Active Power Losses Curtailed by Reconfiguration with DG source in Distribution Systems

P.SUNDARARAMAN
Department of Electrical, Electronics and Communication Engineering,
GITAM University – Bangalore,
SOUTH INDIA

Abstract: Distributed generation and optimal placement of capacitors have the impending to improve the complete performance of the distribution systems using multi-objective soft computing techniques. The profits of the finest location of DG inserting and optimal placement of capacitors are important to selecting the number and volume of devices. This proposed research will be implemented a hybrid BAT algorithm for an optimal location to inject the reactive power and capacity of DGs. The proposed method has a high convergence speed and is not confined to resident optimal. The hybrid methodologies are enhanced using multi-objective functions technically, economically, and environmentally minimizing the active power losses, Voltage stability Index, the total cost of energy saving, and total emissions from generation sources in the system. This research has been executed with MATLAB 2021b software and The concert of the results have been compared with GO, Fireworks algorithm, cuckoo crunch algorithm, shuffled Frogs leaf algorithms, and Antlion Optimizations with standard IEEE 33 bus and IEEE 69 bus and standard Indian test 62 bus systems. Based on the results, the proposed BAT algorithm is a more efficient tool for curtailing the active power losses and maintaining the voltage deviation in the buses.

Keywords: Network reconfigurations, Distribution systems, Bat algorithm, curtailing Losses, DG sources, Voltage Stability Indicator.

Received: March 21, 2022. Revised: September 12, 2022. Accepted: October 14, 2022. Published: November 2, 2022.

1. Introduction

Distribution system is the one of the main and important part of systems in power sectors. This connects the high voltage transmission networks to lower voltage tail end of consumers premises. Distribution system is the largest system and has the power losses are more due to low voltage with high current consumption, usage of improper conductors, high value of R/X ratio of lines. Curtailing the power losses is the very interesting and compulsory duties of every electrical engineers and researchers. The distribution networks [1]connects many interconnected networks operated in radial networks using Tie and sectionalised switches. Network reconfiguration is a main multifaceted activity. Network reconfiguration techniques is the simple and superior techniques among all other techniques in power systems. The process of network reconfiguration is changing the structure using the tie and sectionalised switches to maintain the radial network[2]. This method can improve the performance of the system according to various objectives and constraints and to maintain the stability of the system. The major objectives of the network reconfiguration are to maintain the system voltage stability, curtailing the power losses, improving the voltage profile using novel stability Indicator. Distributed generation is an evolving method for supplying electric power in the soul of the power system. By fixing the DG units in a suitable places to reduce the losses in the distribution lines. DG units are improving the voltage profile, maintain the power factor and system stability. Optimal locations of DG and sizing of DG have an important role in distribution systems. In this research, optimal location of DG placement, suitable sizes of DG sources are the most cost effective and solve the economical solutions to solve the power losses problems in the distribution systems. In the recent days, the drastically growth of consumption electrical energy by domestic[3], industrial consumers more voltage instability occurs, which leads voltage collapse. Due to instability of voltage, the systems are easily failure. So many implementations have been required to minimise the power losses and improve the voltage profile in distribution systems. The installation and integration of DGs[4-5] in distribution system is the only solution to avoid the voltage instability of the systems.

Nowadays many algorithms have been used to find the optimal solution for the minimizing the power losses[6], optimal location for injecting the reactive power and optimal allocation of capacitors with low cost using the new results of real engineering design optimization glitches. Su and Zhangiabadi et al (2011) presented the paper, the ambiguity of operation in load, network reconfiguration, and control of voltages devices. Sivanagaraju et al [7] implemented his research , the network reconfiguration has been achieved using onning and offing specific switches. Prasad et al proposed the paper , network reconfiguration derived for time varying loads using the tie and sectionalised switches. Distribution loads are not time varying loads, which has been changing with respect to nature of the loads. C.Venkatesan et al implemented the paper, the cost of the DG Source has not been derived[8]. Cost function is very important for radial distribution systems. HF Kadem et al presents the paper, the cost function of DG ad placing of DG insertion have not been correctly derived. Cost of annual saving is not derived. Assumption of w1,w2, are not feasible. A.Salan et al presented the paper, loads are taking constantly, only approximate loads have been taken into account. The Distribution systems are not constant loads in all the times. H . Hamar et al commented the paper, online voltage stability prediction using LSTM software. They derived only for the different states like alert and an emergency states and also found the stability by prediction only not in the measured. Md Hyder et al [2016] presented the paper, the total losses cannot be consider for loss minimization, cost of the single switch can be taken into account for loss minimization, and after DG injected[9], the reconfiguration has been taken only part of the system not for whole system. S.Lemdani et al [2021], derived the paper, Load factor (λ)consider only at the time of peak load times, λ varies all the other parameters varies, λ should not be constant, this paper only deals the stability of transmission systems, not for the distribution systems, this paper deals the FACTs devices not in the DG source and consider for peak load times only. Kahonli etal [2021] reviewed the paper, Voltage and current constraint only taken into account, considered all the nodes are supplied by only unique and finally shunt capacitors and DG sources not considered in the distribution system, DG sources and capacitors are very important and power , nodes are not consider as constraints for the loss minimization submitted the paper. Mirjali etal [2015] presented the paper, no optimization problems solved, considered only DG injection of nodes. PDP Reddy et al [2017] submitted the paper has not been proved for cost calculation and rate of DG has not been calculated. Alinasser et al [2019] presented the paper, status of previous eggs level, eggs position, colours of eggs, and sizes of eggs have not been considered for the calculation. The weight of eggs and holding capacity of nest have not consider for the calculation. A.S.Hassen et al [2020] presented the research article, frogs direction has been fixed, Location of frogs also has been identified by randomly, fitness function also not clearly implemented.

2. Novel Voltage Stability Indicator (Novel VSI)

The single diagram of three phase distribution system assumes a balanced network as given below in the Figure 1.0 The multiple branch of recursive equations are simplified a single equations obtained from the forward backward sweep aalgorithm using the branch exchange methods to measure the real and reactive power quantities[10].

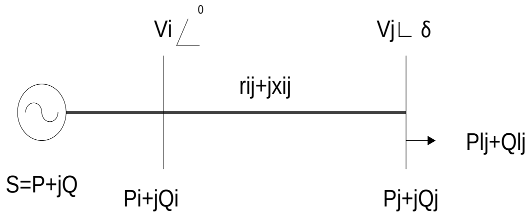

Fig 1. Single line diagram of two bus system for VSI

The two bus system mentioned as **'i'** bus is the sending end notations and **'j'** bus is the receiving end modelled as a single line diagram as shown in Figure 1.0 The distribution systems has 'n' bus system to established in a relationship between the both ends power and voltages. Current flows through the distribution systems assumes as receiving end voltage angle δ and the sending end voltage is zero.

Let it be assumed that sending end bus is 'i' as a reference bus, then the current flow is I_{ij} is measured as

$$I_{ij} = \frac{V_i\angle 0 - V_j\angle\delta}{r_{ij} + jx_{ij}} \tag{1}$$

The current flow of the line is from the apparent power flow equations as

$$S_j = V_j * I_{ij}^* \tag{2}$$

$$I_{ij}^* = \left[\frac{S_j}{V_j}\right] \tag{3}$$

From the receiving end equations, the current flow is measured using this equation

$$\frac{P_j - Q_j}{V_j^*\angle-\delta} = I_{ij}^* \tag{4}$$

The aforementioned equations are derived from apparent power, active and reactive power flow of the distribution lines to form the new current flow equations. The losses have been found using forward-backward sweep algorithms

$$P_l^k = |I_{ij}^2| * r_{ij} \quad (5)$$
$$Q_l^k = |I_{ij}^2| * x_{ij} \quad (6)$$

The distribution losses have been found from the above equations.

$$P_l = |I_{ij}^2| * r_{ij} = \frac{P_i^2+Q_i^2}{V_i^2} * r_{ij} \quad (7)$$
$$Q_l = |I_{ij}^2| * x_{ij} = \frac{P_i^2+Q_i^2}{V_i^2} * x_{ij} \quad (8)$$

Based on the distribution systems, the sending node power is to meet the entire consumed power flow of the loads and the losses of the lines. Based on a few deviances, the new complex equations have been articulated as[11]

$$\{(P\_j + jQ\_j)(r\_ij + jx\_ij) = (P\_i + jQ\_i)(r\_ij + jx\_ij) - I\_ij^2 (r\_ij + jx\_ij)(r\_ij + jx\_ij)\} \quad (9)$$

The real and imaginary terms are separated and gives

$$(P_j r_{ij} - Q_j x_{ij}) = (P_i r_{ij} - Q_i x_{ij}) + I_{ij}^2 (r_{ij}^2 - x_{ij}^2) \quad (10)$$

The quadratic equation has been simplified, real roots have been found the dependability of any system.

$$V_j = \frac{1 \pm \sqrt{\left(1 - 4\left((P_i r_{ij} - Q_i x_{ij}) + (P_j^2 - Q_j^2)(r_{ij}^2 - x_{ij}^2) r_{ij} P_L + P_i^2 r_{ij}^2 + Q_i^2 r_{ij}^2\right)\right)}}{2} \quad (11)$$

The quadratic term of an right side equation should be positive and the value should be minimum and equated with the other part.

$$1\text{-}4* \left((P_i r_{ij} - Q_i x_{ij}) + (P_j^2 - Q_j^2)(r_{ij}^2 - x_{ij}^2)\right) \geq 0 \quad (12)$$

The value of $\Delta = \sqrt{(b^2 - 4ac)}$ is separated to zero, square terms should be zero. Now this equation 4ac =1. The new voltage stability indicator equation has been formed as

$$\text{VSI} = 4*\left((P_i r_{ij} - Q_i x_{ij}) + (P_j^2 - Q_j^2)(r_{ij}^2 - x_{ij}^2)\right) = 1 \quad (13)$$

The receiving end voltage varies from 0 to maximum of 1. Nearly many numbers of indicators have been obtainable. The control value of the real roots margins are called Voltage Stability Indicator (VSI). If the system would be stability, the VSI has been placing from minimum value of 0 to the maximum value of 1[12]. Now the conductors capacity have been based on the current flow and voltage drops in the distributions side. Based on the calculations, with the help of the power losses, the novel VSI is the best, simple, effective tool to determine the stability, instability and collapse point of distribution lines. If the VSI has been placed from minimum value of zero 0 to the maximum value of 1one, the system will be stable condition[13]. The power has been clearly transmitted or distributed entire buses the systems. If the VSI has been placed below the minimum value of 0 or the above maximum value of 1, the system would be unstable, the power flow of the distribution system has been failed, if leads the system would be collapse, the VSI is the best, simple tool to determine the capacity of lines. The simple way to determine the stability condition of the conductors or distribution lines. The proposed VSI have been tested with IEEE 33 bus[14] , IEEE 69 bus and south Indian real time 62 bus systems. The results are tabulated clearly in the table 1.0 The distribution system consist of many distribution lines. The lines are connected to transformer to transformer and, transformer to consumer end. In this research the four lines has been utilized for power transmission. The lines are Raccoon, Beaver , Weasel, Rabbit, These are the technical specifications of lines are tabulated. The details are only for the constant temperature of 40°C.[15]. The results of different conductors of distribution lines the maximum current flow capacity has been found through the navel VSI. By increasing the load gradually using the novel VSI, the stability point has been found clearly. The load values for the calculation is depends upon the distribution lines. It has started from 1.0 to the maximum value of lines. The results are tabulated is given below in table 2.0.[16]

3. Problem Formulation Of Bat Algorithm In Distribution Systems

The important objective function of the network reconfiguration and placing the DG sources to curtailed the power losses and maintain the voltage profile of distribution systems using novel VSI. The proposed research having the main objective functions for minimizing the active power losses as written in the equations are given below.[17]

$$MiniF = \sum_{i=1}^{nb} r_i * \left(\frac{P_i^2 + Q_i^2}{|V_i|^2} \right) \quad (14)$$

Table 1
Technical details of different conductors

S.No	**Name of the conductor**	**Size (mm)**	**Size (Inch)**	**Copper area (Sq.mm)**	**R (Ω/km)**	**X_L (Ω/km)**	**Current carrying capacity**
1	RACCOON	7/4.09	7.0.161	48	0.395	0.29	200
2	BEAVER	7/3.99	7/0.157	45	0.42	0.3	189
3	WEASEL	7/2.59	7/0.102	20	0.587	0.333	100
4	RABBIT	7/3.35	7/0.132	30	0.685	0.347	148

Table : 2.
The conductor maximum capacity of four different conductors

S.No.	RACCOON		BEAVER		WEASEL		RABBIT	
	LMF	VSI	LMF	VSI	LMF	VSI	LMF	VSI
0.85 pf	4.145	0.9995	3.78	0.9983	3.90	0.9986	2.11	0.9998
0.9 pf	5.040	0.9999	4.56	0.9981	4.55	0.9981	2.37	0.9971
0.95 pf	6.3339	0.9997	5.58	0.9985	5.37	0.9982	2.68	0.9917

Table 3
Results and comparison of IEEE 33 bus with and without DG source using proposed algorithm

Parameters	EGWO	cuckoo crunch algorithm	shuffled Frogs leaf algorithms	Antlion	MSA	SPSO	Proposed BAT algorithm
Year	2021	2019	2019	2017	2020	2020	-
Tie switches	14,24,30	8,5,37,30,12	35,14,26,24,33	6,30,16	7,14,9, 32,28	7,11,28, 32,34	7,9,14,32,37
Qc (KVAr)	2.92 MW	300	0.27MW	1542.67	-	100	0.96MVAr
Cost ($)	-	$ 50103	-	-	-	$ 5000	
Location	-	8,30,23	35,14,26,24,33	6,30,16	7,14,9, 32,28	7,30,28	7,9,14,32,37,
Ploss (KW)	171.457	195.6628	139.98	185.80	202.68	231.18	140.62
V min	0.9687	0.9704	0.9621	0.9527	0.9412	0.9245	0.9652
Vmax	0.9941	1.0	-	-	1.0	1.0	1.0
% saving	92.52		-	-	30.94	36.64 %	-
Iter	-	50	-	-	150	150	100

Table 4
Results and Comparison of IEEE 69 bus with and without DG source

Parameters	EGWO	cuckoo crunch algorith m,	shuffled Frogs leaf algorithms	Antlion	MSA	SPSO	Proposed BAT algorithm
Year	2021	2019	2019	2019	2020	2019	-
Tie switches	11,18,6 1	15,50,61	57,73,13,69 ,12	30,55,6 1	69,70,14, 5761	20,59, 68.	s69, s70 s71, s72, s73.
Qc (KVAr)	2.62	1950	0.89 MVAr	946.347	-	600	1.2MVAr
Cost ($)	-	$ 64397	-	-	-	58650	$ 75000
Location	-	15,50,61	57,73,13,69 ,12	30,55,6 1	69,70,14, 57,61	59,20	45,46,71
Ploss (KW)	164.42 8 M W	190.8139	149.51	224.049	198.58	201.87 6	190.064
V min	0.979	0.96	0.98	0.9109	0.9454	0.955	0.9624
Vmax	0.9987	1.0	-	-	1.0	1.0	1.05
% saving	69.14	54.4%	75.57	-	56.16	49.60	70.12%
Iter	-	100	-	--	-	100	100

Table 5
Results and comparison of Indian standard test 62 bus system

Parameters	cuckoo crunch algorithm,	shuffled Frogs leaf algorithms	Antlion	MSA	Proposed BAT algorithm
Tie switches	12,34,62	12,36,62	15,48,56	13,46,58	15,46,51
Qc (MVAr)	1.125	1.5	1.34	1.12	0.93MVAr
Qct (MVAr)	2.0	1.75	1.75	1.56	1.25MVAr
Location	13,35,60	12,36,62	15,48,56	13,46,58	11,35,58
Ploss (KW)	86.12	67.78	86.28	98.38	63.44KW
V min	0.9312	0.9226	0.9312	0.9438	0.96
Vmax	1.0	1.0	1.0	1.0	1.0
% saving	28%	34%	29%	12%	39.82%
Iter	50	50	75	70	75

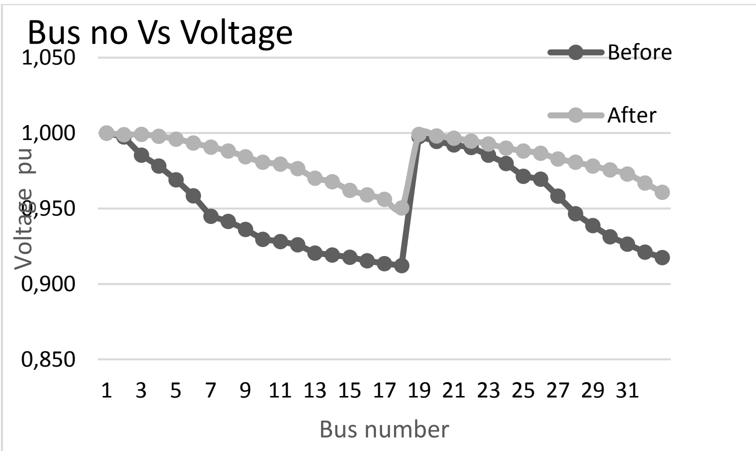

Fig 2. Bus voltages with bus numbers for IEEE 33 bus system

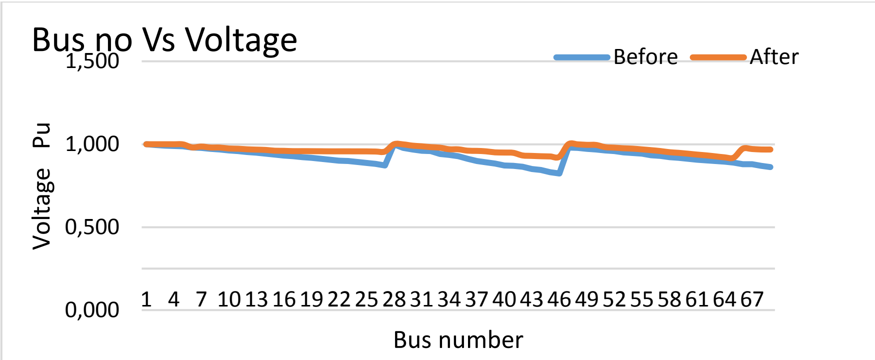

Fig 3. Bus voltages with bus numbers for IEEE 69 bus system

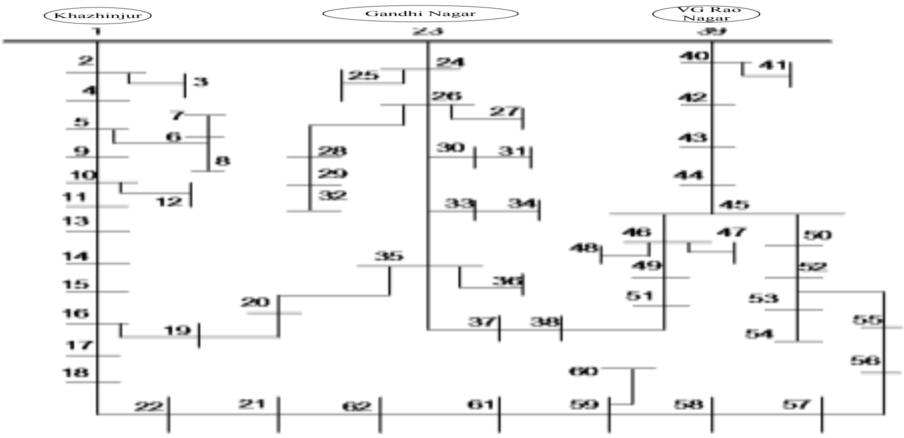

Figure 4. Single line diagram of Indian Test System

Table 6
Main parameters for Indian test systems after reconfiguration

S.No.	N	A_0	r_0	f_{min}	f_{max}
1	50	0.58	0.598	0	2.063

Table 7
Results of power losses of Indian 62 bus systems used BAT algorithm

Type	Tie switches placed	P_{LOSS} (KW)	Q_{LOSS} (KVAr)	Min Node Voltage	Power loss reduction
Proposed BA	12-32, 36-48, 38-57. (3 switches)	63.44 KW	42.58 KVAr	0.9357, Node 11. 0.9278, Node 35. 0.9391, Node 58.	38.92%

The constraints exposed to network reconfiguration and DG installation problems with [15]
Power flow limitations : $P_{max} \geq P_i \geq P_{min}$

Bus voltage constraints : $V_{max} \geq V_i \geq V_{min}$

Bus apparent power flow limits: $S_{max} \geq S_i, S_{min} \leq S_i$

Bus current flow controls values : $I_{max} \geq I_i, I_{min} \leq I_i$

Structure of network : The reconfiguration system must be radial in structure

Sizes of DGs : $Q^c{}_{max} = L * Q^c{}_o$ [15]

Generally Bats are different types of animal and it has reversibly hanging in the roof of buildings. It has radiates sound signal as echolocation in the wings to find their food even in darkness. The wings are advanced echolocation capability to determine the foods. Individually bat operates the echolocation techniques to calculate the distance and time to reach the food. It kills background sprints in some charmed way using the echolocation techniques. x_i the direction of position flies, Vi is the velocity of randomly moving the bats, f_{mn} is the pulse frequency of generated, λ is the wave length of signals[19] , A_0 is the loudness of the sound, pulse rate 'r' is always form 0 to1, G_{best} is stored after generating of populations in randomly. Bats are fly based on the velocity, position, frequency, loudness of sound , pulse rate to find their prey. The loudness has been varies based on the distance and positions. In generally, the frequency range of bats from20 KHz to500 KHz[20] and wavelength is from0.7 mm to 17mm. The number of practical bats are 10 to 40. The values are restructured based on the loudness of sound, movement, and pulse rate. The following equations are determine the movements of bats, loudness of sound, pulse emission rates. In this algorithm, there are some guidelines for finding the positions of x_i and velocities Vi of the simulated bats.

$$f_i = f_{min} + \left(f_{max} - f_{min} \right) \beta \quad (16)$$

$$V_i^t = V_i^{t-1} + \left(x_i^{t-1} - x^* \right) f_i \quad (17)$$

$$x_i^t = x_i^{t-1} + v_i^t \quad (18)$$

Where β is the random vector and placing in between 0 to 1, The best solution of all the bats is x^*. [21]
The results shows the superiority of the proposed algorithm is best than other results. The time taken to

$$x_{new} = x_{old} + \varepsilon A^t \quad (19)$$

The scaling factor is 'ε' placing in between -1 to 1, where α and γ are constant values, the initial values of loudness is 0 and the maximum values is 1. Loudness and pulse rates are our convenient. .

$$A_i^{i+1} = \alpha A_i^t \quad (20)$$

$$r_i^{t+1} = r_i^0 \left[1 - exp\left(-\gamma * Iter \right) \right] \quad (21)$$

4. Results and Discussions

So that validate the proposed BAT algorithm, for analyzing the network reconfiguration and DG allocation to the sufficient reactive power to the nodes in the distribution systems. This algorithm has been tested in IEEE 33 bus, IEEE69 bus and implemented in Real time Indian 62 bus system. The maximum sizes of the DG sources are 100KW to maximum of 2 MW. The results are achieved the future Bat algorithm were equated to Antlion, Flower pollination, GO, Fireworks algorithm, cuckoo crunch algorithm and shuffled Frogs leaf algorithms and which have been efficient and optimal solution has been implemented. There are four situations are taken for compares and to determine the optimal problems.
Type 1: Test system without network reconfiguration and DG installation
Type 2: DG installation after network reconfiguration
Type 3: Reconfiguration of network after DG installation [22-25]
Type 4: Reconfigured with DG installation and optimal DG location.

4.1 IEEE 33 Bus System

The seven results were tested and compared with MATLAB 2016 software and these results has been getting from the Forward Backward sweep algorithm using reduction techniques for the choosing the best of conductors and optimal placements of DG source for reducing the power losses in the distribution systems. 32 sectionalized switches, 32 branches and 5 normally tie switches for the basic configuration of the system. The rating of the system is 3.2 MVA, 2.3 MVAr, 12.7 KV. Before the reconfiguration the system producing the active power losses 228.68KW and 153.3 KVAr, the minimum voltage flow of the node is 0.9012 pu. After the network reconfiguration using the BAT algorithm the power losses are very less 204.62 Kw, 153.33 KVAr and the minimum voltage of 0.96pu.

the test for one year variation of loads in the distribution systems. It has been decided that the proposed algorithm attained the maximum power losses and better voltage profile, minimum cost of DG and optimal location of DG[28]. The proposed algorithm has been proved the superiority of all other algorithms. The proposed VSI of Forward Backward sweep algorithm using reduction techniques has been proved the best VSI for identify the distribution line and best performance for optimal location and minimized the cost of DG source in the distribution systems. The table gives the better performance of optimal location, correct sizes of DG source, number of DG source required to compensate the voltage profile in the distribution systems. The previous results have been violating the number of restrictions of sizes of capacitors, location of DG[29] sources in the distribution networks. The proposed algorithms confirmed the number of sizes of DG source and optimal locations in the distribution systems. The proposed algorithms proves the dominance and cost wise success of these algorithm for the properly selection of capacity, location, selection of conductors, minimizing the cost of DG source in the distribution systems. When comparing the performance of proposed algorithm to EGWO, Cuckoo crunch algorithm, shuffled Frogs leaf, Antlion, MSA and SPSO algorithms. The proposed BAT algorithm has been provide the maintain the better voltage profile and curtailing the maximum power losses using the proposed VSI in the distribution systems. The convergence features of the proposed BAT algorithm for the active power loss reduction and better voltage level of the 33 bus system is given fig 2.0, after 72 iterations the proposed BAT algorithm have converged to the optimal results[30]. the node is 0.9566 are shown in Table 3, The initial tie switches are 33,34,35,36 and 37. The tested results are tabulated as shown in table 3.0.[26] It is perceived the power factor of the system is approximately constant as 0.95 lagging and the power factor is still low in lagging the DG source requirement also changes. In this substations the requirement of reactive power is insufficient, so the losses are more than the reconfiguration.

4.2 IEEE 69 bus system

In this IEEE 69 bus system results have been tested and compared with six algorithms as shown in the table 4.0, for minimizing the active power losses and improve the voltage profile of the above systems. In this system have 7 main feeders, 3 laterals and 5 tie lines with 68 load buses, the capability of 3.80 MW, 2.69 MVAr and 12.66 KV. For the 69 bus system, without inserted DG source the active losses and reactive power losses are 224.476 KW and 178.56KVAr. The minimum voltage before inserted the DG source unit is 0.9101. Table 4.0 shows, after the injecting the different sizes of DG source in the different nodes, the power losses are curtailed and maintain the voltage profile are shown the table 4.0, The optimal reconfiguration of the system is achieved from active losses 224.996 KW to 190.64 KW, The reactive power losses are achieved from178.56KVAr to 89.56KVAr and the bus voltage of the node is minimum of 0.9624pu. When comparing the performance of proposed algorithm to EGWO, Cuckoo crunch algorithm, shuffled Frogs leaf, Antlion, MSA and SPSO algorithms. The proposed BAT algorithm has been provide the maintain the better voltage profile and curtailing the maximum power losses using the proposed VSI in the distribution systems. The value of DG and location of DG were optimally implemented using the eight algorithms. The primary configuration of the system confined 68 normally closed sectionalized switches and 5 normally opened tie switches. The table contains comparisons of all the eight algorithms and concluded the proposed algorithm is the most superior than other mentioned algorithms in terms of voltage, power losses, optimal locations, sizes of DG, locations of DG and saving of cost also. The results of network reconfiguration and optimal placements of DG source in the radial distribution systems as shown in table 4. The tested results and comparisons, which explains the reduction of active power losses, improved the voltage profile and saving the cost of DG source have been improved in drastically as shown in table 4.0

4.3 Real-time Indian 62 Bus System

The small distribution system will be taken for the research for curtailing the power losses and maintain the voltage profile as constant in all buses. The various level of load nodes are the installed capacity of 3600 KVA, 4000 KVA, and 5350 KVA. The total installed capacity of main distribution station is 10 MVA, The incoming line voltage is 33 KV and outgoing lines are 11 KV and the conductor size is 91.97mm^2. The station power factor is always maintained in 0.96lagging. The minimum operating voltage in the existing systems is nearly 10 KV. The position of the switches to be selected in the distribution network as suitable is expressed by 0, 1 integer variables. The binary encoding approach are implemented for this research. The proposed BAT

Algorithm for loss reduction has been tested and evaluated by implementing on the real-time Indian distribution system of 62 bus system. Prior to reconfiguration, the active losses and reactive power loss are 90.0851 KW and 72.812 KVAr respectively. The optimal reconfiguration of the systems achieves the active losses from 90.0851 KW to 63.447 KW while reactive power achieves losses from 72.812 KVAr to 42.56 KVAr. Based on the proposed novel VSI equation, The RACCON conductor has been implemented to the distribution system and the maximum power with standing capacity of the conductor load factor is 6.34. The assumption of the system is connected a full load condition for all feeders with 0.96 pf lagging. The 100 numbers of best convergence for the proposed algorithms. The data's for the proposed systems have been utilized to find the optimal locations and curtailed the minimum losses in the distribution systems. The population sizes are 20, the number of generations are 50, loudness are 0.565 and pulse rates are 0.531. Based on the trial and error method followed to set the parameters for this research. There are only three sectionalized switches for minimum loss achieved by the proposed network reconfiguration process, when compared to the existing configurations, which had fifteen switches for the network. The parameters used for Real-time 62 bus system is as follows are given in Table 6.0. The best optimal solution would be availed in the table 7.0 by used these parameters. In this research, 50 numbers of bats, 0.58 emission rate, 0.598 loudness, frequency 2.063 are the data's used to get the optimal solution. Less number of iterations used for the computations. The recent proposed BAT algorithm coding are verbalized and performed in this research.

5. Conclusion

The most importance of this research is curtailing the maximum power losses , maintain the voltage profile in the radial distribution systems. The novel VSI has been derived which is different from other existing VSI, which is found the stability point of conductor and implemented in the distribution systems. Using a different sectionalized and tie switches by changing the positions, the weak node has been found. In this weak node , required amount of DG source injected the stability of the system improved. With the help of BAT algorithm, the optimum point of instability point or weak node have been found and optimizing the switching positions are implemented in real time systems. The BAT algorithm has been utilized to find the optimal size of reactive power source of DGs, location of DGs, the amount of insufficient DGs and the maximum quantity of DGs inserted to the distribution system for minimizing the losses. The novel VSI has been derived from the distributed power flow analysis using the forward backward sweep algorithm with branch exchange techniques using node reduction method. The power losses are curtailed IEEE 33 bus system is from 283.56 to 202.4KW, IEEE 69 bus system is from 224.996 KW to 190.64 KW and the real time system power losses are from is90.0851 KW to 63.447 KW, and the bus voltage is maintained from 1.02 pu to 0.96pu. The nonlinear optimization problem has been formulated for the better objective functions. The novel VSI is the most useful, applicable to transmission lines conductor manufacturing companies. Many power flow equations could be obtained from different soft computing algorithms using the MATLAB coding without any disturbances with the few seconds operating of systems in future research.

References

[1] Inkollu, S.R., Kota, V.R. (2016). Optimal setting of FACTS devices for voltage stability improvement using PSO adaptive GSA hybrid algorithm. Engineering Science and Technology, an International Journal, 19(3): 1166-1176.

[2] Naganathan, A., Ranganathan, V. (2016). Improving voltage stability of power system by optimal location of FACTS devices using bio-inspired algorithms. Circuits and Systems, 7(6): 805-813.

[3] Gaur, D., Mathew, L. (2018). Optimal placement of FACTS devices using optimization techniques: A review. In IOP Conference Series: Materials Science and Engineering, 331(1): 012023.

[4] Machavarapu, S., Rao, M.V.G., Rao, P.V.R. (2019). Machine learning algorithm based static VAR compensator to enhance voltage stability of multimachine power system. Mathematical Modelling of Engineering Problems, 6(4): 641-649. https://doi.org/10.18280/mmep.060420

[5] Machavarapu, S., Rao, M.V.G., Rao, P.V.R. (2019). Modelling and optimal siting of static VAR compensator to enhance voltage stability of power system with uncertain load. Advances in Modelling and Analysis C, 74(2-4): 111-116.

[6] Issam, G., Sabir, M. (2019). A new adaptive neuro-fuzzy inference system (ANFIS) and PI controller to voltage regulation of power system equipped by wind turbine. Italian Journal of Engineering Science, 21(2): 149-155.

[7] Inji Ibrahim Atteya, Hamdy Ashour, Nagi Fahmi, Danielle Strickland : "Radial distribution network

reconfiguration for power losses reduction using a modified particle swarm optimization”, 24th International Conference & Exhibition on Electricity Distribution (CIRED), pp 2505- 2508.

[8] Kayal, P.; Chanda, C.K. Placement of wind and solar based DGs in distribution system for power loss minimization and voltage stability improvement. Int. J. Electr. Power Energy Syst. 2013, 53, 795–809.

[9] Sultana, B.; Mustafa, M.W.; Sultana, U.; Bhatti, A.R. Review on reliability improvement and power loss reduction in distribution system via network reconfiguration. Renew. Sustain. Energy Rev. 2016, 66, 297–310.

[10] Swarnkar, A.; Gupta, N.; Niazi, K.R. Adapted ant colony optimization for efficient reconfiguration of balanced and unbalanced distribution systems for loss minimization. Swarm Evolut. Comput. 2011, 1, 129–137.

[11] Niknam, T.; Farsani, E.A. A hybrid self-adaptive particle swarm optimization and modified shuffled frog leaping algorithm for distribution feeder reconfiguration. Eng. Appl. Artif. Intell. 2010, 23, 1340–1349.

[12] Nguyen, T.T.; Truong, A.V.; Phung, T.A. A novel method based on adaptive cuckoo search for optimal network reconfiguration and distributed generation allocation in distribution network. Int. J. Electr. Power Energy Syst. 2016, 76, 801–815.

[13] Rao, R.S.; Ravindra, K.; Satish, K.; Narasimham, S.V.L. Power loss minimization in distribution system using network reconfiguration in the presence of distributed generation. IEEE Trans. Power Syst. 2013, 28, 317–325.

[14] Arandian, B.; Hooshmand, R.A.; Gholipour, E. Decreasing activity cost of a distribution system company by reconfiguration and power generation control of DGs based on shuffled frog leaping algorithm. Int. J. Electr. Power Energy Syst. 2014, 61, 48–55.

[15] Chidanandappa, “GA based network reconfiguration in distribution systems with multiple A three phase load flow algorithm for distribution systems for time varying loads“, elsevier procedia technology, SMART grid technologies, 2015.

[16] MayaK, “A three phase load flow algorithm for distribution systems for distributed generator models,“Elsevierprocedia technology,vol.21, pp.126-135, 2015.

[17] Taher S.A, “Optimal reconfiguration and DG allocation of balanced and unbalanced radial distribution system“, AIMS shams Engineering Journal,no.5, pp.735-749, 2014.

[18] N.G.A Hemdan and M Kurrat, “Efficient integration of distributed generation for meeting the increased oad demand,” International Journal of Electrical Power & Energy Systems, vol.33, no.9, pp.1572–1583, Nov 2011.

[19] Hamada M.M, Wahab, M.A.A and Hemdan, N.G.A, “Simple and efficient method for steady-state voltage stability assessment off radial distribution systems”, Electric Power Systems Research, vol.80, no.2, pp.152-160, 2010.

[20] Zhang X, Wong C.K, “Comparison of Voltage Stability Indexes Considering Dynamic Load”, IEEE Electrical Power and Energy Conference, 2011.

[21] H Musa, S.S Adamu, “Enhanced PSO based multi objective distributed generation placement and sizing for power loss reduction and voltage stability index improvement Energetic”, IEEE, pp.1-6, 2013.

[22] S. Mandal, K. K. Mandal, B. Tudu, and N. Chakraborty, “A new improved hybrid algorithm for multi-objective capacitor allocation in radial distribution networks,” Soft Computing for Problem Solving, vol. 816, pp. 585–597, 2019.

[23] S. Nawaz, A. K. Bansal, and M. P. Sharma, “A novel analytical technique for optimal allocation of capacitors in radial distribution systems,” Journal of Engineering and Technological Sciences, vol. 49, no. 2, pp. 236–246, 2017.

[24] P. Diaz, M. Perez-Cisneros, E. Cuevas, O. Camarena, F. A. Fausto Martinez, and A. Gonzalez, “A swarm approach for improving voltage profiles and reduce power loss on electrical distribution networks,” IEEE Access, vol. 6, pp. 49498–49512, 2018.