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Blockage control utilizing generator and burden rescheduling

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Abstract. *CM techniques are examined in this paper, as well as how the new competitive structure of the electricity market affects them. If the system's workload grows or a contingency emerges, many lines may get overloaded. Energy production and distribution must be optimized to meet demand in order for the system to function optimally. The researchers in this study used swarm intelligence techniques and the best possible rescheduling of production units and load needs to handle the CM problem. A combination of fuzzy adaptive PSO and Particle Swarm Optimization (PSO) is employed to solve the CM problem here (FA-PSO). IEEE 30 bus and Indian 75 bus are used as the test platforms for this approach to CM.*

1. Introduction

So that power system security and reliability may be maintained at appropriate levels while simultaneously optimizing market efficiency, regulations are required for a deregulated power system. When electric energy producers and consumers wish to generate in amounts that exceed one or more transfer constraints, transmission networks are deemed congested. The security and reliability of the system are directly impacted by congestion. Dynamic congestion may occur if the system becomes insecure due to an interruption or outage, forcing other lines to become crowded as well. Congestion Management (CM) may be the most fundamental problem with transmission management, which requires monitoring the transmission system to ensure that transfer limits are not exceeded.

Maximizing profit necessitates bidding the extra cost of an electricity generator, which is the case for price takers. Bidding by a generator to improve profits by taking advantage of market inefficiencies is referred to as "strategic bidding. Literature offers a wide range of solutions to the CM issue. For the most part, the solutions used to alleviate the congestion include rearranging the timing of generator outputs, making provision for reactive power, and cutting down on load demands and transaction volume. OPF-based CM methods may be found all throughout the scientific literature [2].

For reducing generator rescheduling costs while also alleviating line congestion, a novel Particle Swarm Optimization (PSO) method is presented in [3]. By using the Cuckoo Search method in [4], we may reduce the cost of generator rescheduling by rescheduling them in the most efficient manner. [5] proposes an enhanced inertia weight PSO-based CM strategy for a deregulated energy market. Referencing references [7], an Artificial Bee Colony algorithm is proposed, based on generator rescheduling and inspired by the intelligent foraging behavior of honey bee hives.

With the use of demand response and FACTS (Flexible Alternating Current Transmission System) devices, reference [10] provides a transmission CM strategy in a restructured market. Consider the dynamic voltage stability boundary of the power system while developing a new CM framework [11].

CM theory and practice are critically examined in detail in the reference [12]. In this essay, we'll go through the most prevalent methods of doing CM. Multiple goals, such as cost, voltage security, and dynamic security, may all be met simultaneously via a multi-objective framework [3]. Hybrid power market framework for hydro and thermal unit combinations is proposed in [4].

In [8], an approach for real-time CM of MV/LV transformers is presented. [9] proposes an algorithmic technique for CM on the electricity market that uses an entirely new generation rescheduling algorithm called the [[ant lion optimizer]]. In both regulated and unregulated markets, demand management contracts may benefit the power industry. For a pool-based energy market model.

The operational components of power systems may include some of the most challenging challenges in the restructured structure of the power sector. This article focuses on the CM problem in the context of the restructured power market. It's possible today, instead of the classic OPF problem. By scheduling generators and loads in the most effective way feasible, this approach aims to alleviate the CM problem. The participating generators are selected based on their sensitivity to the overcrowded transmission lines in order to ease congestion. All three methods may be used to address the proposed CM problem. IEEE 30 and Indian 75 bus testing technologies are used to simulate data.

What follows is an outline of the remainder of the paper. Congestion Management (CM) is an issue that has to be addressed. Sec. 3 provides an overview of Swarm intelligence approaches.

2. Congestion Management (CM): Problem Formulation

Two techniques are used to reduce system congestion. These paradigms, as far as I can tell, don't cost anything. They are only considered "free" because of their low marginal costs. Here are some examples of the "not free" paradigm in action.

Generation Rescheduling: To put it another way, the equilibrium point is no longer determined by the cost of equal incremental adjustments as a result of this development. Cost signals may be obtained from the dispatch framework by using mathematical models of pricing tools. In order to avoid paying congestion pricing, market participants may utilize these cost signals to reorganize their power injection and extraction schedules.

Prioritization and curtailment of loads/transactions: Reference [23] provided a new parameter called "willingness-to-pay-to-avoid-curtailment". Setting transaction curtailment techniques with this tool may be useful in the OPF framework implementation.

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3. Swarm Intelligent Techniques

Study attempts to solve the CM problem. PSO was developed by Eberhart and Kennedy in 1995 based on the social behavior of flocks of birds and schools of fish. Genetic Algorithms, an evolutionary computing method, is quite similar to PSO (GAs). After a random population of solutions is generated, the system goes through generations of iterations to discover the optimum answer. As the problem space is traversed by PSO particles, they follow the current optimum particles.

4. Fitness Distance Ratio PSO (FDR-PSO)

If a particle in this oscillation reaches a new best location during this oscillation, it will continue to move toward the convergence of the global best position discovered thus far. A suitable local solution may be quickly found by acting uniformly amongst all of the particles.

Additionally, each particle in FDR-PSO algorithm may learn from the experiences of its neighbors with a better fitness than it. Speed and location updates are not affected by this modification.

Tab. 1: Fuzzy IF/THEN Rules for the Inertia Weight (ω) Correction.

Rule Number	Consequent Inertia Weight Correction ($\Delta\omega$)	Inertia Weight (ω)	Antecedent Normalised Fitness (NIFT)
1	(Zero)	(Small)	(Small)
2	(Negative)	(Medium)	(Small)
3	(Negative)	(Large)	(Small)
4	(Positive)	(Small)	(Medium)
5	(Zero)	(Medium)	(Medium)
6	(Negative)	(Large)	(Medium)
7	(Positive)	(Small)	(Large)
8	(Zero)	(Medium)	(Large)
9	(Negative)	(Large)	(Large)

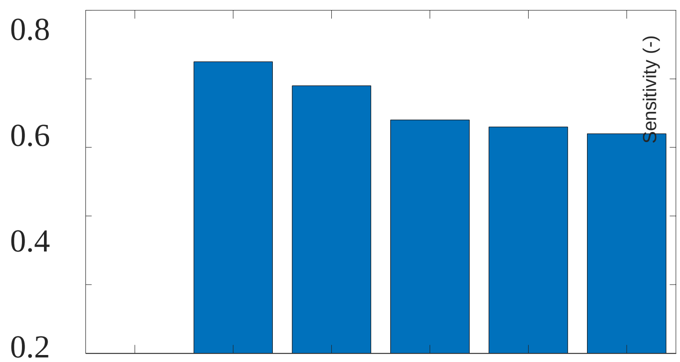
1. Results and Discussion

For PSO, the inertia weight limits are 0.9 and 0.1 for swarms with 60 members, two acceleration constants, and a maximum of 500 generational cycles.

Simulation Results on IEEE 30 Bus Test System

The IEEE 30 bus test system has six generators, 24 load demands, and 41 branching. In order to make comparisons, it is crucial to realize that the sensitivity values acquired are utilized as a baseline. In other words, any system congestion has no effect on the slack bus generator. In this example study, the generators and the load requirements are rescheduled based on two earlier studies. In the event that you are still undecided, here is an illustration:

Generators that are responsive to a crowded or overloaded line are selected by those who take part in the CM. IEEE 30's small bus size means that all the generators in the system are almost equally responsive to the line. Since it acts as a reference bus, the slack bus is always used as the default option.



Tab. 2: Pre- and post-CM IEEE 30 bus system power generating schedules.

Scheduled Generation	Before the CM	After the Congestion Management (CM)		
	Original	PSO	FA-PSO	FDR-PSO
P_{G1} (MW)	139	164.34	163.78	162.76
P_{G2} (MW)	57.55	68.37	66.23	69.90
P_{G5}(MW)	24.54	22.89	15.38	24.76
P_{G8} (MW)	34.9	34.41	34.90	34.86
P_{G11} (MW)	17.92	19.91	24.01	20.45
P_{G13} (MW)	16.89	22.04	20.09	17.24

Scheduled power production in per unit values is shown in Figure 4 before to and after application of FDR-PSO and FA-PSO in conjunction with the PSO.

Tab. 5: Power is flowing in both directions before and after the CM in the crowded line.

Line No.	Before the CM		After the CM using PSO	
	Active power flow (MW)	Reactive power flow (MVAR)	Active power flow (MW)	Reactive power flow (MVAR)
1	128.78	24.23	109.54	60.66

1) **Case 2: Optimized Generator Scheduling and Demand Response Offers in CM**

Generators and load requirements are rescheduled in this way to alleviate system congestion. For this case study, the system's load has increased by 145%. The IEEE 30 bus system has six generators with a total of 21 load needs. System operators (SO) are presumed to be able to request customer demand response and load shedding proposals as part of the CM analysis. 30 percent of a bus's demand is the greatest amount that it can shed in this case study.

Optimal generation schedules for Case 2 are provided in Table 6 based on PSO, FA-PSO, and FDR-PSO algorithms. Transmitter 1 (143.13 MVA) is crowded with power flows of 143, 382, and 36,808. Transmitter 10 (43.82 MVA) is overloaded with power flows of 43 and 43 MVA, respectively. There is a 130 MVA maximum power flow limitation on lines 1, 10, and 18.

2. Conclusion

Using PSO, FDR-PSO, and FA-PSO algorithms, this study was able to schedule load demand/demand and active power generation response to their optimal levels of efficiency. Generator scheduling costs are reduced as much as feasible while still ensuring that all line flow limits are met, therefore rescheduling is required in this scenario. A generator's ability to handle overloaded transmission lines is taken into consideration while making this decision. PSO, FDR-PSO, and FA-PSO are some of the optimization methods utilized to address the CM problem. An IEEE 30 bus and an Indian 75 bus practical test system are both needed to carry out the CM approach described here. Although FDR-PSO needs less computation time, simulation findings show that FA-PSO is more cost-effective than other swarm intelligence techniques.

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