an Enhanced Particle Swarm Optimization and Support Vector Machine

[1]Wasan Kadhim Saad, [2]Waheb A. Jabbar and [3]Ahmed Abdul Rudah Abbas
[1]Engineering Technical College, Al-Furat Al-Awsat Technical University, Najaf, Iraq
[2]Faculty of Engineering Technology, Universiti Malaysia Pahang (UMP), Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Pahang, Malaysia
[3]Department of Computer Science Faculty of Education for Women, University of Kufa, Kufa, Iraq

Abstract: Face recognition is one of the most promising research area in the last decades. The SVM approach is one of the famous approaches in machine learning fields because it can determine the global optimum solutions with lesser number of training samples especially, complex non-linear challenges such as in face recognition applications. Though, there is an important issue that can affects the whole classification process which is picking the optimum parameters of SVM. Recently, Particle Swarm Optimization (PSO) is used to discover the optimal parameters of SVM and many versions of PSO are used for this purpose, like: PSO-SVM technique, opposition PSO and SVM which called (OPSO-SVM) technique and AAPSO-SVM technique which represents adaptive acceleration PSO and SVM. In this study, a new hybrid technique based on the combination of "Accelerated PSO" and "OPSO-SVM" is introduced for face recognition applications. The hybridization can improve the convergence speed in PSO in order to find the optimal parameters of SVM. In the feature extraction process, the PCA algorithm is used for that purpose and the resulted features are delivered to the proposed technique in order to classify the face images. Two human face datasets are used in the experimentation stage such as, SCface dataset and CASIA face dataset in order to validate the performance of the proposed technique. The comparison process for proposed technique with the other recent technique, like: PSO-SVM, OPSO-SVM and AAPSO-SVM is done as an assessment process. The proposed technique provided high accuracy for recognition when we compared it with the other techniques and it was robust in finding the optimal parameters of SVM.

Key words: Support Vector Machine (SVM), Particle Swarm Optimization (PSO), Opposition PSO (OPSP), Adaptive Acceleration PSO (AAPSO), face recognition, PCA

INTRODUCTION

Lately, facial recognition has become one of the most important trends in the field of pattern recognition applications and is used to check using the human face on a large scale (Shailaja and Anuradha, 2017; Abdullah *et al*., 2017). The lack of recognition of faces makes it a complex problem, so, many of studies have in recent years used the techniques of artificial intelligence to deal with the challenges of facial recognition.

Nevertheless, neural networks such as neural network of the posterior proliferation are one of the most common artificial intelligence techniques widely applied in facial recognition domain (Aitkenhead and McDonald, 2003; Sun and Tien, 2008). In addition for the applications of face recognition which use neural networks, it is easily fall into local optimal and over-fitting which can lead to unreliable and undesirable results.

Thus, it is very important to find a new type of facial recognition techniques to ovoid the above problems such as SVM which is represent a one of well-known approach that is classified under the machine learning approaches category. This technique works on the principle of risk reduction with a small number of training samples and a high-risk problems, that can be lead to a global ideal solutions. Gold and Sollich (2003), Lauer and Bloch (2008) and Abdulameer *et al*. (2006). However, the selection process the parameters for SVM training has a significant impact on the performance of the entire SVM.

Recently, PSO is proposed by Kennedy and Eberhart (1995), that is motivated by the social activities among people like the birds blocking or fish grouping (Kalivarapu *et al*., 2009; Africa, 2017). However, PSO is initially begins with an initial set of random solutions called, particles, so that, the resulting particles are random (Karmel, 2017). At this stage, it studies through the

Corresponding Author: Wasan Kadhim Saad, Engineering Technical College, Al-Furat Al-Awsat Technical University, Najaf, Iraq

modernization of the generations to get the optimal solution. However, the PSO standard suffers from some limitations, like: the fixed value of the inertia weight, the random population configuration and the fixed values in speed coefficients (Abdulameer *et al*., 2014). Therefore, for the applications of face recognition, there are several various versions of PSO algorithm that have been used with the SVM technique to obtain the optimal parameters for the SVM such as PSO-SVM technique which presented by Wei *et al*. (2011) for face recognition and optimize the SVM parameters through used the standard SPO. Nevertheless, the populations are generated randomly in PSO which can affect the population result. Consequently, a modified version based on opposition PSO and SVM which called(OPSO-SVM) technique has been provided by Hasan *et al*. (2013) to resolve this problem where the populations are created on the basis of random numbers and opposition. In addition, Yang *et al*. (2011) introduced another new version of PSO with SVM, named, accelerated PSO-SVM technique for the purpose of business optimization which was a simplified and accurate version of PSO. However, accelerated PSO is utilized to find the finest kernel parameters in SVM, then used the resulted kernel parameters to build the SVM. In addition, the use of random values to calculate velocity has affected the selection of SVM parameters. Moreover, Abdulameer *et al*. (2014) have developed a new strategy, called: AAPSO-SVM technique which represents adaptive acceleration PSO and SVM and it is basis on the fattiness values to choose the velocity coefficients in the PSO.

Nevertheless, the issue still has a room of improvements in choosing the optimal parameters of SVM. Thus, in this study, a new technique is developed based on the hybridization between "Accelerated PSO" that was presented by Yang *et al*. (2011) and "OPSO-SVM" which was presented by Hasan *et al*. (2013) for face recognition applications.

MATERIALS AND METHODS

The proposed methodology is consist of three different parts:

- Feature extraction using Principle Component Analysis (PCA)
- The proposed Accelerated PSO+OPSO-SVM technique
- Selecting SVM parameters using the proposed Accelerated PSO+OPSO-SVM technique

The main structure of the whole proposed technique is depicted in Fig. 1.

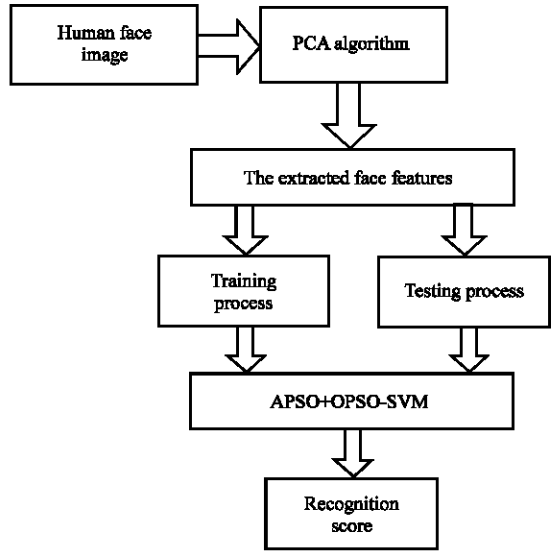

Fig. 1: The proposed methodology

Feature extraction using PCA: The extracted features can have a high power on the verification process for the proposed technique to authenticate the human face perfectly. Thus, we need a reliable and well-known algorithm to complete the proposed methodology for face recognition applications such as PCA which have been used in this study for this purpose. Originally, Karl Pearson (1901) was developed PCA in mechanics field in place of an analogue of the "principal axis theorem", it was future individually advanced in 1930s and named through "Harold Hotelling". It works as described below:

- Ignore the class labels after taking the entire dataset
- D-dimensional mean vector is computed
- Scatter matrix is computed
- The covariance matrix is otherwise to the scatter matrix
- Compute eigenvectors and equivalent eigenvalues
  - Examine the Eigenvector-eigenvalue production
  - Seeing the Eigenvectors
- Sort the eigenvectors by eigenvalues reduction
- Picking k Eigenvectors with the baggiest Eigenvalues
- Transform the samples to new subspace

The proposed accelerated PSO+OPSO-SVM technique: PSO is originally presented by Kennedy and Eberhart (1995) and it was imitating the social behavior of fish school and the bird groups. It is primarily begin with a gathering of random solutions that is termed as particles, so, the produced particles will be random (Karmel, 2017). In that time, it seeks by updating generations in order to find the optimal solution.

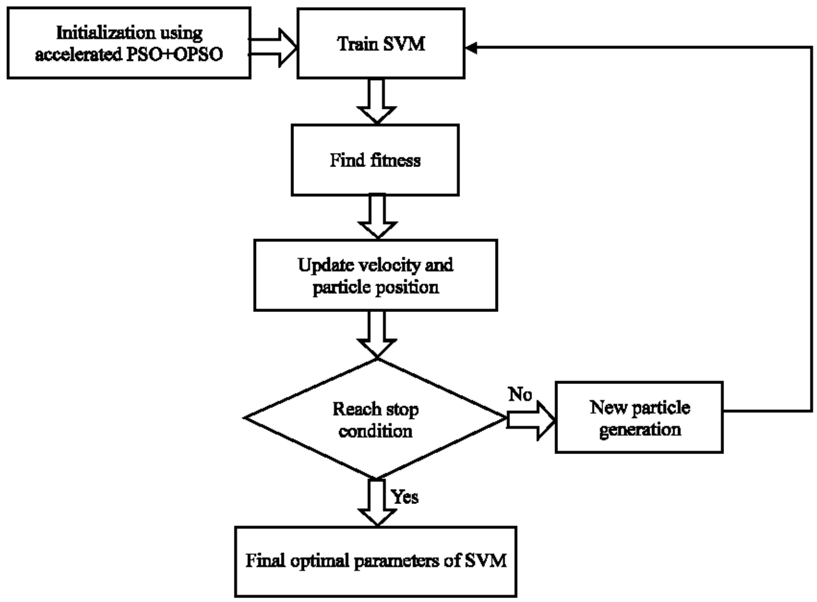

Fig. 2: SVM parameters optimization using accelerated PSO+OPSO

In this proposed technique, a generation of particles has been created randomly and use the opposite number in accordance with the OPSO-SVM approach. However, description of the strategy of exhibition numbers have been briefly explaining in accordance with these rules: consider fgenerated between the intervals {s,h} as a real number, then the opposition numbert-can bedefined by using this formula f- = s+h-f.

Consider m = $\{f_1, f_2, ..., f_l\}$ as a point whereas i∈ $\{s_i+h_i+f_i\}$ and it is dependent onthose points, thus, the opposition points will be defined as s_i- = $\{f_1, f_2, ..., f_r\}$ whereas f_i- = $s_i+h_i+f_i$.

However, each particle in every iteration is updated by used two values such as local best value (Lbest) and another value which called global best (gbest) that can be obtained it for any particle in the entire population.

The simplified version that can accelerate convergence of the algorithm in the proposed technique is through use the global best (g*) only. Thus, the velocity vector in the accelerated (PSO) is generated by a simpler formula as follow:

$$V_i^{t+1} = V_i^t + \alpha \in_n + \beta(g^* = x_i^t) \quad (1)$$

where, x_i and V_i the position vector and velocity for the particle i and ε_n use to replace the second term through drawn from N (0, 1) while the parameters α and β are the learning parameters or acceleration constants. Therefore, the update of the position is simply as follow:

$$X_i^{t+1} = X_i^t + V_i^{t+1} \quad (2)$$

We can see that this simpler version will give the same order of convergence, thus, can be conclude that through comparison with many PSO variants, APSO is much simple mechanism and can be understand it as well as it is uses only two parameters for operation.

Selection of SVM parameters using accelerated PSO+OPSO technique: The optimization process of SVM parameters are optimized through using the accelerated PSO+OPSO technique as shown in Fig. 2.

RESULTS AND DISCUSSION

Two different datasets are used in this study such as SCface face dataset (Grgic *et al*. 2011) and CASIAface dataset (Anonymous, 2007) as shown in Fig. 3 which shows an example of SCface database and CASIA face database images, respectively. The experimentation for these images are done through using MATLAB environment. The human face datasets are used to investigate the performance of the proposed technique in face recognition applications.

SCface face image: This is the database for testing of static images (in visible and infrared spectrum) of human faces that contains 4160 static images for 130 people. The images were taken in an internal environment that is not subject to control through used five video surveillance

Table 1: The accuracy results for the SCface database of the PSO-SVM, OPSO-SVM, AAPSO-SVM and the proposed technique

Experiments	PSO-SVM	OPSO-SVM	AAPSO-SVM	The proposed accelerated PSO+OPSO-SVM
1	75	82	79	88
2	80	87	75	87
3	78	85	74	89
4	74	84	77	90
5	88	90	83	94
6	73	81	72	94
7	74	81	79	87
8	77	84	71	93
9	79	85	78	85
10	70	80	70	93

Table 2: The accuracy results for the CASIA face database of the PSO-SVM, AOPSO-SVM and the proposed technique

Experiments	PSO-SVM	OPSO-SVM	AAPSO-SVM	The proposed accelerated PSO+OPSO-SVM
1	75	80	84	94
2	76	86	83	99
3	70	90	83	94
4	77	91	89	100
5	70	89	80	93
6	76	91	84	98
7	70	93	87	92
8	75	90	84	100
9	80	91	85	96
10	80	87	86	90

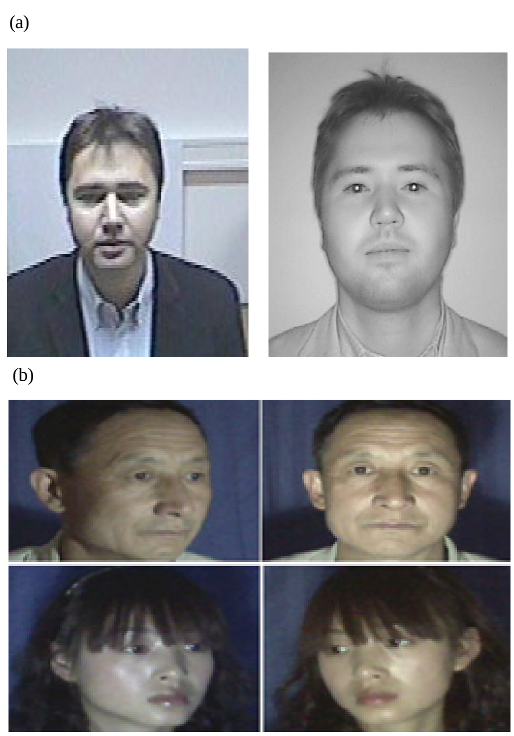

Fig. 3: a) SCface image example and b) CASIA face image

cameras of the different qualities. Mimic images from various quality cameras the conditions of real world and enables the testing of strong face recognition algorithms, focusing on various scenarios for law enforcement and surveillance. In this study, there are 500 images were used in the experimentation through divided the database into training and testing images by use 50% for training and 50% testing in the assessment process. The n-fold cross verification is utilized to examine the proposed technique as well as the use of equivalent statistical methods.

CASIA face image: This is a test database that contains 4000 face color images for 1000 people which captured in one session through use Logitech USB camera. In this study, 500 images were used in the experimentation process where the database is divided into 50% for training and 50% testing images through the assessment process. However, the PCA algorithm has been used in feature extraction process while the proposed Accelerated PSO+OPSO technique has been utilized for the recognition process. Thus, to accomplish the verification process, ten folds of training and testing databases which means (n = 10) are created by the folding process. The accuracy measurement is used to verify the recognition process of both datasets and the results are compared with the recently developed techniques such as PSO-SVM, OPSO-SVM and AAPSO-SVM, respectively. The results show that the proposed technique in this study has higher accuracy than the others approaches as illustrated in Table 1 and 2 and Fig. 4, respectively.

In Fig. 4, we can notice clearly that the proposed technique was achieved superior results in terms of accuracy when it compared with the other techniques "PSO-SVM, OPSO-SVM and AAPSO-SVM" in most of the experiments. Moreover, Table 3 is illustrate the comparison between all these methods in computational time that been used to find the optimal parameters of the SVM (Hotelling, 1933; Jabeen *et al*, 2009).

Table 3: Totaling time to find the parameters in seconds for the PSO-SVM, AOPSO-SVM and the proposed technique

	Finding parameters totaling time (sec)			
Images	PSO	OPSO	AAPSO	The proposed technique
1	0.022013	0.043251	0.133412	0.102431
2	0.031124	0.022510	0.032263	0.085874
3	0.010260	0.003658	0.079958	0.022149
4	0.068695	0.033986	0.088694	0.024812
5	0.087802	0.098955	0.103784	0.125742
6	0.079326	0.088649	0.099789	0.174910
7	0.085831	0.098976	0.075892	0.086851
8	0.046118	0.085969	0.246921	0.062479
9	0.033492	0.069989	0.087965	0.023215
10	0.068452	0.088478	0.177132	0.056911

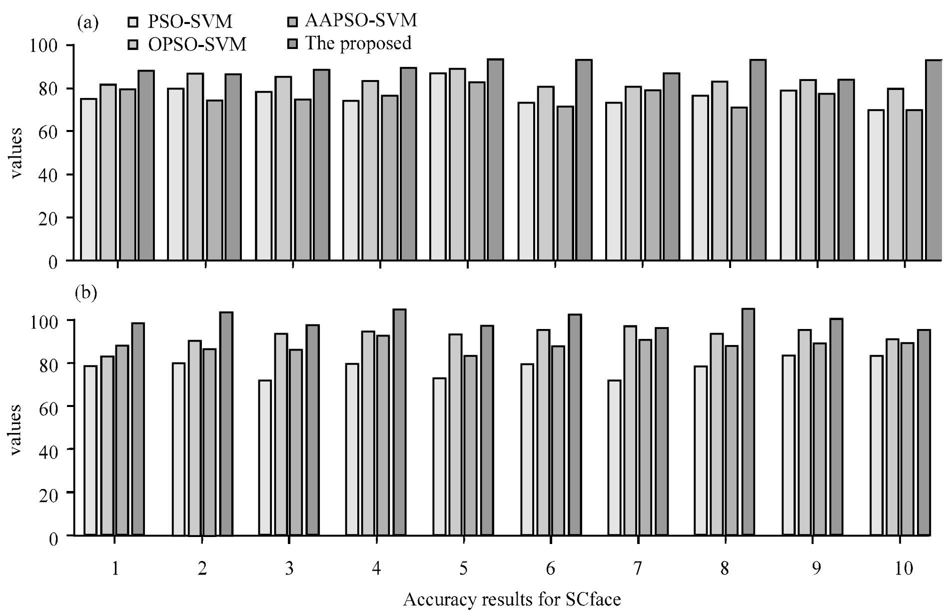

Fig. 4: Accuracy results for PSO-SVM, OPSO-SVM, AAPSO-SVM and the proposed technique: a) Scface dataset and b) CASIA face database

CONCLUSION

A face recognition approach based on accelerated PSO method and OPSO-SVM method has been proposed in this study for the face recognition applications. The feature extraction process was done by PCA algorithm and the resulted features is sent to the proposed recognition technique. To verify the performance of the proposed technique, two human face datasets which are SCface and CASIA face datasets have been used in the experiments. To test the effectivity of the proposed technique, two types of comparisons have been made with the most recent methods such as PSO-SVM, OPSO-SVM and AAPSO-SVM techniques. The first comparison was in term of accuracy performance and the other in term of computational time. The results revealed that our proposed technique has better accuracy performance and the computational time when compared with the others recent developed techniques in most cases. Furthermore, the proposed technique led to increase the convergence speed better than the standard PSO.

REFERENCES

Abdulameer, M.H., D. Mohammed, S.A. Mohammed, M. Al-Azawi and Y.M.H. Al-Mayali *et al*., 2006. Face recognition technique based on Adaptive-Opposition Particle Swarm Optimization (AOPSO) and Support Vector Machine (SVM). ARPN. J. Eng. Appl. Sci., 13: 2259-2266.

Abdulameer, M.H., S.N.H.S. Abdullah and Z.A. Othman, 2014. Support vector machine based on adaptive acceleration particle swarm optimization. Sci. World J. 10.1155/2014/835607

Abdullah, S.N.H.S., M.H. Abdulameer, N.A. Zamani, F. Rahim and K.A.Z. Ariffin *et al.*, 2017. 2.5 D facial analysis via bio-inspired active appearance model and support vector machine for forensic application. Intl. J. Adv. Comput. Sci. Appl., 8: 370-375.

Africa, A.D.M., 2017. A particle swarm optimization conflict resolution model for computer network diagnostics. J. Eng. Appl. Sci., 12: 4330-4333.

Aitkenhead, M.J. and A.J.S. McDonald, 2003. A neural network face recognition system. Eng. Appl. Artif. Intell., 16: 167-176.

Anonymous, 2007. CASIA face database. Chinese Academy of Sciences, Beijing, China.

Gold, C. and P. Sollich, 2003. Model selection for support vector machine classification. Neurocomputing, 55: 221-249.

Grgic, M., K. Delac and S. Grgic, 2011. SCface-surveillance cameras face database. Multimedia Tools Appli., 51: 863-879.

Hasan, M., S.N.H.S. Abdullah and Z.A. Othman, 2013. Face recognition based on opposition particle swarm optimization and support vector machine. Proceedings of the 2013 IEEE International Conference on Signal and Image Processing Applications (ICSIPA'13), October 8-10, 2013, IEEE, Melaka, Malaysia, ISBN: 978-1-4799-0267-5, pp: 417-424.

Hotelling, H., 1933. Analysis of a complex of statistical variables into principal components. J. Educ. Psychol., 24: 498-520.

Jabeen, R., A. Ahmad and M. Iqbal, 2009. Phytoremediation of heavy metals: Physiological and molecular mechanisms. Bot. Rev., 75: 339-364.

Kalivarapu, V., J.L. Foo and E. Winer, 2009. Synchronous parallelization of particle swarm optimization with digital pheromones. Adv. Eng. Software, 40: 975-985.

Karl Pearson, F.R.S., 1901. LIII. On lines and planes of closest fit to systems of points in space. Lond. Edinburgh Dublin Phil. Maga. J. Sci., 2: 559-572.

Karmel, A., 2017. Review of particle swarm optimization for energy management in mobile ad hoc networks. J. Eng. Appl. Sci., 12: 6042-6044.

Kennedy, J. and R. Eberhart, 1995. Particle swarm optimization. Proc. IEEE Int. Conf. Neural Networks, 4: 1942-1948.

Lauer, F. and G. Bloch, 2008. Incorporating prior knowledge in support vector machines for classification: A review. Neurocomputing, 71: 1578-1594.

Shailaja, K. and B. Anuradha, 2017. Improved face recognition using a modified PSO based self-weighted linear collaborative discriminant regression classification. J. Eng. Appli. Sci., 12: 7234-7241.

Sun, T.H. and F.C. Tien, 2008. Using backpropagation neural network for face recognition with 2D+3D hybrid information. Expert Syst. Appl., 35: 361-372.

Wei, J., Z, Jian-Qi and Z. Xiang, 2011. Face recognition method based on support vector machine and particle swarm optimization. Expert Syst. Appl., 38: 4390-4393.

Yang, X.S., S. Deb and S. Fong, 2011. Accelerated Particle Swarm Optimization and Support Vector Machine for Business Optimization and Applications. In: Networked Digital Technologies, Fong, S. (Ed.). Springer, Berlin, Germany, ISBN:978-3-642-22184-2, pp: 53-66.