Control Theory and Informatics
ISSN 2224-5774 (Paper) ISSN 2225-0492 (Online)
Vol.4, No.9, 2014
www.iiste.org

Voltage Profile Amplification and Attenuation of Real Power Loss by Using New Cuttlefish Algorithm

Mr.K.Lenin*[1], Dr.B.Ravindhranath Reddy[2], Dr.M.Surya Kalavathi[3]

1. Research Scholar, Jawaharlal Nehru Technological University Kukatpally, Hyderabad 500 085, India.
2. Deputy Executive Engineer, Jawaharlal Nehru Technological University Kukatpally, Hyderabad 500 085, India.
3. Professor of Electrical and Electronics Engineering, Jawaharlal Nehru Technological University Kukatpally, Hyderabad 500 085, India.

* E-mail of the corresponding author: gklenin@gmail.com

Abstract

This paper presents an algorithm for solving the multi-objective reactive power dispatch problem in a power system. Modal analysis of the system is used for static voltage stability assessment. Loss minimization and maximization of voltage stability margin are taken as the objectives. Generator terminal voltages, reactive power generation of the capacitor banks and tap changing transformer setting are taken as the optimization variables. Global optimization methods play an important role to solve many real-world problems. However, the implementation of single methods is excessively preventive for high dimensionality and nonlinear problems, especially in term of the accuracy of finding best solutions and convergence speed performance. In this paper, a New Cuttlefish Algorithm (NCFA) is proposed to solve reactive power dispatch problem. The algorithm imitates the method of colour altering behaviour used by the cuttlefish .The patterns and colours seen in cuttlefish are produced by reflected light from different layers of cells including (chromatophores, leucophores and iridophores) heap together, and it is the amalgamation of certain cells at once that allows cuttlefish to acquire such a huge array of patterns and colours. The projected algorithm considers two key progressions: reflection and visibility. Reflection process is projected to replicate the light reflection mechanism used by these three layers, while the visibility is projected to replicate the visibility of matching pattern used by the cuttlefish. These two processes are used as a explore strategy to find the global optimal solution. The proposed New Cuttlefish Algorithm (NCFA) has been tested on standard IEEE 30 bus test system and simulation results show clearly the better performance of the proposed algorithm in enhancing the voltage stability and reducing the real power loss.

Keywords: Optimal Reactive Power, Transmission loss, Cuttlefish algorithm, Reflection, Visibility, Optimization, Chromatophores, Iridophores, Leucophores.

1. Introduction

Optimal reactive power dispatch (ORPD) problem is one of the difficult optimization problems in power systems. The sources of the reactive power are the generators, synchronous condensers, capacitors, static compensators and tap changing transformers. The problem that has to be solved in a reactive power optimization is to determine the required reactive generation at various locations so as to optimize the objective function. Here the reactive power dispatch problem involves best utilization of the existing generator bus voltage magnitudes, transformer tap setting and the output of reactive power sources so as to minimize the loss and to enhance the voltage stability of the system. It involves a nonlinear optimization problem. Various mathematical techniques have been adopted to solve this optimal reactive power dispatch problem. These include the gradient method (O.Alsac et al.1973; Lee K Yet al.1985), Newton method (A.Monticelli et al.1987) and linear programming (Deeb Net al.1990; E. Hobson1980; K.Y Lee et al.1985; M.K. Mangoli 1993) .The gradient and Newton methods suffer from the difficulty in handling inequality constraints. To apply linear programming, the input-output function is to be expressed as a set of linear functions which may lead to loss of accuracy. Recently Global Optimization techniques such as genetic algorithms have been proposed to solve the reactive power flow problem (S.R.Paranjothi et al 2002;D. Devaraj et al 2005). In recent years, the problem of voltage stability and voltage collapse has become a major concern in power system planning and operation. To enhance the voltage stability, voltage magnitudes alone will not be a reliable indicator of how far an operating point is from the collapse point (C.A. Canizares et al.1996). The reactive power support and voltage problems are intrinsically related. Hence, this paper formulates the reactive power dispatch as a multi-objective optimization problem with loss minimization and maximization of static voltage stability margin (SVSM) as the objectives.This paper proposes New Cuttlefish Algorithm (NCFA) is proposed for solving reactive power dispatch problem. The proposed algorithm [M. M. Lydia et al 2008; www.thecephalopodpage.org] imitates the light reflection process through the amalgamation of these layers, and the visibility of matching pattern procedure used by cuttlefish to match its background. The algorithm divides the population (cells) into four groups, each group works autonomously sharing only the best solution. Two of them used as a global search, while others used as a local search. The proposed algorithm NCFA has been evaluated in standard IEEE 30 bus test system. The simulation results show that our proposed approach outperforms all the entitled reported algorithms in minimization of real power loss.

2. Voltage Stability Evaluation

2.1Modal analysis for voltage stability evaluation

The linearized steady state system power flow equations are given by.

$$\begin{bmatrix}\Delta P\\ \Delta Q\end{bmatrix} = \begin{bmatrix} J_{p\theta} & J_{pv} \\ J_{q\theta} & J_{QV}\end{bmatrix} \quad (1)$$

Where

ΔP = Incremental change in bus real power.

ΔQ = Incremental change in bus reactive Power injection

$\Delta\theta$ = incremental change in bus voltage angle.

ΔV = Incremental change in bus voltage Magnitude

$J_{p\theta}$, J_{PV} , $J_{Q\theta}$, J_{QV} jacobian matrix are the sub-matrixes of the System voltage stability is affected by both P and Q. However at each operating point we keep P constant and evaluate voltage stability by considering incremental relationship between Q and V.

To reduce (1), let $\Delta P = 0$, then.

$$\Delta Q = [J_{QV} - J_{Q\theta} J_{P\theta}^{-1} J_{PV}]\Delta V = J_R \Delta V \quad (2)$$

$$\Delta V = J^{-1} - \Delta Q \quad (3)$$

Where

$$J_R = (J_{QV} - J_{Q\theta} J_{P\theta}^{-1} JPV) \quad (4)$$

J_R is called the reduced Jacobian matrix of the system.

A. Modes of Voltage instability:

Voltage Stability characteristics of the system can be identified by computing the eigen values and eigen vectors

Let

$$J_R = \xi \wedge \eta \quad (5)$$

Where,

ξ = right eigenvector matrix of J_R

η = left eigenvector matrix of J_R

$\wedge$ = diagonal eigenvalue matrix of J_R and

$$J_R^{-1} = \xi \wedge^{-1} \eta \quad (6)$$

From (3) and (6), we have

$$\Delta V = \xi \wedge^{-1} \eta \Delta Q \quad (7)$$

or

$$\Delta V = \sum_I \frac{\xi_i \eta_i}{\lambda_i} \Delta Q \quad (8)$$

Where ξ_i is the ith column right eigenvector and η the ith row left eigenvector of J_R.

λ_i is the ith eigen value of J_R.

The ith modal reactive power variation is,

$$\Delta Q_{mi} = K_j \xi_{ji} \quad (9)$$

where,

$$K_j = \sum_j \xi_{jj}^2 - 1 \quad (10)$$

Where

ξ_{ji} is the jth element of ξ_i

The corresponding ith modal voltage variation is

$$\Delta V_{mi} = [1/\lambda_j]\Delta Q_{mi} \quad (11)$$

In (8), let $\Delta Q = e_k$ where e_k has all its elements zero except the kth one being 1. Then,

$$\Delta V = \sum_j \frac{\eta_{1k}\, \xi_1}{\lambda_1} \quad (12)$$

η_{1k} k th element of η_1

V –Q sensitivity at bus k

$$\frac{\partial V_K}{\partial Q_K} = \sum_j \frac{\eta_{1k}\, \xi_1}{\lambda_1} = \sum_j \frac{P_{ki}}{\lambda_1} \quad (13)$$

3. Problem Formulation

The objectives of the reactive power dispatch problem considered here is to minimize the system real power loss and maximize the static voltage stability margins (SVSM).

3.1Minimization of Real Power Loss

It is aimed in this objective that minimizing of the real power loss (Ploss) in transmission lines of a power system. This is mathematically stated as follows.

$$P_{loss} = \sum_{\substack{k=1 \\ k=(i,j)}}^{n} g_k (V_i^2 + V_j^2 - 2V_i V_j \cos\theta_{ij}) \quad (14)$$

Where n is the number of transmission lines, g_k is the conductance of branch k, V_i and V_j are voltage magnitude at bus i and bus j, and θij is the voltage angle difference between bus i and bus j.

3.2Minimization of Voltage Deviation

It is aimed in this objective that minimizing of the Deviations in voltage magnitudes (VD) at load buses. This is mathematically stated as follows.

Minimize VD = $\sum_{k=1}^{nl} |V_k - 1.0|$ (15)

Where nl is the number of load busses and V_k is the voltage magnitude at bus k.

3.3System Constraints

In the minimization process of objective functions, some problem constraints which one is equality and others are inequality had to be met. Objective functions are subjected to these constraints shown below.

Load flow equality constraints:

$$P_{Gi} - P_{Di} - V_i \sum_{j=1}^{nb} V_j \begin{bmatrix} G_{ij} & \cos\theta_{ij} \\ +B_{ij} & \sin\theta_{ij} \end{bmatrix} = 0, i = 1,2 \ldots ., nb \quad (16)$$

$$Q_{Gi} - Q_{Di} - V_i \sum_{j=1}^{nb} V_j \begin{bmatrix} G_{ij} & \cos\theta_{ij} \\ +B_{ij} & \sin\theta_{ij} \end{bmatrix} = 0, i = 1,2 \ldots ., nb \quad (17)$$

where, *nb* is the number of buses, P_G and Q_G are the real and reactive power of the generator, P_D and Q_D are the real and reactive load of the generator, and G_{ij} and B_{ij} are the mutual conductance and susceptance between bus *i* and bus *j*.

Generator bus voltage (V_{Gi}) inequality constraint:

$$V_{Gi}^{min} \le V_{Gi} \le V_{Gi}^{max}, i \in ng \quad (18)$$

Load bus voltage (V_{Li}) inequality constraint:

$$V_{Li}^{min} \le V_{Li} \le V_{Li}^{max}, i \in nl \quad (19)$$

Switchable reactive power compensations (Q_{Ci}) inequality constraint:

$$Q_{Ci}^{min} \le Q_{Ci} \le Q_{Ci}^{max}, i \in nc \quad (20)$$

Reactive power generation (Q_{Gi}) inequality constraint:

$$Q_{Gi}^{min} \le Q_{Gi} \le Q_{Gi}^{max}, i \in ng \quad (21)$$

Transformers tap setting (T_i) inequality constraint:

$$T_i^{min} \le T_i \le T_i^{max}, i \in nt \quad (22)$$

Transmission line flow (S_{Li}) inequality constraint:

$$S_{Li}^{min} \le S_{Li}^{max}, i \in nl \quad (23)$$

Where, nc, ng and nt are numbers of the switchable reactive power sources, generators and transformers.

4. Cuttlefish Skin Apparatus

Cuttlefish is a type of cephalopods which is well known for its ability to alter its colour shown in Fig .1 either apparently disappears into its environment or to create dramatic displays. The patterns and colours seen in cephalopods are formed by different layers of cells [Adel Sabry Eesa et al 2013] stacked collectively including chromatophores, leucophores and iridophores, and it is the amalgamation of certain cells operations of reflecting light and matching patterns at once that allows cephalopods to acquire such a huge array of patterns and colours. These layers are explained as follows: *Chromatophores*: are groups of cells that comprise an elastic saccule that holds a pigment, as well as 15-25 muscles attached to this saccule [R. T. Hanlon et al 1996]. These cells are positioned directly under the skin of cuttlefish. When the muscles contract, they elongate the saccule allowing the pigment within to wrap a larger surface area. When the muscles relax, the saccule reduces in size and hides the pigment [E. Florey et al 1996]. *Iridophores*: are found in the next layer under the chromatophores [R. T. Hanlon et al 1990; K. M. Cooper et al 1990]. Iridophores are layered stacks of platelets [R. A. Cloney et al 1983] that are chitinous in some species and protein based in others. They are accountable for producing the metallic looking greens, blues and gold's seen in some species, as well as the silver colour in the region of the eyes and ink sac of others. Iridophores work by reflecting light and can be used to conceal organs, as is often the case with the silver coloration in the region of the eyes and ink sacs. In addition, they aid in concealment and communication. *Leucophores*: these cells are accountable for the white spots happening on some species of cuttlefish, squid and octopus.Leucophores are flattened, branched cells that are thought to disperse and reflect incoming light. In this way, the colour of the leucophores will reflect the prime wavelength of light in the environment [D. Froesch et al 1978]. In white light they will be white, while in blue light they will be blue. It is contemplation that this adds to the animal's capability to unify into its environment. Chromatophores cells have red, orange, yellow, black, and brown pigments. But a set of mirror-like cells (iridophores and leucophores) permits cuttlefish skin to guess all the affluent and speckled colours of its environment. The look of the cuttlefish thus depends on which skin elements affect the light incident on the skin. Light may be reflected by either chromatophores or by reflecting cells (iridophores or leucophores) or a amalgamation of both, and it is the physiological volatility of the chromatophores and reflecting cells that enables the cuttlefish to create such a wide repertoire of optical effects. A illustration in Fig 2 of Cuttlefish skin detailing the three main skin structures (chromatophores, iridophores and leucophores), two illustration states (a, b) and three distinct ray traces (1, 2, 3) show the stylish means by which cuttlefish can alter reflective colour [K. Eric et al 2012].

Fig 1. Different colours of Cuttlefish

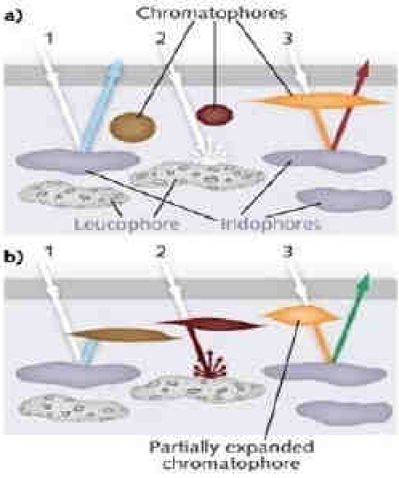

Fig. 2. Diagram of cuttlefish skin detailing the three main skin structures (chromatophores, iridophores and leucophores)

5. New Cuttlefish Algorithm

The projected (NCFA) algorithm imitates the work of the three cell layers that are used by cuttlefish to change its skin colours. To do this, we reordered the six cases shown in Fig 2 to be as shown below Fig 3.

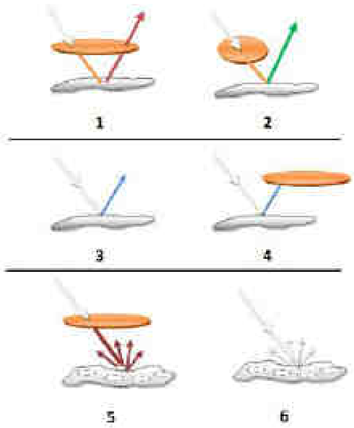

Fig. 3. Reorder of the six cases

From Fig 3 we imagine two main processes (*reflection* and *visibility*). Reflection method represents the system used by cuttlefish to reflect incoming light and it can by any case of the six cases considered in Fig 3. While visibility is representing the matching pattern precision that the cuttlefish try to replicate the patterns appear in its environment. We understood that the final pattern is the global optimum solution, while visibility is the difference between the best solution and the present solution. The projected New Cuttle Fish Algorithm (NCFA) is designed based on these two methods (*reflection* and *visibility*) and they used as a explore strategy to find the new solutions. The formulation of finding the new solution (*new P*) using reflection and visibility is described in (24).

$$newP = reflection + visibility \qquad (24)$$

The main steps of NCFA algorithm are concise as follow:
i. Begin the population with arbitrary solutions, compute and keep the best solution and the average value of the best solution’s points.
ii. Employ communication operator between chromatophores and iridophores cells in case 1 and 2, to create a new solution based on the reflection and the visibility of pattern (global search).
iii.Employ iridophores cells operators in case 3 and 4 to compute new solutions based on the reflected light coming from best solution and the visibility of matching pattern (local search).
iv. Employ leucophores cells operator in case 5 to create new-fangled solution by reflecting light from the area around the best solution and visibility of the pattern (local search).
v. Employ leucophores cells operator in case 6 for arbitrary solution by reflecting incoming light (global search).

Initialization
First the population *P* (*cells*) of *N* primary solutions *P* = *cells* = {*points*1, *points*2, ..., *points* N}, is extend over *d*-dimensional problem space at arbitrary positions (*points*) using (25).

$$P[i] \cdot points[j] = random * (upperlimit - lower\ limit) + lower\ limit \qquad (25)$$

Where *upperLimit* and *lowerLimit* are the upper and the lower limits in the problem area and *random* is a random number between (0, 1). Each individual $points_i$ in of the population represents a solo cell and it is connected with two values, fitness and a vector of *d*-dimension continuous values. After that the best solution will be reserved in *Best*, and the average of the *Best* points are computed and stored in AV_{Best}. Then the population is alienated into four groups of cells. Each group will work autonomously sharing only the best solution, two of them (group 1 and 4) are work as a local search, while group 2 and 3 are work as a global search.

Group 1-Simulation of case 1 and 2
Reflected color (light) shown in Fig 3 case (1 and 2) is formed due the communication between chromatophores and iridophores cells, each chromatophors cell will contract or relax its muscles to extend or shrink its saccule.

While iridophores cells will reflect the light that is coming from chromatophors cells. The reflected light may infiltrate the chromatophors cells or not. The elongate and shrink process in chromatophors cells and the reflected light from iridophores cells and visibility of the pattern used by cuttlefish to match its background, are used to find a new-fangled solution. The formulations of these progressions are described in (26) and (27), respectively.

$$reflection_j = R * G_1[i]points[j] \qquad (26)$$

$$visibility_j = V * (Best\ points[j] - G_1[i]points[j]) \quad (27)$$

In (26) and (27), G_1 stand for a group of chromatophors cells used to simulates case (1 and 2). i, is the i^{th} cell of group $G1$. $Points[j]$ symbolize the j^{th} point of i^{th} cell. *Best. Points* stand for the best solution points. R, represents the reflection degree used to find the elongate range of the saccule when the muscles of the cell is in contract or relax. V, represents the visibility degree of the concluding view of the pattern. The value of R and V are computed as follows:

$$R = random() * (r_1 - r_2)r_2 \qquad (28)$$

$$V = random\ () * (v_1 - v_2)v_2 \qquad (29)$$

Where, *random* ( ) function is a function used to create an arbitrary numbers between (0, 1). r_1, r_2 are two constant values used to find the stretch interval of the chromatophors cells. While v_1 and v_2 are two stable values used to find the interval of the visibility's degree of the final view of the pattern. Sometime the value of R or value of V is just set to 1, or else it will be computed. In this group only value of V is set to 1 and R will be computed.

Group 2-Simulation of case 3 and 4

As described before the iridophores cells are light reflecting cells. From Fig 3, case (3 and 4), the iridophores cells will reflect inward light from the outside (environment), and the reflected colour is a precise colour. Iridophores cells are assisting in camouflage or used to conceal organs. We believed that the concealed organs are represented by the best solution. So the formulation of finding the visibility is left behind as it, while the formulation of finding the reflection is rewritten as follows:

$$reflection_j = R * Best\ point[j] \qquad (30)$$

Group 3-Simulation of case 5

Leucophores cells are work as a mirror. In this way, the cells will reflect the predominant wavelength of light in the environment. In white light they will reflect the white, in brown light they will reflect brown and etc., In this case (case 5 in Fig 3) the light is coming through chromatophors cells with specific colour. The reflected light is very similar to the light that coming from the chromatophors cells. In order to cover the similarity between the incoming colour and the reflected colour, we assumed that the incoming colour is the best solution (*Best*), and the reflected colour could be any value around the *Best*. The interval that is used around the *Best* is produced by visibility. The two Equations (26) and (27) of finding the reflection and the visibility are modified as follows:

$$reflection_j = R * Best\ points[j] \qquad (31)$$

$$visibility_j = V * (Best\ points[j] - AV_{Best}) \quad (32)$$

Where, AV_{Best} is the average value of the *Best* points. The value of R is set to 1, while the value of V will be computed.

Group 4-Simulation of case 6

In this case, the leucophores cells will just reflect the inward light from the environment. This operator permits the cuttlefish to unify itself into its environment. As a recreation, one can presume that any incoming colour from the environment will be reflected as it and can be represented by any arbitrary solution. Thus this case (case 6 in Fig 3) works as initialization utilize (25) to find the new solutions.

New Cuttlefish Algorithm for Solving Optimal Reactive Power Dispatch Problem

```
i. Begin population (P [N]) with random solutions. Allocate the values of $r_1$, $r_2$, $v_1$, $v_2$.
ii. Calculate fitness of the population and Keep the best solution in Best.
iii. Segregate population (cells) into four groups ($G_1$, $G_2$, $G_3$ and $G_4$).
iv. While (stopping criterion is not met)
    v. Compute the average value of the best solution, and accumulate it in $AV_{Best}$.
    vi. Case (1, 2)
        For every cell in $G_1$ do
            Create new solution using Equation (26 and 27)
            If (the new solution is better than the Best)
                Reinstate the Best with it.
            If (the new solution is better than the current solution)
                Reinstate the current solution with it.
        End
    vii. Case (3, 4)
        For every cell in $G_2$ do
            Create new solution use Equations (30, 27)
            If (the new solution is better than the Best)
                Reinstate the Best with it.
            If (the new solution is better than the current solution)
                Reinstate the current solution with it.
        End
    viii. Case (5)
        For every cell in $G_3$ do
            Create new solution use Equations (31, 32)
            If (the new solution is better than the Best)
                Reinstate the Best with it.
            If (the new solution is better than the current solution)
                Reinstate the current solution with it.
        End
    ix. Case (6)
        For each cell in $G_4$ do
            Create a random solution using Equation (25)
            If (the new solution is better than the Best)
                Replace the Best with it.
            If (the new solution is better than the current solution)
                Reinstate the current solution with it.
        End
10. End While.
11. Return the best solution (Best)
```

6. Simulation results

The validity of the proposed technique NCFA is demonstrated by simulating it on IEEE-30 bus system. The IEEE-30 bus system has 6 generator buses, 24 load buses and 41 transmission lines of which four branches are (6-9), (6-10) , (4-12) and (28-27) - are with the tap setting transformers. The lower voltage magnitude limits at all buses are 0.95 p.u. and the upper limits are 1.1 for all the PV buses and 1.05 p.u. for all the PQ buses and the reference bus. The simulation results has been presented in Tables 1, 2, 3 &4. And in the table 5 shows clearly that proposed algorithm powerfully reduces the real power losses when compared to other given algorithms. The optimal values of the control variables along with the minimum loss obtained are given in Table 1. Corresponding to this control variable setting, it was found that there are no limit violations in any of the state variables.

Table 1. Results of NCFA – ORPD optimal control variables

Control variables	***Variable setting***
V1	1.041
V2	1.040
V5	1.039
V8	1.032
V11	1.010
V13	1.033
T11	1.03
T12	1.00
T15	1.0
T36	1.0
Qc10	3
Qc12	3
Qc15	4
Qc17	0
Qc20	1
Qc23	4
Qc24	3
Qc29	3
Real power loss	4.2315
SVSM	0.2379

ORPD including voltage stability constraint problem was handled in this case as a multi-objective optimization problem where both power loss and maximum voltage stability margin of the system were optimized concurrently. Table 2 indicates the optimal values of these control variables. Also it is found that there are no limit violations of the state variables. It indicates the voltage stability index has increased from 0.2379 to 0.2388, an advance in the system voltage stability. The Eigen values equivalents to the four critical contingencies are given in Table 3. From this result it is observed that the Eigen value has been improved considerably for all contingencies in the second case.

Table 2. Results of NCFA -Voltage Stability Control Reactive Power Dispatch Optimal Control Variables

Control Variables	***Variable Setting***
V1	1.043
V2	1.044
V5	1.041
V8	1.035
V11	1.003
V13	1.038
T11	0.090
T12	0.090
T15	0.090
T36	0.090
Qc10	3
Qc12	3
Qc15	4
Qc17	0
Qc20	3
Qc23	4
Qc24	3
Qc29	3
Real power loss	4.9869
SVSM	0.2388

Table 3. Voltage Stability under Contingency State

Sl.No	***Contigency***	***ORPD Setting***	***VSCRPD Setting***
1	28-27	0.1404	0.1440
2	4-12	0.1628	0.1651
3	1-3	0.1754	0.1743
4	2-4	0.2022	0.2021

Table 4. Limit Violation Checking Of State Variables

State variables	***limits***		***ORPD***	***VSCRPD***
	Lower	***upper***		
Q1	-20	152	1.3422	-1.3269
Q2	-20	61	8.9900	9.8232
Q5	-15	49.92	25.920	26.001
Q8	-10	63.52	38.8200	40.802
Q11	-15	42	2.9300	5.002
Q13	-15	48	8.1025	6.033
V3	0.95	1.05	1.0372	1.0392
V4	0.95	1.05	1.0307	1.0328
V6	0.95	1.05	1.0282	1.0298
V7	0.95	1.05	1.0101	1.0152
V9	0.95	1.05	1.0462	1.0412
V10	0.95	1.05	1.0482	1.0498
V12	0.95	1.05	1.0400	1.0466
V14	0.95	1.05	1.0474	1.0443
V15	0.95	1.05	1.0457	1.0413
V16	0.95	1.05	1.0426	1.0405
V17	0.95	1.05	1.0382	1.0396
V18	0.95	1.05	1.0392	1.0400
V19	0.95	1.05	1.0381	1.0394
V20	0.95	1.05	1.0112	1.0194
V21	0.95	1.05	1.0435	1.0243
V22	0.95	1.05	1.0448	1.0396
V23	0.95	1.05	1.0472	1.0372
V24	0.95	1.05	1.0484	1.0372
V25	0.95	1.05	1.0142	1.0192
V26	0.95	1.05	1.0494	1.0422
V27	0.95	1.05	1.0472	1.0452
V28	0.95	1.05	1.0243	1.0283
V29	0.95	1.05	1.0439	1.0419
V30	0.95	1.05	1.0418	1.0397

Table 5. Comparison of Real Power Loss

Method	***Minimum loss***
Evolutionary programming(Wu Q H et al 1995)	5.0159
Genetic algorithm (S.Durairaj et al 2006)	4.665
Real coded GA with Lindex as SVSM (D.Devaraj 2007)	4.568
Real coded genetic algorithm(P. Aruna Jeyanthy et al 2010)	4.5015
Proposed NCFA method	4.2315

7. Conclusion

NCFA algorithm has been effectively solved optimal reactive power problem. NCFA based Optimal Reactive Power Dispatch problem has been tested in standard IEEE 30 bus system. The performance of the proposed algorithm demonstrated through its voltage stability assessment by modal analysis is effective at various instants following system contingencies. Also this method has a good performance for voltage stability Enhancement of large, complex power system networks. Real power loss considerably reduced and voltage profile index also enhanced.

References

O.Alsac,and B. Scott, “Optimal load flow with steady state security”,IEEE Transaction. PAS -1973, pp. 745-751.

Lee K Y ,Paru Y M , Oritz J L –A united approach to optimal real and reactive power dispatch , IEEE

Transactions on power Apparatus and systems 1985: PAS-104 : 1147-1153

A.Monticelli , M .V.F Pereira ,and S. Granville , "Security constrained optimal power flow with post contingency corrective rescheduling" , IEEE Transactions on Power Systems :PWRS-2, No. 1, pp.175-182.,1987.

Deeb N ,Shahidehpur S.M ,Linear reactive power optimization in a large power network using the decomposition approach. IEEE Transactions on power system 1990: 5(2) : 428-435

E. Hobson ,'Network consrained reactive power control using linear programming, ' IEEE Transactions on power systems PAS -99 (4) ,pp 868=877, 1980

K.Y Lee ,Y.M Park , and J.L Oritz, "Fuel –cost optimization for both real and reactive power dispatches" , IEE Proc; 131C,(3), pp.85-93.

M.K. Mangoli, and K.Y. Lee, "Optimal real and reactive power control using linear programming" , Electr.Power Syst.Res, Vol.26, pp.1-10,1993.

S.R.Paranjothi ,and K.Anburaja, "Optimal power flow using refined genetic algorithm", Electr.Power Compon.Syst , Vol. 30, 1055-1063,2002.

D. Devaraj, and B. Yeganarayana, "Genetic algorithm based optimal power flow for security enhancement", IEE proc-Generation.Transmission and. Distribution; 152, 6 November 2005.

C.A. Canizares , A.C.Z.de Souza and V.H. Quintana , " Comparison of performance indices for detection of proximity to voltage collapse ,'' vol. 11. no.3 , pp.1441-1450, Aug 1996 .

M. M. Lydia, J. D. Eric, and T. H. Roger, N. M. Justin, Mechanisms and behavioural functions of structural coloration in cephalopods, J. R. Soc. Interface, 2008.

http://www.thecephalopodpage.org/.

Adel Sabry Eesa, Adnan Mohsin Abdulazeez Brifcani, Zeynep Orman, Cuttlefish Algorithm – A Novel Bio-Inspired Optimization Algorithm, International Journal of Scientific & Engineering Research, Volume 4, Issue 9, September 2013.

R. T. Hanlon, and J. B. Messenger, Cephalopod Behavior, Cambridge: Cambridge University Press, 1996.

E. Florey, Ultrastructure and function of cephalopod chromatophores, Am. Zool. 1969.

R. T. Hanlon, K. M. Cooper, B. U. Budelmann. and T. C. Pappas, Physiological color change in squid iridophores I, Behavior, morphology and pharmacology in Lolliguncula brevis, Cell and Tissue Research. 259, 1990.

K. M. Cooper, R. T. Hanlon, and B.U. Budelmann, Physiological color change in squid iridophores II, Ultrastructural mechanisms in Lolliguncula brevis, Cell and Tissue Research. 259, 1990.

R. A. Cloney, and S. L. Brocco, Chromatophore organs, reflector cells, iridocytes and leucophores in cephalopods, Am. Zool. 1983.

D. Froesch and J. B. Messenger, On leucophores and the chromatic unit of Octopus vulgaris, J. Zool, 1978.

K. Eric, M. M. Lydia, T. H. Roger, B. D. Patrick, R. N. Rajesh, F. Eric and H. Jason, Biological versus electronic adaptive coloration: how can one inform the other, J. R. Soc. Interface, 2012.

Wu Q H, Ma J T. Power system optimal reactive power dispatch using evolutionary programming. IEEE Transactions on power systems 1995; 10(3): 1243-1248 .

S.Durairaj, D.Devaraj, P.S.Kannan ,' Genetic algorithm applications to optimal reactive power dispatch with voltage stability enhancement' , IE(I) Journal-EL Vol 87,September 2006.

D.Devaraj ,' Improved genetic algorithm for multi – objective reactive power dispatch problem' European Transactions on electrical power 2007 ; 17: 569-581.

P. Aruna Jeyanthy and Dr. D. Devaraj "Optimal Reactive Power Dispatch for Voltage Stability Enhancement Using Real Coded Genetic Algorithm" International Journal of Computer and Electrical Engineering, Vol. 2, No. 4, August, 2010 1793-8163.