Transmission Line Overload Control by Using Hybrid Fish Bee Optimization

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Abstract- *Optimal location of FACTS (Flexible AC Transmission System) is very important for static voltage stability. Voltage collapse indicators indices give exact information about the stability condition of a system. This study reviews the current status on the optimal placement of flexible AC transmission systems (FACTs) devices based on intelligent algorithms. The paper proposes an alternative model that can optimize the placement of FACTs devices based on parallel running algorithms. Artificial Bee Colony and Fish School Search methods are mixed together into hybrid system and implemented through MATLAB on a IEEE 30 bus system. The system solves the load management problem statement bounded by constraints.*

Keywords- *Optimal Placement of FACTS devices, Artificial Bee Colony (ABC) Algorithm, Fish School Search (FSS) Algorithm.*

I. INTRODUCTION

Congestion management includes transmission system activities which relieve transmission constraints in competitive electricity markets. Presently, competitive power markets have various utilities to manage congestion using specific physical/financial mechanisms with a set of rules/guidelines. There are many congestion management schemes reported in the literature based on different electricity market structure. There are two paradigms that are economically employable for congestion management viz. cost-free means and not-cost-free means. The former includes congested lines out aging, transformer taps operation, phase shifters/ FACTS devices. These are called cost-free as only marginal costs (not capital costs) are involved in usage and they are nominal. The later includes generation rescheduling and prioritization/curtailment of loads/ transactions.

Congestion management includes the determination of proper generation pattern without breaking the line flow restrictions. In such an environment an optimal power flow can perform the function of avoiding congestion and minimizing the cost. Transmission pricing and congestion management are the key elements in a competitive, direct access based electricity market. Most debate is focused on them concerning alternative approaches to market design and implementation of a common carrier electricity system. Its highlighted trade-offs between simplicity and economic efficiency in meeting transmission pricing and congestion management scheme objectives. The author contrasts two extreme approaches: postage stamp approach vs. nodal pricing. The proposed method questions nodal pricing paradigm due to its rigidity/complexity. The author argues that the theoretical efficiency in nodal pricing is unrealistic and there are drawbacks in implementing the suggested approach. Least cost congestion relief's underlying principles are explained and adopted in California to treat congestion relief as an ancillary service. This enables ISO to ensure efficient congestion relief with minimal energy market intervention. It also discusses zonal aggregation, describing a new zonal priority network access pricing. An inter-zonal congestion pricing mechanism is dealt to locate generation resources economically.

Congestion management is described using technical methods and non-technical methods. Technical methods are cost-free methods which take into consideration outages in congested lines and do not cause economic effect. Some methods are the use of FACTS and the operation of transformer taps or phase shifters. Non- technical methods or non-cost free methods take into consideration security-constrained generation dispatches, network security factors methods, congestion pricing, and market-based methods. A few common methods that are used are Generators Rescheduling (GR), load shedding, Distributed Generations (DG), Demand Response (DR), and nodal pricing schemes.

II. FACTS - SOLUTION FOR CONGESTION MANAGEMENT

The objective of present study is to manage congestion in deregulated power systems using an active power rescheduling and FACTS devices. Existing algorithms including Linear Programming based Optimal Power Flow, PSO, ABC and FSO are simulated. A novel algorithm is proposed namely, hybrid Fish – Bee algorithm using ABC and FSO for generator rescheduling based on economic and technical considerations. Another way of relieving congestion is achieved by improving line transfer capability using FACTS devices. The proper location of FACTS devices has been identified using a proposed objective function with proposed hybrid Fish – Bee algorithm. The installation cost and line losses are reduced for identified location of FACTS devices. The results are validated using different test systems.

III. ARTIFICIAL BEE COLONY ALGORITHM

Karaboga proposed ABC algorithm and its performance was analysed in 2007. The algorithm was developed through inspection of behaviour of real bees to locate food sources called nectar, and sharing food sources information to bees in the hive. In ABC, artificial agents are classified into 3 classes, namely, employed bee, onlooker bee, and scout. Each plays a different role in this process: the employed bee remains on a food source keeping source neighbourhood in memory; the onlooker gets food source information from employed hive bees and selects one food source from which to gather nectar; the scout has to find new food and new nectar sources. The ABC algorithm process is presented as follows:

Step 1: Initiali1zation: Spray 'n_e' percentage of populations into solution space randomly, and calculate fitness values called nectar amounts, where ne represents ratio of employed bees to total population. Once populations are positioned in solution space, they are called employed bees.

Step 2: Move onlookers: Calculate probability of selecting food source by equation (1), select food source to move to through roulette wheel selection for all onlooker bees and determine their nectar amounts. The movement of onlookers follows equation (2).

$$P_i = \frac{F(\theta_i)}{\sum_{k=1}^{s} F(\theta_k)} \qquad (1)$$

$$x_{ij}(t+1) = \theta_{ij}(t) \sum_{k+1}^{n} F_{ik_j}\left(\theta_{ij}(t) - \theta_{kj}(t)\right) \qquad (2)$$

x_i represents position of i_{th} onlooker and t denotes iteration number, θ_k represents randomly chosen employed bee, j is the dimension of solution.

Step 3: Move scouts: If fitness values of employed bees are not improved by continuous predetermined iterations, called "limit", such food sources are abandoned, and employed bees become scouts. The scouts are moved by equation (3).

$$\theta_{ij} = \theta_{jmin} + r(\theta_{jmax} - \theta_{jmin}) \qquad (3)$$

where, r is random number belongs to [0,1]

Step 4: Update best food source found till now: Memorize best fitness value and position, found by bees.

Step 5: Termination checking: Check if iterations amount satisfies termination condition. If termination condition is satisfied, terminate program and output results; or else revert to Step 2.

IV. FISH SCHOOL SEARCH ALGORITHM

This algorithm is inspired by the collective movement of the fish and their social behaviour. Based on a series of instinctive behavior, the fish always try to maintain their colonies and accordingly demonstrate intelligent behaviour. Searching for food, immigration and dealing with dangers all happen in a social form and interaction between all fish in group will result in an intelligent social behavior .This algorithm has many advantages as high convergence speed, flexibility, fault tolerance and high accuracy.

Fish School Search (FSS) is an optimization algorithm based on ocean fish behaviour. It was proposed by Bastos-Filho, et al. In FSS, each fish represents a solution to a problem. The success of a fish during search process is indicated by weight. FSS has 4 operators executed for every fish of school at every iteration;

(1) Individual movement responsible for local search step;

(2) Feeding, this updates fish weights indicating success/failure during search process till now;

(3) Collective-instinctive movement, which makes fish move to a resultant direction; and (4) Collective-volatile movement controlling search granularity. Feeding operator determines fish weight variation at every iteration. It is noticed that fish can increase/decrease its weight depending on success/failure during search. Fish weight is evaluated according to following equation:

$$W_i(t+1) = W_i(t) = \frac{\Delta f_i}{max(|\Delta f|)} \qquad (4)$$

Where, *Wi(t)* is weight of fish *i,* Δf_i is variation of fitness function between new position and current position of fish, max(|Δf|) is absolute value of greatest fitness variation among all fish. There is a parameter w_{scale} limiting maximum fish weight. The weight fish varies between 1 and w_{scale} with an initial value equal to $w_{scale}/2$.

V. HYBRID FISH BEE ALGORITHM

Hybrid fish bee swarm optimization Both the optimization is run parallel to optimize the line generation and cost. The optimization terminates on achieving the objective. The objective being, minimize:

- $L_{nmax} - L_n \rightarrow 0$ and ensure L_{nmax} - L_n is greater than or equal to 0
- $G_{imax} - G \rightarrow 0$
- $C_{min\_price} - C_{price\_i} \rightarrow 0$

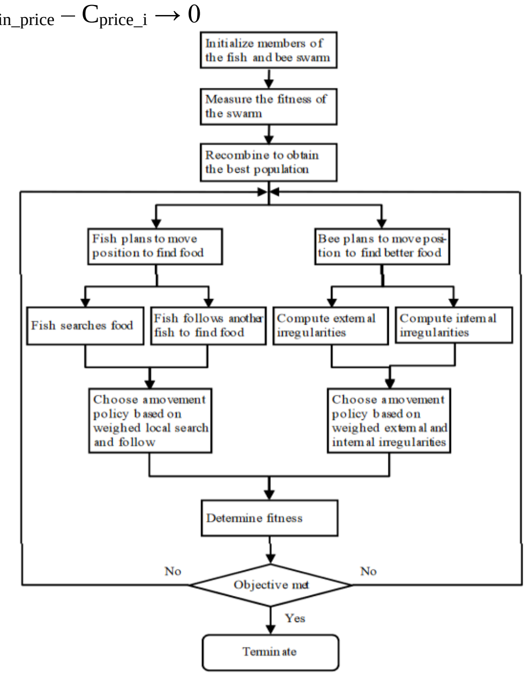

Fig.1: Algorithm for Fish Bee Algorithm

VI. RESULTS AND DISCUSSION

The proposed system was tested on an IEEE 30 bus system using MATLAB platform. The IEEE 30 bus system was used to test the proposed algorithm. Optimal power flow study was carried out with an initial population of 20. Four runs were conducted with different random seeds and the convergence occurred after about 80 iterations. Results were compared with ABC algorithm. First the ABC algorithm method result is given as to form a hybrid algorithm system. System will tested on an IEEE 30 bus system, using MATLAB software platform.

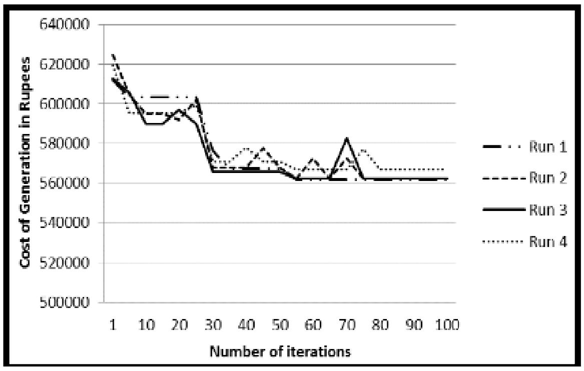

Fig.2: Generation Cost of System for ABC Algorithm System

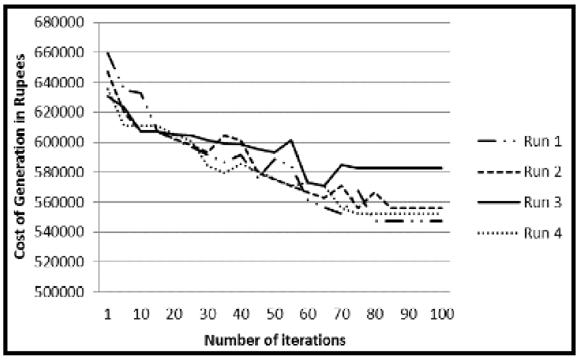

Fig.3: Generation Cost of System for Hybrid System

VII. CONCLUSION

This technique for congestion management using hybrid fish bee optimization is indeed a realistic method to be implemented. Hybrid Fish Bee optimization algorithm is proposed to execute this multi objective task because it can solve combinatorial optimization problem. The system cost is reduced and found to be more beneficial for large systems. Simulated results in MATLAB verify the validity and feasibility of proposed algorithm with rational parameters. The results prove that the method has a strong robustness, faster convergence speed and better estimation precision.

VIII. REFERENCES

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