ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2016

Fingerprint Recognition based Comparative Review of Various Techniques

Gagandeep Kaur, Vikramjit Kang

M. Tech Student, Department of ECE, DAV University, Jalandhar, Punjab, India

Assistant Professor, Department of ECE, DAV University, Jalandhar, Punjab, India

ABSTRACT: Fingerprint is considered as a dominant biometric trait due to its acceptability, reliability, high security level and low cost. Due to the high demand on fingerprint identification system deployments, a lot of challenges arekeep arising in each system’s phase including fingerprint image enhancement, feature extraction, features matching and fingerprint classification. Machine learning techniques introduce non- traditional solutions to the fingerprint identification challenges. This paper presents a short comparative survey that emphasizes the implementations of machine learning notions along with optimization algorithms for compensating some fingerprint problems.

KEYWORDS: Fingerprint Recognition, Biometrics, Security, Neural Network, SVM, LDA.

I. INTRODUCTION

Fingerprints have for some time been utilized as a dependable biometric highlight for individual recognizable proof [1, 2, and 3]. Fingerprint classification alludes to the issue of appointing fingerprints to one of a few pre indicated classes [4]. Automatic classification can be utilized as a preprocessing venture for unique finger impression coordinating, narrowing so as to decrease coordinating time [5]. Fingerprints are graphical pictures of stream such as edges, and they are named left circle (L), right circle (R), whorl (W), curve (An) and tented curve (T) as indicated by Henry's order plan as appeared in Fig. 1.

Classification relies upon the preprocessing steps where different approaches to separate and represent to discernable components among classes can be connected [6, 7]. The elements produced after the preprocessing steps are bolstered into classifiers, for example, neural systems, Hidden Markov model, probabilistic neural systems, and Support vector machines. In this paper, different techniques have been studied and compared.

Fig-1 Fingerprint Template

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2016

II. RELATED WORK

In [1] for the alignment of two fingerprints position, certain land-marks were needed with low misidentification rate which were extracted from the complex orientation field.Complex filters, applied to the orientation field in multiple resolution scales, were used to detect the symmetry and the type of symmetry. In [2] Singular points were identified by its symmetry properties and were extracted from the complex orientation field estimated from the global structure of the fingerprint. In [5] authors proposed three algorithms based on the generalized Hough transform, based on identifying distinctive local orientations,the path of steepest descent in the parameter space are used. In [7] an approach in which flow network-based matching technique was introduced to obtain one-to-one correspondence of secondary features. A two-hidden-layer fully connected neural network was trained to generate the final similarity score based on minutiae matched in the overlapping areas. In [8]the fingerprint valley instead of ridge for the binarization-thinning process to extract fingerprint minutiae was used. Proposed algorithm could detect a maximum number of minutiae from the fingerprint skeleton using the Rutovitz Crossing Number. This allowed the true minutiae preserved and false minutiae removed in later post processing stages. In [13]the new method of steganalysisbased on neural network to get the statistics features of images used to identify the underlying hidden data. Features of the image embedded information were extracted, and then input them into neural network to get the output. The 'Steganalysis' is the field of detecting the covert messages. The neural network in still images was used to overcome the hurdles by hiding the data indirectly into graphical image using neural network algorithm to get cipher bits, the generated cipher bits are then placed in the least significant bit position of the carrier image. In [14] primal problem was solved for both linear and nonlinear SVMs. On the contrary, from the primal point of view, new families of algorithms for large-scale SVM training were investigated. In [15]SVM formulations: C-Support Vector Classification (C-SVC), ν-Support Vector Classification (ν-SVC), distribution estimation (one-class SVM), -Support Vector Regression (-SVR), and ν-Support Vector Regression (ν-SVR) were used. All were supported in LIBSVM were quadratic minimization problems. It used two implementation techniques to reduce the running time for minimizing SVM quadratic problems: shrinking and caching. In [16]an algorithm was presented for selecting support vector machine (SVM) meta-parameter values which was based on ideas from design of experiments (DOE) and demonstrates that it was robust and works effectively and efficiently on a variety of problems. In [18] authors presented the implementation of Firefly Algorithm (FA) in solving the Economic Dispatch (ED) problem by minimizing the fuel cost and considering the generator limits and transmission losses. FA was a meta-heuristic algorithm inspired by the flashing behavior of fireflies. The primary purpose of firefly's flash was to act as a signal system to attract other fireflies. In this paper, 26- bus system was utilized to show the effectiveness of the FA in solving the ED problem.

III. FEATURE EXTRACTION TECHNIQUE

A. *Support Vector Machines (SMV)*

SVM is a classifier that is defined by separating the hyperplane. It is supervised training algorithm. Below figure shows that how line separates the two data classes.

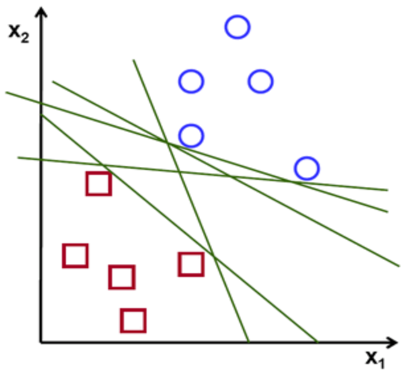

Fig-2 Hyperplane Separating Graph

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2016

Hyperplane can be described as below:

F (x) = $\beta_o + \beta_x$ (4)

Now distance between hyperplaneβ_o, β_x can be shown as below[14, 15]:

Distance = $\frac{\beta_o + \beta_x}{||\beta||}$ (5)

In particular, for the canonical hyperplane, the numerator is equal to one and the distance to the support vectors is

$\text{Distance}_{SVM} = \frac{\beta_o + \beta_x}{||\beta||} = \frac{1}{||\beta||}$(6)

Recall that the margin introduced in the previous section, here denoted as M, is twice the distance to the closest examples [16]:

$M = \frac{2}{||\beta||}$ (7)

B. *Firefly Algorithm*

The Firefly algorithm is a freshly developed nature-inspired Meta heuristic algorithm [18]. The Firefly algorithm is encouraged by the social presentation of fireflies. Fireflies may also be called lightning bugs [18]. There are about 2000 firefly species in the globe. Most of the firefly species construct short and rhythmic flashes. The model of flashes is unique for a particular species. A firefly's twinkle mainly acts as a signal to attract mate partners and potential prey. Flashes also serve as a defensive warning instrument. The following three idealized rules are considered to explain the firefly algorithm [20]:

1) All fireflies are unisex so that one firefly will be involved to other fireflies despite of their sex.

2) Attractiveness is relative to their brightness; thus, for any two flashing fireflies, the less bright one will move in the direction of the brighter one. The attractiveness is relative to the brightness and they both reduce as their distance increases. If there is no brighter one than a particular firefly, it will move arbitrarily.

3) The clarity of a firefly is affected or unwavering by the landscape of the idea function. For a maximization problem, the brightness may be comparative to the objective function value. For the minimization problem, the brightness may be the give-and-take of the objective function value. The make believe code of the firefly algorithm was given by Yang.

A. Attractiveness

The attractiveness of a firefly is determined by its light intensity. The attractiveness may be calculated by using the equation:

B. Distance

The distance among any two firefly's k and l at Xk and Xl is the Cartesian distance.

C. Movement

The movement of a firefly k that is attracted to another more attractive firefly l is determined by 0.

Pseudo code of firefly Algorithm:

Objective function $\boldsymbol{f(x)}, \boldsymbol{x} = (\boldsymbol{x_1}, \dots \boldsymbol{x_d}^{\boldsymbol{T}})$

Obtain original population of fireflies $x_i(i = 1,2,..n)$

$f(x_i)$ Is used to determine the light intensity $I_i$at x_i.

Define light absorption coefficientγ.

While (t<Max generation)

For i=1:n for n fireflies

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2016

For j=1:I for all n fireflies

If $I_j > I_i$, move firefly I towards j in d-dimension ;end

If, Attractiveness vary with distance r via $\exp(-\gamma r)$

Assess novel solution and inform light intensity

end for j

end for i

Rank the firefly and discover the present best

End while

Post process results and visualization

Advantages of SVM over Firefly:

- Firstly it has a regularisation parameter, which makes the user think about avoiding over-fitting.
- Secondly it uses the kernel trick, so you can build in expert knowledge about the problem via engineering the kernel.
- Thirdly an SVM is defined by a convex optimisation problems (no local minima) for which there are efficient methods (e.g. SMO).
- Lastly, it is an approximation to a bound on the test error rate, and there is a substantial body of theory behind it which suggests it should be a good idea.
-

IV. CLASSIFICATION ALGORITHM

A. *Linear Discriminant Analysis (LDA)*

Linear Discriminant Analysis is utmost commonly utilized as dimensionality lessening method in the pre-processing stage for machine learning applications in addition to design-classification. The main objective is to project a specific dataset on top of a lower-dimensional space using virtuous class reparability so as to decrease computational prices as well as also evade over fitting. The novel linear discriminant was first designated for a two-class issue; in addition it was then afterwards widespread as "Multiple Discriminant Analysis" or "multi-class LDA" through C. R. Rao in the year of 1948. Linear Discriminant Analysis is "controlled" as well as calculates the guidelines ("linear discriminants") which would probably signify the axes that are applied to make the most of the separation amongst multiple types of classes. Below are the five basic steps utilized for implementing a LDA technique:

Step 1 : Calculate the d-dimensional mean vectors intended for the dissimilar classes from the specific dataset.

Step 2 : Calculate the disseminate matrices i.e. between-class as well as within-class scatter matrix.

Step 3 : Evaluate the Eigen vectors (e1, e2... ed) as well as corresponding Eigen values (λ1, λ2... λd) for the disseminate matrices.

Step 4 : Sorts the eigenvectors by diminishing Eigen values as well as select k eigenvectors using the leading Eigen values in the direction of forming a d×k-dimensional matrix W i.e. where every particular column exemplifies an eigenvector.

Step 5 : Afterwards, utilize this d×k eigenvector matrix towards transforming the samples onto the new subspace. This could be précised by utilizing the equation Y = X × W i.e. where X is an n×d- dimensional matrix; the i^{th} row signifies the i^{th} sample, and Y is the converted n×k- dimensional matrix using the n samples anticipated into the new subspace.

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2016

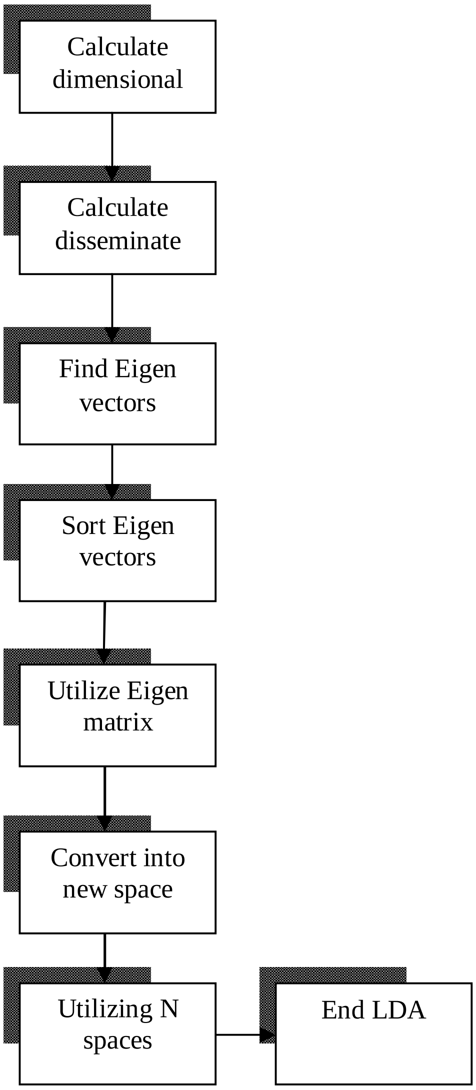

Fig-3 LDA Flowchart

B. *Neural Network*

The basic aim of neural network is to work like human brain works. Neural network consists of various no. of neurons and their working is similar to the brain neuron structure [11, 12]. There are various types of neural networks but commonly used neural network is Back Propagation Neural network. Two types of structure has been found in neural network model:

- Cyclic;
- Acyclic

The normal Back propagation is the mainly applied to train Multilayer FNN. The linear and nonlinear outputs are correspondingly given by [13]:

The net input has given by:

$$n1^{k1+1}(i) = \sum_{j=1}^{s1^{k1}} w1^{k1+1}(i,j)a1^{k1}(j) + b1^{k1+1}(i) \quad (1)$$

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2016

The unit i is given by
$a1^{k1+1}(i) = f1^{k1+1}(n1^{k1+1}(i))(2)$
This recurrence relation is executed at the final layer
$-F1^{M1}(n1^{M1})(t1_{q1} - a1_{q1})(3)$

The structure of neuron can be shown as below:

Fig-4 Neuron Structure

It can be achieved that the function *s* has zero threshold and the actual threshold with the opposite sign is understood as a further weight, *bias* $w_0 = -h$ of additional formal input $x_0=1$ with constant unit value.

Advantages of NN over LDA:

- NN is nonlinear model that is easy to use and understand compared to statistical methods.
- NN is non-parametric model while most of statistical methods are parametric model that need higher background of statistic.
- NN with Back propagation (BP) learning algorithm is widely used in solving various classifications and forecasting problems. Even though BP convergence is slow but it is guaranteed. However, NN is black box learning approach, cannot interpret relationship between input and output and cannot deal with uncertainties.

V. OPTIMIZATION ALGORITHMS

A. *Genetic Algorithm*

According to Goldberg et al., 1989, GA is commonly used in applications where search space is huge and the precise results are not very important. The advantage of a GA is that the process is completely automatic and avoids local minima. The main components of GA are: crossover, mutation, and a fitness function. A chromosome represents a solution in GA. The crossover operations used to generate a new chromosome from a set of parents while the mutation operator adds variation. The fitness function evaluates a chromosome based on predefined criteria. A better fitness value of a chromosome increases its survival chance. A population is a collection of chromosomes. A new population is obtained using standard genetic operations such as single-point crossover, mutation, and selection operator. As a GA is relatively computation intensive, this chapter proposes executing the algorithm only at the base station. The proposed GA is used to generate balanced and energy efficient data aggregation trees for wireless sensor networks.

Step 1 : At random, produce an initial population M (0).
Step 2 : Compute as well as help save the actual fitness f(m) for every specific individual m in the current populationM(t);
Step 3 : Specify selection probabilities p (m) for every specific individual m throughout M (t) making sure that p (m) is actually proportional to f (m).

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2016

Step 4 : Crank out M (t+1) by simply probabilistically choosing individuals from M (t) to produce offspring via genetic operators.

Step 5 : Repeat step 2 until satisfying solution is actually attained.

However, in order for genetic algorithms to work effectively, a few criteria must be met:

- It must be relatively easy to evaluate how "good" a potential solution is relative to other potential solutions.
- It must be possible to break a potential solution into discrete parts that can vary independently. These parts become the "genes" in the genetic algorithm.
- Finally, genetic algorithms are best suited for situations where a "good" answer will suffice, even if it's not the absolute best answer.

B. *BFO*

BFO algorithm is first projected by Passino in 2002. It is motivated by the foraging and Chemo tactic behaviors of bacteria, especially the Escherichia coli (E. coli). Locomotion can be achieved during the process of real bacteria forging through the tensile flagella set. Flagella help an E.coli bacterium to fall or swim, that are two essential operations performed by a bacterium at the instance of foraging. When they revolve the flagella in the clockwise direction, every flagellum pulls over the cell. That results in the moving of flagella separately and lastly the bacterium tumbles with smaller amount of tumbling while in a damaging place it tumbles repeatedly to find a nutrient gradient. Stirring the flagella in the counterclockwise direction helps the bacterium to swim at a very speedy rate. In the above mentioned algorithm the bacteria undergoes chemo taxis, where they like to shift towards a nutrient gradient and shun harmful atmosphere. Usually the bacteria shift for a longer distance in a gracious situation. Figure 1 depicts how clockwise and anti-clockwise movements of a bacterium occur in a nutrient solution. The BFO algorithm is as follows:

Step1: Initialize parameters $p, S, N_c, N_s, N_r, N_{ed}, P_{ed} C(i)(i=1,2,\ldots S), \theta^i$.

Step 2: Elimination dispersal loop=l+1

Step 3: Reproduction loop=k+1.

Step 4: Chemo taxis loop=j+1.

[a] For i=1,2,…S take a chemotactic step for bacterium I as follows.
[b] Compute fitness function (i, j, k, l).
Let ,$J(i,j,k,l) = J(i,j,k,l)+J_{cc} (\theta^i(j,k,l),P(j,k,l)$.
[c] Let J_{last}= j(i,j,k,l) to save this value since we may find a better cost via a run.
[d] Tumble: generate a random vector $\Delta(i) \in R^p$ each element $\Delta_m(i)$,m=1,2,…,p, a random number on [-1,1].
[e] Move: Let

$$\theta^i(j+1,k+1) = \theta^i(j,k,l) + C(i)\frac{\Delta(i)}{\sqrt{\Delta^T(i)\Delta(i)}}$$

This results in a step od =f size C (i) in the direction of the tumble for Bacterioum i.

[f] Compute J (I,j+1,k,l) and let

$(J(i,j+1,k,l) = J(i,j,k,l) + j_{cc}\theta^i(j+1,k.l), P(j+1,k,l))$[g] Swim

i. Let m=0
ii. While $m<N_s$
- Let m=m+1

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2016

- If j(I,j+1,k,l)<J_{last} ,let J_{last}=J(I,j+1,k,l) let, $\theta^i(j+1,k,l) = \theta^i(j,k,l) + C(i)\frac{\Delta(i)}{\sqrt{\Delta^T(i)\Delta(i)}}$
- To count, the new$J(i,j+1,k,l)^i$, $\theta^i(j+1,j,k)$ is used as in [f].

iii. Else, let m=N_s. This is the end of the while statement.

[h].Go to next Bacterioum (i+1) if i≠S.

Step 5: If j<N_c , go to step 4

Step 6: Reproduction:

[a]. For the given k and l , used for every h i=1,2,..S. take

$$J^i_{health} = \sum_{j=1}^{N_c+1} J(i,j,k,l)$$

Be the health of bacterium i. Sort bacteria and Chemo tactic parameters C(i) in order of ascending cost J_{health}.

[b]. The S_r bacteria with the highest J_{health} values die and the remaining S_r bacteria with the best values split.

Step 7: if k<N_{re}, go to step 3.

Step 8: Elimination-dispersal: For i=1, 2…S with probability P_{ed}, eradicate and scatter every bacterium. For this, a bacterium need to be eliminated; so scatter one more to an arbitrary position on the optimization sphere. Go to step 2 if l< N_{ed} else end.

Advantages of GA over BFO:

- There are multiple local optima
- The number of parameters is very large
- The objective function is noisy or stochastic
- Concept is easy to understand
- Modular, separate from application
- Supports multi-objective
- Optimization Good for “noisy” environments
- Always an answer; answer gets better with time
- Inherently parallel; easily distributed

VI. CONCLUSION AND FUTURE SCOPE

Recent studies have showed that about 70% of clients are using the biometrics technology for security concerns. Biometric technology is emerging rapidly as it reliable, easy to operate, robust, secure as well as free from memorize the passwords and pins as it is needed in earlier systems. There are different biometric technologies like ear, face recognition, fingerprints, finger geometry, iris recognition, retinal sketching, voice recognition, signature verification etc. on the basis of which recognition of an individual is done. This paper has made a comparative review on various methods for feature extraction as well as classification. It is concluded that in Feature extraction, SVM performs better than Firefly. Similarly, in Classification process, NN is better than LDA. At last, in Optimization process, GA is better than BFO.

REFERENCES

1. Nilsson, K., and Bigun, J., (2002) "Complex filters applied to fingerprint images detecting prominent symmetry points used for alignment in Biometric Authentication, in: LNCS, Springer, Vol, 2359, pp. 39-47.

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2016

2. Nilsson, K., and Bigun, J., (2003) “Localization of corresponding points in fingerprints by complex ltering" Pattern Recognition, Vol. 24, pp. 2135-2144.
3. Jain, A., Ross, A and Prabhakar, S., (2004) “An introduction to biometric recognition” IEEE Transactions on Circuits and Systems for Video Technology, Special Issue on Image- and Video-Based Biometrics, Vol. 14, No. 1, pp. 1-29.
4. Zhou, J., and Gu, J., (2004) “A model-based method for the computation of fingerprints’ orientation field” IEEE transactions on image processing, Vol. 13, No. 6, pp. 821-835.
5. Yager, N., and Amin, A., (2005) “Coarse fingerprint registration using orientation fields” EURASIP Journal on Applied Signal Processing, Vol. 13, pp. 2043–2053.
6. Yang, S., Qi, J., and Wang, Y., (2005) “Fingerprint matching combining the global orientation field with minutia” Pattern Recognition Letters, Vol. 26, pp. 2424–2430.
7. Yang, T., and Govindaraju, V., (2005) “A minutia-based partial fingerprint recognition system” Pattern Recognition, Vol. 38, pp. 1672–1684.
8. Zhao, F., and Tang, X., (2007) “Pre-processing and post-processing for skeleton-based fingerprint minutiae extraction” Pattern Recognition, Vol. 40, pp. 1270 – 1281.
9. Fronthaler, H., Kollreider, K., and Bigun, J., (2008) “Local features for enhancement and minutiae extraction in fingerprints” IEEE transactions on image processing, Vol. 17, No. 3, pp. 354-363.
10. Kaur, M., Singh, M., Girdhar, A., and Sandhu, P., (2008) “Fingerprint verification system using minutiae extraction technique” World Academy of Science, Engineering and Technology, Vol. 46, pp. 497-502.
11. Kuzmina, et al, (2015) "Neural network control system for a tracked robot," in Young Researchers in Electrical and Electronic Engineering Conference (EIConRusNW), 2015 IEEE NW Russia , pp.233-235.
12. Liu Shaohui, et al, (2003) "Neural Network based Steganalysis in Still Images" Proceedings of IEEE ICME.
13. Khan et al, (2010) "Neural network based steganography algorithm for still images," in Emerging Trends in Robotics and Communication Technologies (INTERACT), 2010 International Conference on , pp.46-51.
14. Olivier Chapelle, (2007) “Training a Support Vector Machine in the Primal,” Neural Computation, v.19 n.5, p.1155-1178.
15. Chih-Chung Chang and Chih-Jen Lin, (2011) “LIBSVM: A library for support vector machines,” ACM Transactions on Intelligent Systems and Technology (TIST), v.2 n.3, p.1-27.
16. Staelin C, (2003) “Parameter selection for support vector machines,” Hewlett-Packard Company, Tech. Rep. HPL-2002-354R1.
17. Sabrina Merkel, Christian Werner Becker, Hartmut Schmeck (2012), “Firefly-Inspired Synchronization for Energy-Efficient Distance Estimation in Mobile Ad-hoc Networks”, IEEE, pp.205-212.
18. M. H. Sulaiman, M. W. Mustafa, (2012), “Firefly Algorithm Technique for Solving Economic Dispatch Problem”, IEEE, pp. 90-95.
19. K. Naidua, H. Mokhli, A. H. A. Bakar, (2013), “Application of Firefly Algorithm (FA) based optimization in load frequency control for interconnected reheat thermal power system”, 2013 IEEE Jordan Conference on Applied Electrical Engineering and Computing Technologies (AEECT), IEEE.

BIOGRAPHY

Gagandeep Kaur received her degree of B.Tech in Electronics and Communications Engineering from DAV institute of Engineering and Technology, Jalandhar, Punjab, India in June 2013. She is pursuing M.Tech in Electronics and Communications Engineering from DAV University, Jalandhar, Punjab, India. Her areas of interest include Signal and Systems, Digital Signal Processing.

Vikramjit Singh received his B.Tech from Baba Banda Singh Bahadur Engineering College, Fatehgarh Sahib, Punjab, India in 2006. He received his M.Tech (with distinction) in communication systems from Guru Nanak Dev University, Amritsar, Punjab, India in 2008.He is pursuing doctorate in Biomedical Signal Processing. His primary research interest includes Bio-signal Processing, Digital Signal Processing and Digital Communications. His experience of teaching is about 7.5 years for both undergraduate and postgraduate classes.