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OPTIMAL ECONOMIC DISPATCH BIASED ON PARTICLE SWARM OPTIMIZATION: 400kv IRAQI SUPER GRID

Assist Lecture Mohammed Kdair Abd

Department of Electrical Engineering, University of Technology, Baghdad, Iraq

E-mail: mka_ms2005@yahoo.com

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ABSTRACT:- In this paper application of Particle Swarm Optimization (PSO) based algorithm for Optimal Power Flow (OPF) in Economic Dispatch (ED) was studied. Firstly, this method is dynamic in nature and it beats the arrears of other evolutionary computation techniques such as premature convergence and provides high quality solutions. Secondly, the aim objective is to minimize the fuel cost generation of Iraqi Super Grid (ISG400Kv, 24-bus) by using PSO. Third, the proposed algorithm had been tested based on two system; first tested theoretically (IEEE, 26-bus) and the second was tested practically the Iraqi Super Grid (ISG400Kv, 24-bus) with new data at October, 2010. Finally, the simulated results shows three major benefits of the proposed method on the systems studied as; Cost-minimization generation; Decreasing the energy loss and Enhancement of the voltage profile.

Keywords: Economic dispatch, Iraqi Super Grid 400kv, Particle Swarm Optimization, Optimal Power Flow.

Nomenclature:

F_T : Total fuel cost.

n : Number of online generating unit.

$F_i(P_i)$: Operating fuel cost of generating unit i.

a_i, b_i, c_i: Cost coefficients of generating unit i.

Pi : Power generation unit i.

D : Total load demand.

P_L : Total transmission line loss.

$P_{i,min}$, $P_{i,max}$: Minimum and maximum power output of unit i.

$rand_1$, $rand_2$: Uniformly random numbers between 0 and 1.

v_{id}^k : Current velocity of individual i in dimension d at iteration k.

v_{id}^{k+1} : Velocity of individual i in dimension d at iteration $k+1$.

x_{id}^k : Current position of individual i in dimension d at iteration k.

$pbest_{id}$: Dimension d of the pbest of individual i.

$gbest_d$: Dimension d of the g*best* of the swarm.

ω : Inertia weight factor.

ω_{max} : Maximum value of weighting factor.

ω_{min} : Minimum value of weighting factor.

$iter_{max}$: Maximum number of iterations.

$iter$: Current number of iteration.

x_{id}^{k+1} : Position of individual *i* in dimension *d* at iteration *k+1*.

1- INTRODUCTION

Economic dispatch problem is allocating loads to plants for minimum fuel cost generation whiles meeting the barriers. Economic dispatch problem is one of the important optimization problems in a power system. In a practicable power system, power plants are not loaded at the same distance from the center of loads additionally their fuel cost generation is different. The generation capacity is more than the demand and losses.

Many researcher focuses on Economic Dispatch. In this paper are include some of important sources in this subject like, D.C. Secui, I. Felea, S. Dzitac, L. Popper, presented how examines two techniques of the Particle Swarm Optimization method (PSO) can be used to solve the Economic Power Dispatch (EPD) problem [(1)]. S.M.V.Pandian, K.Thanushkodi, present an Efficient Particle Swarm Optimization (EPSO) technique, employed to solve Economic Dispatch (ED) problems including losses in power system. With practical consideration, ED will have non-smooth cost functions with equality and inequality constraints that make the problem, a large-scale highly constrained nonlinear optimization problem. To demonstrate the effectiveness of the proposed method it is being applied to test ED problems, one with smooth and other with non smooth cost functions considering valve-point loading effects [(2)]. K.S. Kumar et al, have presented the use four modified versions of particle swarm optimizer (PSO) have been applied to the economic power dispatch with valve-point effects [(3)]. K. Mahadevan, et al., have presented a new approach using Particle Swarm Optimization (PSO) for solving the ED problem of generating units having non-smooth fuel cost functions with ramp rate limits [(4)]. J.B. Park, et al., proposed improved particle swarm optimization (IPSO) combines the PSO algorithm with chaotic sequences technique solving ED problems [(5)]. S. Khamsawang and S. Jiriwibhakorn, presented the mutation operators of the differential evolution (DE) are used for improving diversity exploration of PSO, which called particle swarm optimization with mutation operators (PSOM). The mutation operators are activated if velocity values of PSO nearly to zero or violated from the boundaries [(6)]. Hadi Saadat, descript the basic optimal power flow model for the analysis of problems concerning the installations of reactive power shunt compensators and the optimization of load shedding. The procedures, tested on several real networks having various characteristics and sizes, proved to be more accurate than the traditional de-coupled programs of optimal power flow [(7)]. Genetic algorithm (GA) method that used the system incremented cost as encoded parameter for solving ED problems that can take into account network losses, ramp rate limits, and value-point zone is presented by Chen and Chang [(8)]. Although the Particle Swarm Optimization (PSO) seems to be sensitive to the tuning of some weights or parameters, many researchers are still in progress for proving its potential in solving complex power system problems. Researchers have presented a use of PSO method for solving efficiently the economic dispatch problem [(9, 10 and 11)].

In this paper, PSO method used as powerful tool for solving OPF problem for Iraqi super grid 400Kv as practical test case. In addition, the proposed approach tested effectiveness on two power systems with 6 and 11 generating units respectively. The first tested theoretically (IEEE, 26-bus) results have been compared to published results in reference [12] and found to be superior. Finally, the simulation results proof that PSO success for solving the OPF problem.

2- RELATED WORK

Basic economic dispatch formulation: The aim of ED is to determine the generator levels for all units, minimizing the fuel cost function while satisfying a set of constraints. It can be represented as following:

a- Fuel cost

The cost function of ED problem is defined as follows:

$$\text{Minimize } F_T = \sum_{i=1}^{n} F_i(P_i) \quad (1)$$

The optimal power flow equation of the power network is given by the following evaluation function.

$$F_i(P_i) = a_i + b_i P_i + c_i P_i^2 \quad (2)$$

b- Capacity Limits Constraint

The generation power of each generator has some limits and it can be expressed as:

$$P_{i,min} \le P_i \le P_{i,max} \quad (3)$$

c- Power Balance Constraint

The total power has to be equal to the sum of load demand and transmission line loss as given by:

$$\sum_{i=1}^{n} P_i = D + P_L \quad (4)$$

The transmission loss can be determined from power flow. And show in equation as follow:

$$P_i = real(\sum_j^n V_i Y_{ij} \quad {}^*V_j) \quad (5)$$

$$Q_i = imag(\sum_j^n V_i Y_{ij} \quad {}^*V_j) \quad (6)$$

d- Description of Tested Systems

Test System 1 (IEEE 26-bus): The first system is a thermal power plant having six generating units. The data for the six generators (cost coefficients and limits of generated powers) are presented in reference [12]. The total power demanded in the system is PD = 1263 Mw.

Test System 2 (ISG400Kv 24-bus): The second system is composes 24-bus, 40 transmission lines (T.L) and eleven generating stations with different capacities of generation and the total length is 3723.3 Km. Figure (2) shows a configuration of this grid, Tables 1 and 2 shows bus data and line data respected at 10/8/2010 [(13)]. The transmission level in the Iraqi electrical network consists of the 400kv grid (Iraqi Super Grid) and part of the 132 kV network connected to it. The total power demanded in the system is PD = 5996 Mw.

3- PROPOSE ALGOITHM

As mentioned before, PSO was introduced by Kennedy and Eberhart, in 1995. PSO is initialized with a group of random particles (solution) and then searches for optima by updating generations. In every iteration, each particle is updated by following two “best” values. The first one is the best solution it has achieved do far. This value called *pbest.* Another one called *gbest* which is global best, this value is tracked by the particle swarm optimizer is the best value, obtained so far by any particle in the population [(2, 14)].

After finding the two values, the particle updates its velocity and positions with equation (7) and (9).

$$v_{id}^{k+1} = w^k . v_{id}^k + c_1 . rand_1 . (pbest_{id} - x_{id}^k) + c_2 . rand_2 . (gbest_d - x_{id}^k) \quad (7)$$

Constant *C* is constriction factor; *c1* and *c2* represent the weighting factor and are tuned in the process. The constants *c1* and *c*2 represent the weighting factor of the acceleration terms that pull each particle toward the *pbest* and *gbest* positions. Low values allow particles to roam far from the target regions before being tugged back.

Here ω is the inertia weight parameter which controls the global and local exploration capabilities of the particle. In PSO, the balance between the global and local exploration abilities is mainly controlled by inertia weights. ω often decreases linearly from about 0.9 to 0.4 during the run. Its value is set according to the following equation:

$$\omega = \omega_{max} - \left[\frac{\omega_{max} - \omega_{min}}{iter_{max}}\right] * iter \quad (8)$$

Each individual moves from the current position to the next one by the modified velocity in eq. (7) using the following equation:

$$x_{id}^{k+1} = x_{id}^k + v_{id}^{k+1} \quad (9)$$

Figure 1, shows the concept of the searching mechanism of PSO using the modified velocity and position of individual *i* based on eq. (7) and (9) if the values of *ω, c1, c2, rand1, rand2* are equal 1.

The procedures of **ED-PSO** algorithm can be explained as follow steps:
Step 1: Input bus data, line data, base mva, number of iterations, maximum demand, generation cost.
Step 2: Input parameters of system, and specify the lower and upper boundaries of each control variable.
Step 3: Initialize learning factors c1, c2, inertia weight w and the initial velocity v1.
Step 4: Modify the organ velocity v of each individual particle according by applying eq. (7).
Step 5: Modify the organ position of each individual particle according by applying eq. (9).
Step 6: If the account value of each population is advantageous than the bygone *pbest* the current value is allocate to be *pbest*. If the best *pbest* is advantageous than the *gbest* the value is allocate to be *gbest*.
Step 7: If the number of iterations areas the maximum, then go to step 8, or go to step 4.
Step 8: The particle that generates the latest *pgbest* is the global optimum.
Step 9: account the total fuel cost by applying eq. (2).
Step 10: account the total power has to be equal to the sum of load demand and transmission line loss by applying eqs. (4), (5), (6).
Step 11: Stop the program, print the results.

4- RESULTS AND DISCUSSION

The aim of PSO methods have been successfully applied additionally the results were obtained for (IEEE 26- bus) and (ISG400Kv 24-bus) systems applying MATLAB 7.8.0-R2009a software. This PSO method is modern heuristic algorithm developed through simulation of a simplified social system, and has been found to be robust in solving continuous nonlinear optimization problems. It was developed from communal action of the organisms such as bird flocking which is applied for detecting optimal power flow solution for ED.

Standard system data are taken for the cost coefficients, generation limits, transmission loss coefficients, this data are shown in appendix one and two [12, 13]. In the proposed PSO based OPF an Newton Rapshon method [7, 12] and applying for getting the optimal solutions.

After executing the simulation studied. By using PSO and applied to (IEEE 26- bus), Table (3) show the values fuel cost generation, compared the results with reference [12]. The results indicated that PSO has proved to be successful in obtaining fuel cost generation less, when we applied our proposed method we get Fuel Cost Generation equal to 15440 $/h, while in [12] equal to 15460 $/h.

After the success of an application PSO on the (IEEE 26- bus), has been applied for the first time on the Iraqi Super Grid (ISG400Kv, 24-bus) to get the lowest fuel cost generation and losses, as shown in Table (4), the total losses starting equal to 138.078 Mw and the total losses final equal to 60.464 Mw. Tables (5) and (6) show the power flow solution by Newton-Raphson Method before and after using PSO Method. The simulation studies were carried out on Pentium Intel(R), Core(TM), i3 CPU, 64-bit, 2.40GHz, 2GB RAM system.

5- CONCLUSIONS

In this paper Particle Swarm Optimization algorithm method is applied to getting solves the economic dispatch of power system and decrease the fuel cost generation. The proposed algorithm is applied on the two systems, the first one is IEEE 26-bus and the other is ISG400Kv 24-bus. When compare the starting values of generation with final values of generation, the results show that the proposed algorithm is applicable and effective in the solution of ED problems and decrease the fuel cost generation. Other main advantage of PSO over other modern heuristics is modeling stability, flexibility, sure and fast convergence than other heuristic methods. PSO method requires only a few parameters to be adjusted, which make easy method to implement and high quality solution.

6- REFERENCE

(1) D.C. Secui, I. Felea, S. Dzitac, L. Popper, (2010). “A Swarm Intelligence Approach to the Power Dispatch Problem”, Int. J. of Computers, Communications & Control, ISSN 1841-9836, E-ISSN 1841-9844, Vol. V, No. 3, (pp. 375-384).

(2) S. M. V. Pandian, K. Thanushkodi, (2008). “An Efficient Particle Swarm Optimization (EPSO) for Economic Dispatch Problems With Transmission Losses for Both Smooth and Non-smooth Cost functions”, WSEAS TRANSACTIONS on POWER SYSTEMS, Issue 11, Vol. 3, (pp. 685-694).

(3) K. S. Kumar, R. Rajaram, V. Tamilselvan, V. Shanmugasundaram, S.Naveen, I.G.Mohamed Nowfal, Hariharan, T. Jayabarathi, (2009). “Economic Dispatch with Valve Point Effect using various PSO Techniques”, International Journal of Recent Trends in Engineering, Vol. 2, No. 6, (pp. 130-135).

(4) K. Mahadevan, P. S. Kannan, S. Kannan, (2005). “Particle Swarm Optimization for Economic Dispatch of Generating Units with Valve-Point Loading”, Journal of Energy & Environment , (pp. 49 – 61).

(5) J. B. Park, K.-S. Lee, J.-R. Shin, and K. Y. Lee, (2005). “A particle swarm optimization for economic dispatch with nonsmooth cost functions”, IEEE Trans. Power Syst., Vol. 20, No. 1, (pp. 34–42).

(6) S. Khamsawang, S. Jiriwibhakorn, (2009), "Solving the Economic Dispatch Problem using Novel Particle Swarm Optimization", International Journal of Electrical and Electronics Engineering Vol. 3, No. 1, (pp. 41-46).

(7) Hadi Saadat, (1999). "Power System Analysis", International editions. WCB/McGraw-Hill.

(8) H. Chen and H. C. Chang, (1995). "Large-scale economic dispatch by genetic algorithm", IEEE Trans. on Power Systems, Vol. 10, No. 4, (pp. 1919-1926).

(9) Z.-L. Giang, (2003). "Particle swarm optimization to solving the economic dispatch considering the generator constraints", IEEE Trans. On Power system, (pp. 1187-2123).

(10) J. B. Park, K. S. Lee, J. R. Shin, K. Y. Lee, (2005). "A particle swarm optimization for economic dispatch with nonsmooth cost functions", IEEE Trans. On Power System, Vol. 20, No. 1, (pp. 34-42).

(11) A. I. Selvakumar, K. Thanushkodi, (2007). "A new particle swarm optimization solution to nonconvex economic dispatch problem", IEEE Trans. On Power system, Vol. 22, No. 1, (pp. 42-51).

(12) S. K. Ibrahim, (2005). "Economic Dispatch Improvement by using Fixed Reactive Power Compensation", M.Sc. Thesis, University of Technology, Baghdad.

(13) متطلبات مركز السيطرة الوطني، الشركة العامة لإنتاج الطاقة الكهربائية، وزارة الكهرباء، (٢٠١٠).

(14) J. Kennedy and R. Eberhart, (1995). "A Particle Swarm Optimization, In: Proc. of IEEE International conference on Neural Networks", Vol. 4, Perth, Australia (pp. 1942-1948).

Table (1): Bus data of Iraqi Super Grid at October, 2010 (ISG400Kv, 24-bus).

Bus No.	Full Name	Abb.	Code	Bus Code	Voltage Mag.	Angle Degree	Load		Generator				Injected
							Mw	Mvar	Mw	Mvar	Qmin	Qmax	Mvar
1	Mosul dam-main	MMDH	11420	1	1.025	0	0	0	998	0	-260	400	0
2	Mosul 400	MSL4	11421	2	1	0	668	312	0	0	0	0	-50
3	Baiji 400	BAJP	12410	2	1	0	128	95	1458	0	-300	450	0
4	Baiji G.P.S	BAJG	12411	2	1	0	0	0	956	0	-320	440	0
5	Kirkuk 400	KRK4	15403	2	1	0	135	63	260	0	0	0	-100
6	Baghdad West 400	BGW4	16407	0	1	0	593	312	0	0	0	0	-200
7	Baghdad South 400	BGS4	16419	0	1	0	0	0	0	0	0	0	0
8	Baghdad East 400	BGE4	16428	0	1	0	874	304	0	0	0	0	-50
9	Baghdad North 400	BGN4	16436	0	1	0	425	144	0	0	0	0	0
10	Qudis G.P.s	QDSG	16442	2	1	0	0	0	664	0	-140	280	0
11	Alameen 400	AMN4	16443	0	1	0	130	58	0	0	0	0	0
12	Rasheed 400	BGC4	16470	0	1	0	52	187	0	0	0	0	0
13	Dyala	DAL4	17402	0	1	0	86	22	0	0	0	0	0
14	Kut 400 (Wasit)	KUT4	18405	0	1	0	268	112	0	0	0	0	-100
15	Hadiytha Dam	HDTH	19408	2	1	0	260	78	660	0	-120	140	0
16	Qaim 400	QIM4	19411	0	1	0	113	40	0	0	0	0	0
17	Musayab P.S	MUSP	20401	2	1	0	206	56	1200	0	-480	1080	0
18	Musayab G.P.S	MUSG	20402	2	1	0	0	0	500	0	0	0	0
19	Babil 400	BAB4	20412	0	1	0	317	82	0	0	0	0	0
20	Kadisiyah 400	KDS4	23402	0	1	0	220	156	0	0	0	0	-50
21	Nassiriya 400 P.S	NSRP	25403	2	1	0	435	204	840	0	0	0	0
22	Amara 400	AMR4	26417	0	1	0	343	204	0	0	0	0	-100
23	Hartha 400 P.S	HRTP	27421	2	1	0	160	74	400	0	-150	200	-50
24	Khor Al-Zuber P.S	KAZG	27426	2	1	0	583	303	498	0	-100	160	-50

Table (2): Line data of Iraqi Super Grid at October, 2010 (ISG400Kv, 24-bus).

From Bus Number	From Bus Name	To Bus Number	To Bus Name	Line R (pu)	Line X (pu)	Charg. (pu)	L
11420	MMDH	11421	MSL4	0.00144	0.01177	0.36439	63
11420	MMDH	11421	MSL4	0.00144	0.01177	0.36439	63
11421	MSL4	12410	BAJP	0.0042	0.03437	1.06426	184
11421	MSL4	12410	BAJP	0.0042	0.03437	1.06426	184
12410	BAJP	12411	BAJG	0.00002	0.0002	0.00584	1
12410	BAJP	16407	BGW4	0.00483	0.04393	1.30165	223
12410	BAJP	16407	BGW4	0.00496	0.04511	1.33667	229
12410	BAJP	19408	HDTH	0.00345	0.03132	0.92808	159
12411	BAJG	15403	KRK4	0.0018	0.01635	0.48447	83
15403	KRK4	16428	BGE4	0.005114	0.046492	1.377532	236
15403	KRK4	17402	DYL4	0.004247	0.038612	1.144052	196
16407	BGW4	16436	BGN4	0.00093	0.00847	0.25099	43
16407	BGW4	16470	BGC4	0.000616	0.005608	0.166179	28.5
16407	BGW4	19408	HDTH	0.00485	0.04405	1.30515	223.6
16419	BGS4	16443	AMN4	0.00082	0.00749	0.22181	38
16419	BGS4	16443	AMN4	0.00082	0.00749	0.22181	38
16419	BGS4	16470	BGC4	0.000964	0.008772	0.259921	44.5
16419	BGS4	20401	MUSP	0.00122	0.01015	0.31897	53.5
16419	BGS4	20402	MUSG	0.001094	0.009106	0.286176	48
16419	BGS4	23402	KDS4	0.00308	0.02795	0.82827	141.9
16428	BGE4	16436	BGN4	0.00029	0.00262	0.07763	13.3
16428	BGE4	16443	AMN4	0.00043	0.00394	0.11674	20
16428	BGE4	16443	AMN4	0.00043	0.00394	0.11674	20
16428	BGE4	17402	DYL4	0.00087	0.00788	0.23348	40
16436	BGN4	16442	QDSG	0.00015	0.00138	0.04086	7
16436	BGN4	16442	QDSG	0.00015	0.00138	0.04086	7
16443	AMN4	18405	KUT4	0.02744	0.22904	0.09156	140
18405	KUT4	25403	NSRP	0.00432	0.03928	1.1639	199.4
18405	KUT4	26417	AMR4	0.00479	0.04354	1.28998	221
19408	HDTH	19411	QIM4	0.00292	0.02391	0.74035	128
20401	MUSP	20402	MUSG	0.000125	0.001043	0.032791	5.5
20401	MUSP	20412	BAB4	0.00081	0.00673	0.21165	35.5
20401	MUSP	20412	BAB4	0.00081	0.00673	0.21165	35.5
20412	BAB4	23402	KDS4	0.00233	0.01935	0.60812	102
20412	BAB4	23402	KDS4	0.00233	0.01935	0.60812	102
23402	KDS4	25403	NSRP	0.00383	0.03485	1.03256	176.9
25403	NSRP	27426	KAZG	0.00439	0.03993	1.18316	202.7
26417	AMR4	27421	HRTP	0.0029	0.0264	0.78216	134
27421	HRTP	27426	KAZG	0.00118	0.01076	0.3187	54.6
27421	HRTP	27426	KAZG	0.00118	0.01076	0.3187	54.6

Table (3): Minimum Solution - (IEEE 26- bus).

Output power	OED [12]	PSO
P1 (Mw)	400.11	449.25
P2 (Mw)	156.901	173.3
P3 (Mw)	281.231	263.96
P4 (Mw)	141.562	130.73
P5 (Mw)	198.33	177.118
P6 (Mw)	96.589	86.291
TL (Mw)	11.7296	17.6605
F ($/h)	15460	15440

Table (4): Minimum Solution – (ISG400Kv, 24-bus).

Output power	PSO
P1 (Mw)	682.9772
P3 (Mw)	623.7636
P4 (Mw)	753.0688
P5 (Mw)	259.9290
P10 (Mw)	562.2853
P15 (Mw)	572.5695
P17 (Mw)	735.3131
P18 (Mw)	465.4850
P21 (Mw)	714.1571
P23 (Mw)	287.5753
P24 (Mw)	417.4463
F ($/h)	334021.5

Table (5): Power Flow Solution by Newton-Raphson Method before PSO Method (ISG400Kv, 24-bus).

Line		Before PSO Method		Line		Before PSO Method	
from	to	P(Mw)	Q(Mvar)	from	to	P(Mw)	Q(Mvar)
1	2	-1301.922	865.889	11	14	40.609	19.995
2	1	1319.140	-798.830	12	6	178.962	-17.367
2	3	-1987.140	436.830	12	7	-230.962	-169.633
3	2	2078.818	103.593	13	5	-110.409	-75.880
3	4	-873.902	87.877	13	8	24.409	53.880
3	6	227.155	-14.823	14	11	-39.971	-22.943
3	15	-102.072	-33.483	14	21	-283.337	-193.746
4	3	874.056	-86.918	14	22	55.308	4.689
4	5	81.944	-32.683	15	3	102.437	-56.010
5	4	-81.822	-14.654	15	6	184.186	-10.946
5	8	95.863	-36.554	15	16	113.377	-30.621
5	13	110.959	-31.984	16	15	-113.000	-40.000
6	3	-225.588	-223.640	17	7	438.100	63.449
6	9	-6.262	-192.473	17	18	-10.483	-0.383
6	12	-178.752	3.623	17	19	566.382	28.447
6	15	-182.398	-99.510	18	7	489.517	74.130
7	11	695.916	50.805	18	17	10.483	-2.895
7	12	231.761	151.979	19	17	-565.073	-59.740
7	17	-435.682	-74.831	19	20	248.073	-22.260
7	18	-486.810	-79.861	20	7	5.188	-32.854
7	20	-5.185	-48.092	20	19	-247.334	-91.541
8	5	-95.340	-93.850	20	21	22.146	-81.605
8	9	-231.656	-170.117	21	14	288.523	133.641
8	11	-522.639	-13.951	21	20	-22.089	-20.096
8	13	-24.365	-76.082	21	24	138.566	54.171
9	6	6.584	171.393	22	14	-54.936	-106.504
9	8	231.901	164.821	22	23	-288.064	-197.496
9	10	-663.486	-480.214	23	22	292.141	168.505
10	9	664.000	476.968	23	24	-52.141	-22.962
11	7	-693.858	-75.040	24	21	137.159	-153.924
11	8	523.249	-2.955	24	23	52.159	-34.400

Table (6): Power Flow Solution by Newton-Raphson Method after PSO Method(ISG400Kv, 24-bus).

Line		After PSO Method		Line		After PSO Method	
from	to	P(Mw)	Q(Mvar)	from	to	P(Mw)	Q(Mvar)
1	2	663.464	239.009	11	14	102.144	24.883
2	1	-659.920	-285.138	12	6	-163.162	39.404
2	3	-8.080	-76.862	12	7	111.162	-226.404
3	2	8.101	-136.901	13	5	-278.131	-48.257
3	4	-327.215	32.539	13	8	192.131	26.257
3	6	720.490	-3.636	14	11	-98.928	-6.285
3	15	94.624	-55.395	14	21	-288.362	-200.664
4	3	327.236	-32.906	14	22	119.290	-5.051
4	5	425.764	-56.014	15	3	-94.312	-34.583
5	4	-422.483	37.371	15	6	293.936	-4.607
5	8	265.962	-39.227	15	16	113.377	-30.621
5	13	281.520	-33.611	16	15	-113.000	-40.000
6	3	-707.567	-130.792	17	7	136.364	93.114
6	9	240.782	-245.914	17	18	-281.965	32.580
6	12	163.351	163.351	17	19	674.602	35.829
6	15	-289.567	-82.036	18	7	183.934	103.888
7	11	276.767	98.676	18	17	282.066	-35.017
7	12	-110.564	206.973	19	17	-672.745	-62.551
7	17	-135.992	-121.516	19	20	355.745	-19.449
7	18	-183.411	-127.793	20	7	-152.451	-17.659
7	20	153.200	-56.341	20	19	-354.238	-87.682
8	5	-262.300	-62.538	20	21	286.689	-100.659
8	9	-375.687	-168.148	21	14	293.854	143.770
8	11	-44.226	-77.631	21	20	-283.365	28.869
8	13	-191.787	-45.683	21	24	268.511	50.404
9	6	-239.661	232.187	22	14	-118.338	-90.874
9	8	376.195	165.232	22	23	-224.662	-213.126
9	10	-561.534	-541.419	23	22	227.753	175.246
10	9	562.000	537.733	23	24	-99.753	-17.519
11	7	-276.384	-138.177	24	21	-264.819	-129.370
11	8	44.240	55.294	24	23	99.819	-39.405

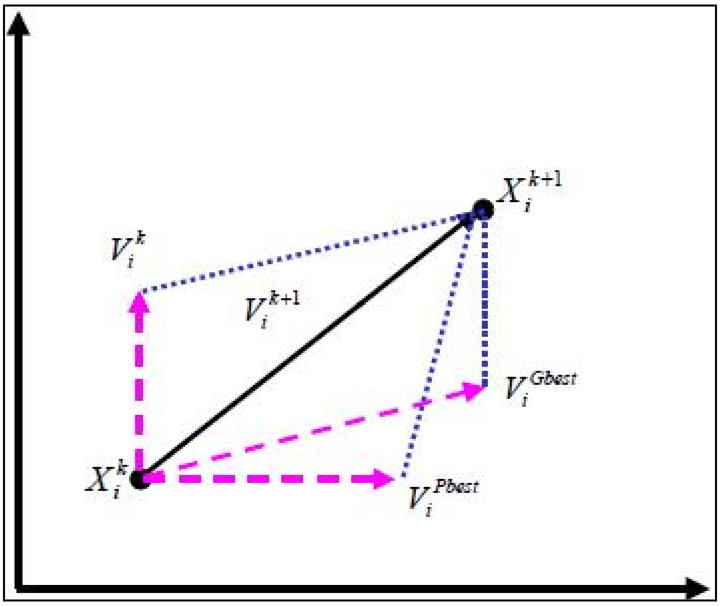

Fig.(1): The searching mechanism of the particle swarm optimization. (2)

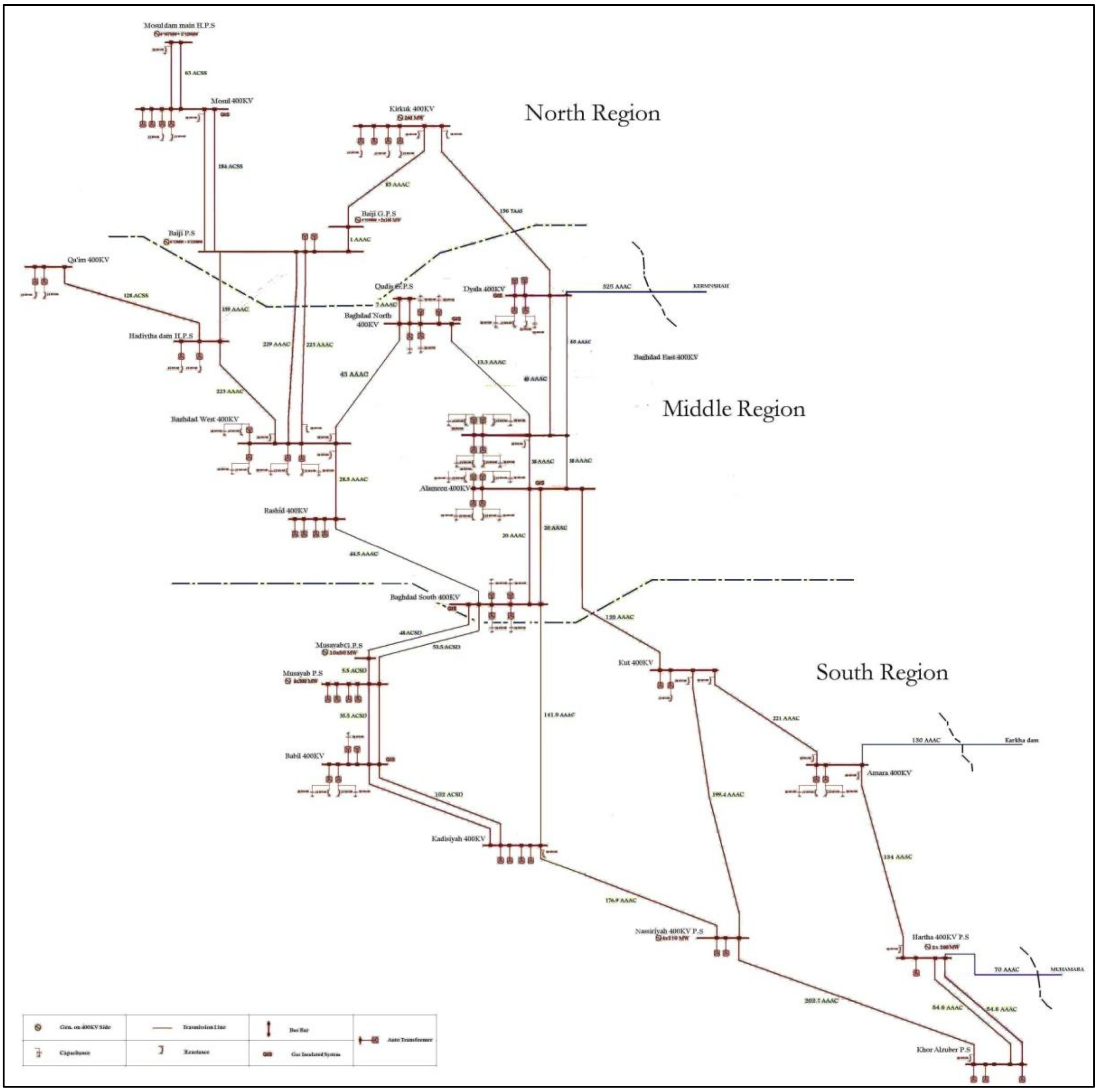

Fig.(2): Iraqi Super Grid at October, 2010 (ISG400Kv, 24-bus).

Appendix-One

Standard system data for **Test System 1 (IEEE 26-bus)**

```
gencost = [1   0.007   7    240  100 500
         2   0.0095  10   200  50  200
         3   0.009   8.5  220  80  300
         4   0.009   11   200  50  150
         5   0.0080  10.5 220  50  200
         26  0.0075  12   120  50  120];
```

Appendix-Two

Standard system data for **Test System 2 (ISG400Kv 24-bus)**

```
gencost = [1   0.045    33.6  1200  400  1000
         3   0.06562  49    1750  400  1460
         4   0.04312  32.2  1150  219  960
         5   0.01125  8.4   300   120  260
         10  0.03     22.4  800   160  665
         15  0.02962  22.1  790   270  660
         17  0.05437  40.6  1450  360  1200
         18  0.0225   16.8  600   150  500
         21  0.0375   28    1000  460  850
         23  0.01875  14    500   120  400
         24  0.0225   16.8  600   40   500];
```

التحميل الاقتصادي المثالي بالاعتماد على تحقيق أمثلية حشد الجزيئة: شبكة الضغط الفائق العراقية 400kv

م.م. محمد خضير عبد

قسم الهندسة الكهربائية، الجامعة التكنولوجية، بغداد، العراق

الخلاصة:

في هذا البحث تم دراسة تطبيق تحقيقِ أمثلية حشد الجزيئة (PSO) تعتمدخوارزميةً للتدفقِ الأمثل للطاقة الكهربائية (OPF) في التحميل الاقتصادي (ED). أولاً، هذه الطريقة ديناميكية في الطبيعة وهي تتغلب على عيوب تقنيات الحساب المطورة الأخرى مثل التقارب البطيء وأيضا تعطي حلول عالية النوعيةَ. ثانياً، الهدف الأساسي من البحث هو تقليل كلفة وقود التوليد لشبكة الضغط الفائق العراقية (ISG400Kv, 24-bus)باستخدام طريقة تحقيقِ أمثلية حشد الجزيئة (PSO).

ثالثاً، الخوارزمية المقترحة اختبرت على نظامين؛ الأول تم اختباره على نظام نظري (IEEE, 26-bus) والثاني تم اختباره عملياً على شبكة الضغط الفائق العراقية (ISG400Kv, 24-bus) باستخدام أخر تحديث للبيانات أكتوبر/تشرين الأولِ ، ٢٠١٠. أخيراً، توضح النتائج المحاكاة ثلاث فوائد رئيسية من خلال تطبيق الطريقة المقترحة على الأنظمة التي تم اختبارها وهي؛ كلفة اقل للتوليد؛ تقليل خسائر الطاقة وتحسين الفولتية.