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Genetic Algorithm Based ATC Enhancement Strategy

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ABSTRACT

In a modern electrical network, there is a focus to restructure the electric power industry in order to promote competitive bidding in power transactions. The market players are forced to operate their facilities at a higher efficiency. It demands dependable and accurate information about network capability for further safe commercial activity over and above the already committed uses. This is precisely defined as Available Transfer Capability (ATC) Therefore, transmission networks demand an adequate ATC to ensure all economic transactions while sufficient ATC is needed to support free market trading and maintain an economical and secure operation over an extensive range of system conditions and constraints. There are different methods proposed by researchers to enhance the ATC for the assumed transactions. However the role of intelligent strategies appears to be attractive and require investigations to credit its preference. In this article the Genetic Algorithm (GA) based ATC enhancement strategy is envisaged.

Keywords: available transfer capability, genetic algorithm, independent system operator, power market, power transactions.

1. Introduction

The deregulation of electric power systems all over the world presents an opportunity to create Competitive markets to trade electricity, which in turn presents new technical challenges to market participants and power system researchers. In this new environment, the security and economical issues of power Systems are coordinated tightly than before. Thus, evaluation of Available Transfer Capability (ATC) is one of the most important items that many researchers face.

In a deregulated system, the generation and distribution companies (i.e., market players) engage in transactions (i.e., selling or buying electricity) through a competitive bidding process administered by an agency known as power exchange apart from the transactions through bilateral negotiations. Every intended transaction is communicated to the transmission network operator termed independent system operator (ISO) [1]. The transactions are evaluated by ISO on the basis of an index termed ATC.

The bus at which a generation company sells (injects) power is termed source, and the one at which a distributor buys (extracts) power is called "sink." ATC between a given source-sink pair is the highest allowable size of a transaction over and above the already committed uses of the transmission system (i.e., existing base case) so that no line is overloaded in excess of its thermal loading limit megavolt-ampere (MVA) when the system is in steady-state condition. ATC is computed in real time at periodic intervals for each source-sink pair separately considering the base case that exists just before the current interval. Notably this base case is the outcome of the transactions that have already taken place between the current interval and the immediately preceding one. Thus, ATC computation for a large system with many pairs of source-sink buses is a dimensional process [2-4].

ATC calculations must: (1) Give a reasonable and dependable indication of transfer capabilities. (2) Recognize time-variant conditions, simultaneous transfers, and parallel flows. (3) Recognize the dependence on points of injection/extraction. (4) Reflect regional coordination to include the interconnected network. (5) Conform to organizational system reliability criteria and guides. (6) Accommodate reasonable uncertainties in system conditions and provide flexibility.

The linear ATC is based on using DC power transfer distribution factors (DCPTDF) [5] and used to allocate real power flows on the transmission lines. However this method assures a poor accuracy due to the assumption involved in the DC power flow model and hence few researchers computed ATC based on AC distribution factors [6-7]. So GA Based ATC Enhancement strategy is proposed in this article. Before computing the ATC, the basic optimal power flow solution is to be determined [8].

2. Problem formulation

ATC at base case, between bus m and bus n using line flow limit is mathematically formulated using PTDF as

$$ATC_{mn} = \min\left\{ \frac{(P_{ij}^{\max} - P_{ij}^{o})}{PTDF_{ij,mn}} ij \in N_L \right\}$$

Where, P_{ij}^{max} is the MW power limit of a line between bus i and j,

P_{ij}^{o} is the base case power flow in the line between bus i and j,

$PTDF_{ij,mn}$ is the power transfer distribution factor for the line between bus i and j when a transaction is taking place between bus m and n,

N_L – Total number of lines.

3. Genetic Algorithm

Several heuristic tools continue to evolve in the last decade that facilitates solving optimization problems that were previously difficult or impossible to solve. Recently, these new heuristic tools combine among themselves and with knowledge elements, as well as with more traditional approaches such as statistical analysis, to solve extremely challenging problems. The solutions with these tools offer two major advantages: Development time is much shorter than when using more traditional approaches and the systems are very robust, being relatively insensitive to noisy and/or missing data.

GA is a global search technique based on mechanics of natural selection and genetics. It is a general-purpose optimization algorithm that is distinguished from conventional optimization techniques by the use of concepts of population genetics to guide the optimization search. Instead of point-to-point search, GA searches from population to population. The features of genetic algorithm are different from other search techniques in several aspects. First, the algorithm is a multi-path that searches many peaks in parallel, and hence reducing the possibility of local minimum trapping. Secondly, GA works with a coding of parameters instead of the parameters themselves. The coding of parameter helps the genetic operator to evolve the current state into the next state with minimum computations. Thirdly, GA evaluates the fitness of each string to guide its search instead of the optimization function. The GA only needs to evaluate objective function (fitness) to guide its search. There is no requirement for derivatives or other auxiliary knowledge. Hence, there is no need for computation of derivatives or other auxiliary functions. Finally, GA explores the search space where the probability of finding improved performance is high.

The advantages of GA over traditional techniques are:

i) It needs only rough information of the objective function and places norestriction such as differentiability and convexity on the objective function.

ii) The method works with a set of solutions from one generation to the next, andnot a single solution, thus making it less likely to converge on local minima.

iii) The solutions developed are randomly based on the probability rate of thegenetic operators such as mutation and crossover; the initial solutions thus wouldnot dictate the search direction of GA.

4. Results and Discussion

The proposed method of enhancing the Available transfer capability (ATC) is done by using MATLAB 7.0 Software and executed on HP personal computer with Intel core i3 processor with 4GB RAM. The bus data, line data and generator data of IEEE 30 bus system is taken from [7] and are listed in Table 1, 2 and 3 respectively.

TABLE 1: BUS DATA FOR IEEE 30 BUS TEST SYSTEM

BUS	BUS	VOL	ANGLE	LOAD		GENERATION				INJECTED
NO	CODE	MAG	DEGREE	MW	Mvar	MW	Mvar	Q min	Q max	MVAR
1	1	1.06	0	0	0	0	0	0	0	0
2	2	1.043	0	21.7	12.7	0	0	-40	50	0
3	0	1	0	2.4	1.2	0	0	0	0	0
4	0	1.06	0	7.6	1.6	0	0	0	0	0
5	2	1.01	0	94.2	19	0	0	-40	40	0
6	0	1	0	0	0	0	0	0	0	0
7	0	1	0	22.8	10.9	0	0	0	0	0
8	2	1.01	0	30	30	0	0	-10	60	0

9	0	1	0	0	0	0	0	0	0	0
10	0	1	0	5.8	2	0	0	0	0	19
11	2	1.082	0	0	0	0	0	-6	24	0
12	0	1	0	11.2	7.5	0	0	0	0	0
13	2	1.071	0	0	0	0	0	-6	24	0
14	0	1	0	6.2	1.6	0	0	0	0	0
15	0	1	0	8.2	2.5	0	0	0	0	0
16	0	1	0	3.5	1.8	0	0	0	0	0
17	0	1	0	9	5.8	0	0	0	0	0
18	0	1	0	3.2	0.9	0	0	0	0	0
19	0	1	0	9.5	3.4	0	0	0	0	0
20	0	1	0	2.2	0.7	0	0	0	0	0
21	0	1	0	17.5	11.2	0	0	0	0	0
22	0	1	0	0	0	0	0	0	0	0
23	0	1	0	3.2	1.6	0	0	0	0	0
24	0	1	0	8.7	6.7	0	0	0	0	4.3
25	0	1	0	0	0	0	0	0	0	0
26	0	1	0	3.5	2.3	0	0	0	0	0
27	0	1	0	0	0	0	0	0	0	0
28	0	1	0	0	0	0	0	0	0	0
29	0	1	0	2.4	0.9	0	0	0	0	0
30	0	1	0	10.6	1.9	0	0	0	0	0

TABLE 2: LINE DATA FOR IEEE 30 BUS SYSTEM

LINE DATA FOR IEEE 30 BUS SYSTEM						
START BUS	END BUS	R P.U	X P.U	1/2 B P.U	LINE CODE	Flow limit
1	2	0.0192	0.0575	0.0264	1	130
1	3	0.0452	0.1852	0.0204	1	130
2	4	0.057	0.1737	0.0184	1	65
3	4	0.0132	0.0379	0.0042	1	130
2	5	0.0472	0.1983	0.0209	1	130
2	6	0.0581	0.1763	0.0187	1	65
4	6	0.0119	0.0414	0.0045	1	90
5	7	0.046	0.116	0.0102	1	70
6	7	0.0267	0.082	0.0085	1	130
6	8	0.012	0.042	0.0045	1	32
6	9	0	0.208	0	1.0155	65
6	10	0	0.556	0	0.9629	32
9	11	0	0.208	0	1	65
9	10	0	0.11	0	1	65
4	12	0	0.256	0	1.0129	65
12	13	0	0.14	0	1	65
12	14	0.1231	0.2559	0	1	32
12	15	0.0662	0.1304	0	1	32
12	16	0.0945	0.1987	0	1	32
14	15	0.221	0.1997	0	1	16
16	17	0.0824	0.1923	0	1	16
15	18	0.1073	0.2185	0	1	16
18	19	0.0639	0.1292	0	1	16
19	20	0.034	0.068	0	1	32
10	20	0.0936	0.209	0	1	32
10	17	0.0324	0.0845	0	1	32

10	21	0.0348	0.0749	0	1	32
10	22	0.0727	0.1499	0	1	32
21	22	0.0116	0.0236	0	1	32
15	23	0.1	0.202	0	1	16
22	24	0.115	0.179	0	1	16
23	24	0.132	0.27	0	1	16
24	25	0.1885	0.3292	0	1	16
25	26	0.2544	0.38	0	1	16
25	27	0.1093	0.2087	0	1	16
28	27	0	0.396	0	0.9581	65
27	29	0.2198	0.4153	0	1	16
27	30	0.3202	0.6027	0	1	16
29	30	0.2399	0.4533	0	1	16
8	28	0.0636	0.2	0.0214	1	32
6	28	0.0169	0.0599	0.065	1	32
LINE CODE==1 FOR LINES WITHOUT TRANSFORMER TAPPING						
LINE CODE= > OR < 1 FOR LINES WITH TRANSFORMER TAPPING						

TABLE 3: GENERATOR MIN-MAX VALUES

GEN NO	1	2	5	8	11	13
MIN VALUE	50	20	15	10	10	12
MAX VALUE	2000	80	50	35	30	40

Four simultaneous bilateral transactions have been carried out to determine the ATC by applying GA. The obtained ATC results are listed in Table 4 and compared with ACPTDF method. The obtained ATC by GA is 201.72 MW which is much higher than the ATC obtained by ACPTDF method, which shows the superiority of GA over other algorithms in ATC computations.

TABLE 4: ATC (MW) – IEEE 30 BUS SYSTEM

TRANSACTIONS	ATC by ACPTDF method	ATC BY GA
T1 (8-25)	32.80	25.50
T2 (5-30)	87.07	51.90
T3 (11-26)	25.60	74.53
T4 (2-28)	27.16	49.79
TOTAL (MW)	172.63	201.72

5. Conclusion

In this paper, Genetic algorithm has been successfully implemented to solve the available transfer capability problem with the generator constraints. The ATC has been computed for four different transactions in the IEEE 30 bus test system and the performance is found to excel the existing conventional methodologies. It has been observed that GA has the ability to converge to a better quality solution and exhibit robustness. It is clear from the results obtained by different trials that the proposed GA can avoid the shortcoming of premature convergence. Due to these properties, the GA in future can be tried for solution of complex power system optimization problems.

References

1. C.Ejebe Gabriel, G.Waight James, Santos-Nieto and F.Tinney William, "Fast calculation of linear available capability", IEEE Transactions on Power systems 15 (3) (2000) 955-960.
2. W.F.Tinney, X.Wang, J.G Frame, J.G.Waight, J.Tong and G.C.Ejebe, "Available transfer capability calculations", IEEE Transactions on Power systems 13 (4) (1998) 1521-1527.
3. Yan-Ou and Chanan singh, "Assessment of available transfer capability and margins",IEEE Transactions on Power systems 17 (2) (2002) 463-468.
4. R.Christie, B.F.Woolenberg and I.Wangestin, "Transmission Management in deregulated environment", IEEE Proceedings 88 (2000) 170-195.
5. Durgesh P.Manjure and Elham B.Makram, "Investigation of distribution factors for bilateral contract assessment", Electric Power Systems Research 66 (2003) 205-214.
6. Ashwani kumar and S.C.Srivastava, "AC Power Distribution Factors for allocating power transactions in a deregulated market," IEEE Power Engineering Review (2002) 42-43.
7. Ashwani kumar, S.C.Srivastava and S.N.Singh, "ATC determination in a competitive electricity market using AC distribution factors", Electric Power Components and Systems 32 (2004) 927-939.
8. M.A.Avido, "Optimal power flow using particle swarm optimization", *Electric Power and Energy System*,.vol.24. pp: 563-571, Jul.2004.