IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

GENETIC ALGORITHM BASED AVAILABLE TRANSFER CAPABILITY CALCULATIONS

Thota Swathi*, K.Vimala Kumar

M.Tech student, Department of Electrical and Electronics, JNTUACEP, Pulivendula, AP-516390, India
Assitant Professor, Department of Electrical and Electronics, JNTUACEP, Pulivendula, AP-516390, India

ABSTRACT

In the present power market a large number of transmission transactions are required to meet the heavy competition in the electrical industry. These transactions are limited by the system design and operating conditions. The determination of Available Transfer Capability plays an important role in the electrical power market for reserving transmission services, emergency transfers and scheduling energy transactions. This paper reports the application of Genetic Algorithm on a standard IEEE-14 bus system to solve the Available Transfer Capability (ATC) problem. The results are compared with those obtained using the Newton-Raphson method.

KEYWORDS: Total transfer capability, Available transfer capability, Newton-Raphson method, Genetic Algorithm.

INTRODUCTION

The highly regulated power utilities have been significantly transformed into deregulated or restructured utilities in the past few years. The Federal Energy Regulatory Commission (FERC) accepted the open access of the transmission facilities to every participant in the power market in order to promote the choice of customer and generation competition. The transmission information was made publicly available to all the competitors through the Open Access Same Time Information System (OASIS) which mainly consists all the data about the Available Transfer Capability of the system.

The ATC of the considered transmission network is the amount of power transfer capability available above the committed uses for further commercial activities. These ATC values are made available in the OASIS from which all the customers can access to the information and use it for reserving power transmission services and selling power in the competitive power market.

The ATC of the network is fixed by an equation of increasing transfers in electrical power among distinctive frameworks through self-assertive interfaces. The transmission line flows increases with an increase in power transfers. The Total Transfer Capability (TTC) is the maximum of the possible flow in a particular interface with zero thermal overloads, voltage collapse, voltage limit infringement and other security constraints like transient stability. ATC for the particular selected interface can be described by the difference between the total transfer capability, base case flow and convenient transmission margin. The ATC formulated as:

$$ATC = TTC - TRM - CBM$$

The Transmission Reliability Margin (TRM) provides bias for ensuring the secured operation of interconnected transmission network accommodates uncertainties in system conditions. The reliability of the network depends on the reserved transfer capability that is provided by the TRM component. The generation reliability requirements are met by the generation accessed in an interconnected system is ensured by a certain amount of transmission transfer capability known as the Capability Benefit Margin (CBM). The calculation of the ATC values for a transmission network is done by certain methods and procedures which follow certain principles:

- The ATC calculation must identify time-variant power stream conditions furthermore exchanges and parallel way streams in the whole transmission system.
- The computation of the ATC should recognize the dependent factor of ATC on the positions of power injections, direction of powers exchanged and points of power abstraction.
- The ATC calculations should generate financially applicable outputs resulting in fairly appropriate implication of available transfer capabilities on the electrical power market.

STRUCTURE OF ATC

The calculation of ATC can be practically done online using the framework shown in Figure 1. The ATC program in an Energy Management System (EMS) is interfaced by the modules like State Estimator (SE), Security Analysis (SA), Current Operating Plan (COP) and OASIS.

SE provides the present condition of the system; the SA constitutes the list of contingency while the COP system provides information of forecasting of the loads, scheduled generation and outage machinery. The ATC that is calculated is exchanged with the FERC which are posted on the OASIS so that the customer can get a clear idea of the competition in the power market and bid accordingly. The data posted on the OASIS includes the hourly values of ATC and TTC and the run time, the constricted utilities list.

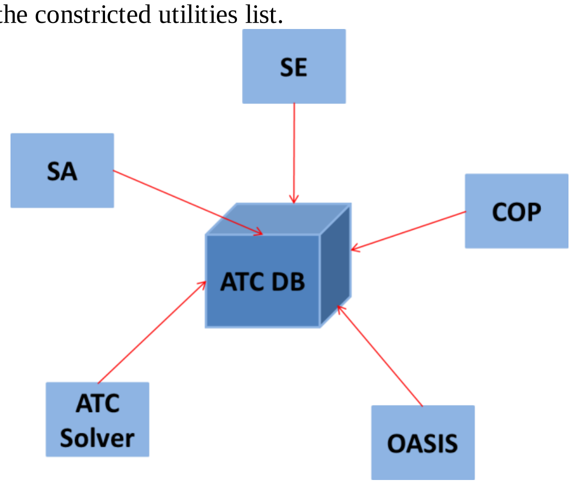

Figure 1: Structure of Online ATC calculations

CALCULATION OF ATC

The calculation of ATC is in other words includes the determination of the highest possible power above the base case value that is available for transfer between the two sets of buses where injections of power are increased in the source side while the power injections on the sink side are decreased. The increase in power transfer results in the increase in the increase in loading in the network to a certain limit imposed by the physical or operational limits. The maximum of the power transfer which does not cause any limit violations is used for the computation of ATC and TTC values. The limitations that are considered are:

- Limited flow in branches
- Limited transfer in the corridors
- Limits on the bus terminal voltages
- Collapse in the voltages

The steps followed for the determination of the ATC for a set of transfers:

- The base case of the power flow is formed and solved for a given time.
- Select any random instant of exchange.
- Transfer power is incremented using the CPF method.
- Form the new problem including the modified transfer powers.
- Determine the new power flow problem obtained in the before step.
- Audit for violations in operational and physical limits. Decrease the power transfer by necessary amount to minimize the violations.

- Repeat the process for a certain number of iterations and obtain the maximum power transfer.
- Calculate ATC from the interface flows from step 7.
- Go back to step 2 for next transfer.

The ATC problem is formed by the terms of an unknown parameter λ which is a scalar quantity that is incremented in each and every ATC instance. The injections of power in the sending end and receiving end buses are given as the continuous function in terms of λ. All the ATC instances are given through the sending end and receiving end buses of its system, aspects of participation, interface and base flow. The symbolic ATC determination is kept running for a week and for each hour of week results another power flow in a base case.

NEWTON RAPHSON METHOD

Maximum value of the scalar parameter can be found using a general method known as the Continuation Power Flow which is a continuous function of variations of injections in different combination of buses in the problem. The CPF method is a versatile method in origin was popularized for the calculation of the highest possible loads that can be applied on the system along with ATC. The algorithm increments efficiently the variable that controls the distinct instants also resolves the obtained final problem at every instant. This proceeding is applied till a predefined situation or limit that prevents any increment in the future is attained. Due to the difficulty in the results and the requirement of Jacobian matrix at every instant, we use the Newton Raphson algorithm. CPF results in solutions at the points of collapse of the voltages also.

During the resulting "continuation power flow", the reevaluated arrangement of mathematical statements stays all around molded so that disparity and lapse because of a particular Jacobian are not experienced. Therefore, single exactness reckonings can be utilized to acquire power flow arrangements at and close to the discriminating point. The basic objective power flow equations are:

$$Pa = \sum_{b \in a} Va\, Vb\, (\, Gab \cos \theta ab + Bab \sin \theta ab\,)$$

$$Qa = \sum_{b \in a} Va\, Vb\, (\, Gab \sin \theta ab - Bab \cos \theta ab\,)$$

GENETIC ALGORITHM

Genetic algorithm is nothing but the process of natural evolution obtained from a population of a single model in the genetics. The figure 2 represents the standard procedure of genetic algorithm. They constitute the following five components:

1. The variables characterizing an individual are represented by chromosomes.
2. Initial individual population.
3. An interpreted equation which takes up the operation of the environment is played by a particular evaluation function which rates the individuals with their values of fitness in the environment, i.e., its strength to sustain.
4. The formation of new population produced is determined by the genetic operators from the before one through a process same as the reproduction.
5. Values of different variables like size of population, the probability function of using the operators consisted in genetics, etc. that are used by GA's.

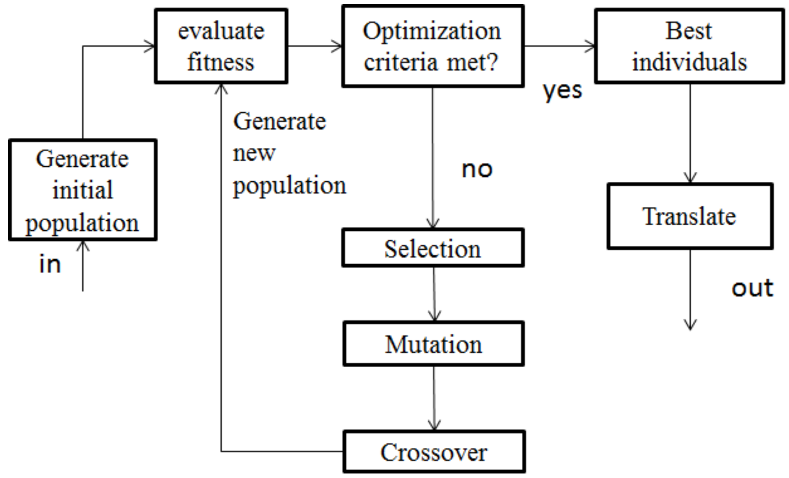

Figure 2: Standard procedure of Genetic Algorithm

A.Representation

The up surged problem that is taken into consideration is used to get the TTC amid two junctions thus increasing the generation at one end while the load at the other one. TTC is the total power boost given to the receiving end. As the accuracy of the solution relies on upon the quantity of bits utilized for speaking to what might as well be called the control parameters in the twofold encoding procedure, the control variables are represented using the floating point numbers. This is a fast and convenient scheme for coding which ensures the reduction of possibilities of error. Every candidate chromosome comprises of an array of power generated on the sending end and a set of loads on the receiving end.

B. Initialization

The strings consisting of initial population are selected randomly in the set of the variables that controls the operation. These control variables become self-restricted because of the constraints imposed on them which are used as the intervals.

C. Fitness Evaluation

The optimal solution is searched by the genetic algorithm by incrementing the predefined equation defining the fitness values, and thus an assessment equation has to be provided with a solution which gives a quality measure of the problem. The evaluation function differentiates among the good and the weak results, in the possible and impossible search sets. The value of fitness is very crucial for the operation of the GA, as an individual's chance to get selected is determined by this function which reproduces the lineaments to the next generations. The fitness equation is written in the generic form:

$$F = J(k) - \sum_{i=1}^{n} \lambda i \, \varphi i \, (k)$$

k represents the state variables of the system, λi and φi the coefficient of penalty and the function of penalty is given by the terms λi and φi respectively. The load flow functions based on equality constraints are settled using fast decoupled algorithm. A penalty is assigned to the fitness of each chromosome that violates the power flow. The infringements in the constraints are classified in three types: quadratic penalty terms are assigned for voltage violations, square roots of infringements in reactive power, and infringements in the line flows are considered directly. Thus the possibility of selection of the chromosomes which is violated as a parent for later reproduction procedure is less.

D. Reproduction

Individuals participating in consecutive generations are produced over an evolution operation or a reproduction process. Depending upon the fitness values of the individual strings, they are duplicated into a mating pool. The probability of providing one / more than one offspring in the next generation is based completely on the value of the fitness of the strings. The mates are selected by the normal geometrical selection.

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785

E.Mutation

The instantaneous changes in different chromosomes are produced by the genetic operator known as the Mutation. Mutation is essential to introduce a type of unreal diversity in the individual's population for avoiding immature meeting to nearby optima. Non-uniform transformation is done in this paper.

F. Crossover

The principle genetic operator that is in charge of worldwide hunt property of GA is the Crossover operator. It focuses on the consolidating of hereditary data acquired from any two unique individuals and shaping another individual. Arithmetic crossover is connected in this paper, characterized by any two corresponding straight blends of the folks.

TEST RESULTS

The ATC and TTC are calculated following the procedure mentioned earlier by finding the fittest of the individuals from the population of strings through the Genetic Algorithm in the MATLAB programming. The program is designed in such a way that the fitness values of each individual are checked iteratively and an appropriate new generation is developed by mutation and crossover using the MATLAB coding to get an optimal case. Thus the best case is found which results in the highest ATC and TTC values without crossing the operational and physical limits.

This section provides the results for a standard IEEE 14 Bus System after applying both the Newton Raphson Method and Genetic Algorithm using the MATLAB code. The values of ATC and TTC in terms of MW are mentioned along with the computational time taken by each method in the Table.1.

Method	ATC(MW)	TTC(MW)	CPU(SEC)
NEWTON-RAPHSON	1027.120	4115.780	4.705
GENETIC ALGORITHM	1043.260	4139.820	6.908

Table.1: Comparison between the two methods

CONCLUSIONS

The ATC is determined using a framework of calculation which is implemented in an EMS. The program calculates the power transfer capabilities within the transmission voltage, reactive power and thermal limits, voltage collapse, and the effect on the system due to the transfer through the suggested interfaces. The ATC calculation engine is a CPF routine based on algorithm of the Newton Raphson power flow method using the MATLAB programming. The Genetic Algorithm is applied to the system for calculating ATC. The genetic algorithm results in better ATC and TTC values as the probability of the best solution is increased during this process.

ACKNOWLEDGEMENT

I wish to express my sincere thanks to my guide **Sri. K. VIMALA KUMAR,** Assistant Professor in the Department of Electrical and Electronics Engineering, JNTUA College of Engineering, Pulivendula for his valuable guidance and erudite analytical suggestions throughout this project.

REFERENCES

1. Available Transfer Capability Calculations by G C Ejebe, J Tong, J G Waight & Frame X Wang Siemens Power Systems Control, Brooklyn Park, MN W F Tinney Consultant Portland, OR.
2. Total transfer capability calculations for competitive power networks using genetic algorithms by Mohamed Shaaban, Malaysia.
3. The Continuation Power Flow: A tool for steady state voltage stability analysis by Venkataramana Ajjarapu, IEEE Member, transactions on power systems
4. Assessment of Available Transfer Capability of Transmission Systems by G.Hamoud

5. Reduction of Transmission Losses based on Optimal Power Flow using Genetic Algorithm" Shahrouz Oghaziyan, Masoud Rashidi Nejad and Amir Abdollah, Science and Research Branch Srijan, Islamic Azad University

AUTHOR BIBLIOGRAPHY

	**K.Vimala Kumar** received the Master of Technology degree in Electrical & Electronics Engineering from Jawaharlal Nehru Technological University Hyderabad, India 2008. He is a research student of Jawaharlal Nehru Technological University, Ananthapur, India. Currently .He is working as Assistant Professor in the department of Electrical and Electronics Engineering, J.N.T.U.A College of Engineering, Pulivendula-516390, Andhra Pradesh, India. His interested areas are power system deregulation, power system operation and control, power system design and dynamic load modeling.
	**Thota Swathi** is pursuing M.Tech in Electrical Power Engineering from JNTUA College of Engineering Pulivendula-516390, Andhra Pradesh, India. She is presently working on her project under the guidance of Asst.Professor K.Vimala Kumar.