Synopsis

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With growing interconnections and loadings in the modern power system networks all over the world, power utilities are observing a major challenge in maintaining desired superiority and security of power supply. Power system security and analysis forms an essential part of modern energy management system. The economic downturn coupled with environmental and ecological pressures have obliged the electric utilities, all over the world, to serve the augment in load demand without corresponding increase in generation and transmission facilities. This has forced the utilities to operate their generators and transmission systems to their maximum capabilities. Hence, the re-regulation of the power system has been derived for getting maximum economical benefits to the society.

The Available Transfer Capability (ATC) has been defined as the additional capability of transmission line including Capacity Benefit Margin (CBM) and Transmission consistency Margin (TRM). The Available Transfer Capability calculation is a prime important issue for the smooth running of the Restructured power market [22]. As because of industrial revolutions, the power demand has been increased in the last few years. In the open access market power players are stack holders. The congestion occurs when a transmission line loaded with simultaneous transactions beyond its capability. To reduce congestion, the optimal real and reactive power management can be done with the help of Particle Swarm Optimization (PSO) [1] using real coded Genetic algorithm. In

this method, one can find a more sensitive generator for rescheduling using Transmission Congestion Distribution Factor (TCDF).

The Most important tasks of the Independent System Operator (ISO) is to manage congestion [2] of electrical power flow in a deregulated electricity market. Because of multiple transactions, system security gets down and may cause inefficiency of the power system. Hence, to manage the system, it's important to reschedule their real and reactive power optimally. The Adaptive Fuzzy Particle Swarm Optimization based Optimal Power Flow (AFPSO-OPF) has been introduced to solve the Congestion Management problem or multi-congestion case using the Non Linear Programming techniques.

To manage congestion, Particle Swarm Optimization with Time-Varying Acceleration Coefficients[3] algorithm has been used for optimal re-scheduling of real power generation. The congestion of a transmission line can manage with the help of three different contributions factors [4], namely; Network contribution factor, Generator contribution factor and load contribution factor. The first priority is given to Network, second to Transmission line and lastly to load.

Available Transfer Capability can be calculated through optimal power flow [5] approach. The voltage stability criteria has been utilized for congestion management with the help of economical cost of generation [6]. The Voltage stability has been calculated by an interior point method. Generator economic margin based on load margin and ranking, the lowest margin value will be adjusted to increase load margin to manage congestion.

The different congestion rates has been used to reduce congestion by deciding its rates for normal operation and abnormal operation of power system with the help of nonlinear programing [7]. Normally, the congestion has been alleviated with the help of generator rescheduling. The congestion relief management (CRM) is used as ancillary services [8] in the restructured electrical power network to improve system security and stability. The CRM maintains system security and define charges as per congestion relieved. A Growing Radial Basis Function (GRBF) [10] Neural Network based methodology for congestion management has been used for prediction of Nodal Congestion Price (NCP) in deregulated power environment.

The selection of generators to reschedule their output for the effective management of congestion has been carried out by an active and reactive power flow tracing-based approach [11]. The reactive power rescheduling cost has been calculated with the consideration of generator reactive power capability curve and reactive power bidding. The

effect of congestion cost in a pool and mix of the pool with bilateral and multilateral transactions has been carried out in this study. For such secure operation, the transaction schedule and re-dispatch cost should be kept as minimum as possible. The value of Transmission Distribution Factors has been used to select re-dispatch of generator schedule and the re-dispatch cost can be optimized with the help of PSO with Time-varying Accelerating Coefficients (PSOTV)

The congestion has been relieved with the help of rescheduling of the generator using Particle Swarm Optimization (PSO) [12]. In this method, two different parameters to be determined namely; the location of the generator which is to be rescheduled and power to be rescheduled.

In a restructured electrical network, the congestion has been managed by rescheduling cost and real power loss minimization. These two parameters are taken as combined as single objective function by the weighted sum method. The Cluster/Zone based method has been used to find a number of generators participating in congestion management with the utilizing Transmission Congestion Distribution Factors (TCDFs). An optimization problem and Generalized Algebraic Modeling System (GAMS) tool [13] is used for solving the above problems.

The congestion has been managed by locating Flexible AC Transmission system (FACTS) devices optimally by Multi-objective PSO. In this method [14] ranking the optimal location of FACTS devices for relieving the congestion in the transmission line.To cope-up with congestion, optimal location and size of Distributed Generation can be found for reliable system operation [15].

The new concept of Relative Electrical Distance (RED) [16] has been introduced between the load and the generator. With this concept System operator have to manage those generator rescheduling having less RED. The generator sensitivity has been used for optimizing the participation of generators.

Due to congestion management, the traders gets benefit during no congestion or less congestion. They can manage their demand during less congestion period. With the help of congestion management risk associated with the transaction will be reduced. There have been certain methods [17] to manage congestion like implicit and explicit auction or counter trade, re-dispatch etc.

A new congestion management system has been proposed in [18], applied under nodal and zonal dispatches with the implementation of fixed Transmission Rights (FTR) and

Flow Gate Rights (FGR), respectively. The FTR model has been proved especially suitable for congestion management in deregulated centralized market structures with nodal dispatch, while the FGR has been used for decentralized markets.

The FACTS devices has been used for Effective Management [19] of electrical power with existing transmission line. The FACTS devices penetrate reactive power to improve the capability of the transmission line. The operation of Power system become worse due to price unpredictability and system stability in a congestion state. The congestion of transmission line depends upon the load demand. Hence, load elasticity plays an important role to manage congestion. Hence, a new concept of demand elasticity has been discussed in [20]. Higher the demand elasticity index lower the charge to electricity.

Due to multiple transactions and penetration of wind power, the reactive power management has been essential for Congestion management. Hence, the rating and location of FACT devices has been decided by the two step and three step optimization techniques [21]. The Federal Electrical Regulatory Commission (FERC) has mandated that the transmission line must be open for all the customers. As per the guideline of North American Reliability Council (NERC) and FERC, the posting of ATC on Open Access Same Time Information System (OASIS) in advance has become mandatory. The validity of the transaction has been decided by ATC data posted on OASIS.

Congestion Management [23] has been identify as a critical problem in deregulated Electrical Power network. The computation of optimized ATC value plays an important role in relieving of congestion in the network. The ATC has been calculated from the Real Transmission Congestion Distribution Factor (RTCDF) [24]. The RTCDF has been defined as the change in the distribution of power flow in the transmission line with simultaneous traded transactions in the electrical market.

For secure and reliable system operation, different Congestion management methods[26] has been used to relieve congestion. The traders are ready to sell their power to the consumer at a competitive rate. The Independent system operator plays an important role to manage extra power with the existing transmission line.

According to the No-Free Lunch Theorem [27], there is no single meta-heuristic which is top most for resolving all optimization problems. It means that, if one particular meta-heuristic may present very accurate results on a specific set of problems, but the same algorithm may represent poor results on a diverse set of problems. Hence, in this work, the performance of different artificial intelligence techniques like Roulette wheel Selection

Genetic algorithm (RWSGA), Tournament Selection Based Genetic algorithm (TSBGA) Particle Swarm Optimization(PSO), and Teaching Learning Based Optimization (TLBO) has been analyzed for solving optimization of ATC with manifold transactions.

The optimized value of Available Transmission Capability (ATC) calculation has been found noisy (Imperfect) output with the help of Roulette Wheel Selection Based Genetic algorithm. To overcome this noisy fitness problem, Tournament Selection Based Genetic algorithm has been proposed in this work. In this proposed work, the different algorithm has been used to compute optimized ATC for a specific loading condition at three different load bus. The load has been served by varying generation at generating bus to get optimized ATC. The objective function taken here is to maximize the value of Available Transmission Capability of the power line with the secured transactions. The different optimization algorithm like RWSGA,TSBGA,PSO and TLBO has been used to identify the best optimization ATC. The projected method has been applied to an IEEE 30 bus test system and 75 bus UPSEB system.

A data set of the generations at generator bus and corresponding value of ATC for a specific loading condition has been used to frame statistical model with regression analysis in this work. The most sensitive generation for a specific load has been identified with this statistical model analysis. Hence, a more reliable transmission system with utmost safety can be obtained.

The following optimization techniques has been used for the calculation of ATC and comparison had been made between these methods to find the best suited method.

1. Genetic Algorithm with Roulette wheel selection (RWSGA)
2. Genetic Algorithm with Tournament Selection (TSBGA)
3. Particle Swarm optimization (PSO)
4. Teaching Learning based Optimization (TLBO)

In this work, the average deviation from the best ATC value has been calculated with the help of a statistical analysis. It has been observed from the analysis that the Teaching Learning based optimization has been found more effective as compare to other methods.

The thesis is organized as follows:

Chapter-1 provides an introduction and article survey on Congestion Management and present scenario in restructured electrical power network. This chapter presents the significance and scope of work to be carried out in the thesis.

In Chapter-2, Basics of Restructuring of the electrical power network and the importance of Available Transfer Capability (ATC) in congestion management has been discussed. The Mathematical modeling of ATC using Power Transmission Distribution factor (PTCDF) has been carried out for congestion management.

Chapter-3 presents Evaluation of ATC value using Artificial Neural Network.

Chapter-4 reports an evaluation of optimized ATC value using Genetic Algorithm (GA) incorporating Roulette Wheel Selection Based GA (RWSGA) and Tournament selection based GA (TSBGA) methods. It also includes simple approach to develop statistical Model and analysis using the statistical tool. With the help of this statistical model, the most sensitive generation for a specific loading condition among all the transactions has been identified.

Chapter-5 describes a new method for computation of optimized ATC value using Particle Swarm Optimization Technique (PSO) for the betterment of results.

In Chapter-6, a novel approach for assessment of optimized ATC value using Teaching Learning based optimization Technique (TLBO) has been presented.

Chapter-7 recapitulate the result comparison between different algorithms.

Chapter-8 summarizes the main findings and its importance as well as contribution of the thesis. Lastly, this chapter also provides few suggestions for future expansion of the work.

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