A EVALUATION ON OPTIMISATION FOR THE OPTIMAL DIVISION OF FACTS DEVICES

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Abstract

Transmission line security, stability, power flow, and voltage are all managed by FACTS devices. Power systems make extensive use of Imperialist Competitive, a recently established optimisation approach. The improvement of electrical equipment is the reason for the massive increase in the demand for power nowadays. On the other side, there's a chance that the limitations on building new transmission lines will cause congestion on the ones that are already in place. Consequently, there might be a systemic blackout. Electrical transmission and distribution firms work to design a method or technology to raise the system's thermal limit or power flow capacity to prevent this catastrophic circumstance. change the line flow in an electrical system, the Flexible AC Transmission System (FACTS) devices are thought to be the most practical and adaptable solution. In this paper researcher address the following things to determine the best position for FACTS devices inside the system, this article outlines the underlying research, device building, and application methods.

Keywords: · Flexible AC transmission systems, Bus voltages, Optimisation techniques

1.Introduction

In the latter part of the 1980s, the Electric Power Research Institute (EPRI) proposed a novel idea known as the "Flexible Alternating Current Transmission System (FACTS)," which uses a variety of power-electronics-based controllers to modify power flow and transmission voltage in order to reduce dynamic turbulences [1]. Because of their continuous progress, FACTS devices have garnered a great deal of attention in the last several years. Because they provide several advantages, including as enhanced voltage profile, decreased power losses, and higher system stability and safety, the use of flexible AC transmission system (FACTS) devices in electrical power systems has grown in popularity in recent years. The best kind, position, and dimensions for FACTS devices may be determined by utilising mixed integer, nonlinear, and nonconvex constraints, which makes it a difficult optimisation issue.

Optimisation based on machine learning: This method makes use of machine learning algorithms to learn from past data and forecast the best FACTS device configuration given the state of the system. Large-scale systems can benefit greatly from the quick and precise solutions that machine learning-based optimisation can offer.

In the case of a deregulated market, the locations of FACTS devices are crucial. Reducing the cost of the electrical system is the main goal of the deregulated market. This is feasible if the costs associated with generation, emissions, congestion, and system gearbox loss are all kept to a minimum. By positioning FACTS devices optimally, the deregulated system's congestion and gearbox loss cost may be reduced. An overview of the relative positioning of FACTS devices in the deregulated electricity market is provided in this study. This study also incorporates the benefits, applications, and classifications.

Robust optimisation: This method takes into account the optimisation problem's uncertainties, such as changes in load demand or the production of renewable energy. Robust optimisation is capable of producing solutions that are less susceptible to variations in the system parameters by introducing uncertainty into the optimisation model.

Multi-objective optimisation: This method takes into account several competing goals at once, such as reducing power losses and enhancing voltage stability. Decision makers can select the best option by using a set of optimum solutions that multi-objective optimisation can produce. These solutions reflect a trade-off between the various objectives.

2. FACTS Devices

Classification of FACTS Devices

FACTS controllers are categorised based on the connection of FACTS devices, subject to the electrical system's device connections. Devices linked to the power system network in series are referred to as series controllers, and devices connected in shunt configuration are referred to as shunt controllers. Sometimes the power system uses a mix of Series-Series or Series-Shunt controllers for greater voltage stability and appropriate placement.

FACTS controllers are categorised according to the device generation as follows: There are two generations of FACTS controllers: the first and the second.

The most basic FACTS devices from the first generation are falls, which are less complicated and have fewer variation out generators. Some examples of first-generation FACTS devices include SVC, TCSC, and TCPST.

The second-generation FACTS devices are utilised in networked systems such combination systems for renewable and non-renewable energy. Second-generation devices are series-parallel combination devices with an interline power flow mechanism that offers improved voltage regulation under load fluctuation. Some examples of second-generation FACTS devices are IPFC, SSSC, UPFC, and STATCOM.

The most significant research projects of late have been completed with the use of TCSC, UPSFC, STATCOM, and SVC due to their increased system network adequacy.

Optimization Techniques

According to their evolutionary history, optimisation techniques may also be divided into three categories, as shown in Figure 2: Classical Analytical-Based Methods (CABMs), Classical Arithmetic Programming-Based Algorithms (CAPBAs), and Modern Metaheuristic-Based Algorithms (MMBAs). The optimisation techniques known as CABMs provide the benefit of computational efficiency and furnish valuable insights on the influence of various scenarios on the optimisation target. They take a lot of time, though, and might not be appropriate for large-scale power systems. Another class of optimisation techniques is the CAPBAs. Although they exhibit good convergence properties, they are frequently ineffective when used to optimisation problems with constraints. Since MMBAs may identify many optimum solutions in a single optimisation, they are the most often utilised optimisation techniques that are appropriate for tackling multi-objective problems.

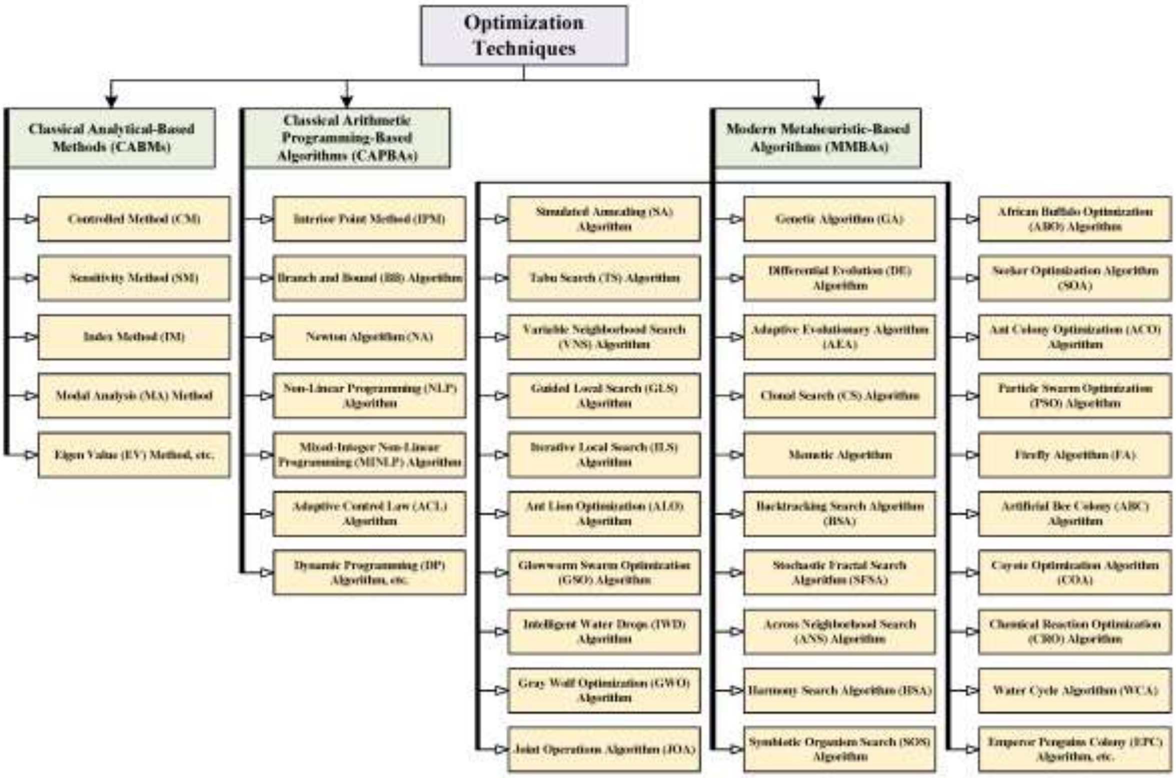

Fig-1 Optimization Techniques

Review on various Optimization Techniques

Authors	Type of FACTS device	Optimization Algorithm	Bus system	Size and Location	Disadvantage	Performance Evaluation
Jordehi, A. Rezaee [5]	TCPST and TCSC	Imperialistc Competitive Algorithm	IEEE 14 and IEEE 39	-	The proposed method has not been compared with other methods. The degree of optimality solutions is unknown.	Overload, voltage deviation.

Phadke et al. [6]	Shunt FACTS controller	The multi-objective fuzzy GA algorithm	IEEE 14 and IEEE 57	Bus 14 location: 9,14 and size 70 MAVR Bus 57 location: 31,35 and size: 63 MAVR	The experimental outcome of the proposed GA has not been validated.	Maximum Loading Margin (MLM) and minimum voltage deviation with less capacity.
Sedighizadeh, M et al. [16]	SVC and TCSC device.	NSPSO and NSGA-II algorithm.	IEEE 14 and IEEE 30	Bus 14 size: 7,9 and location: -27.4020 MAVR, -20.8614 MAVR. Bus 30 size: 20,21 and location: -1.5823 MAVR, -1.322 MAVR.	The performance of the proposed methodology was not validated.	Cost
El-Zonkoly et al. [17]	Static Synchronous Series Compensator (SSSC) controllers.	PSO	IEEE 14 , New England 39.	-	The proposed method was not suitable for a huge power system.	Transmission loss

Ravi, K., and M. Rajaram [19]	STATCOM device	Improved PSO (IPSO) algorithm.	IEEE 30	Bus 30 size:26,30 and location: 1 per unit.	The performance was not much validated by means of cost, transmission loss, and voltage deviation.	Convergence rate
Vilmair E et al. [20]	TCPST devise.	GA with optimal power flow algorithm.	IEEE 291	Bus 291 size:22,211,233 and location: 4.4064 MAVR, 13.8947 MAVR and 2.7771 MAVR.	The GA has found the optimal location and power flow of TCPST, however, the global search capability of GA has not been validated compared to state of the art optimization techniques.	Overload minimization and cost.
Jordehi, A. Rezaee [24]	SVC and TCSC devices.	BSOA algorithm	IEEE 57	-	The proposed algorithm cannot provide an appropriate tradeoff between their exploitative and explorative abilities.	Voltage profile and voltage deviation.

Safari et al. [25]	TCSC and SVC devices	Strength pareto multi-objective evolutionary algorithm	IEEE 30 and IEEE 118	Bus 30 size: 8 and location: 0.8035 MAVR. Bus 118 size: 57 and location: 0.7483 MAVR	The exhaustive search is time-consuming process.	Maximization of the static voltage stability margin and minimizations of real power losses, and load voltage deviation.
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3. Conclusion

Future energy consumption is expected to rise, as shown by many publications from prominent organisations such as the International Energy Agency (IEA) and the Institute of Electrical and Electronics Engineers (IEEE). Given the constant advancements in science and technology, it is probable that new types of gear and equipment will be incorporated into power networks. It implies that the electrical networks will have to develop into increasingly complex systems. The implementation of FACTS devices and the optimisation of several power system-related factors would be essential in such a situation. The use of UPFC and GUPFC in advanced FACTS devices is anticipated to rise over the next several decades due to their capacity to automatically and selectively control Power system performance in terms of transmission congestion, energy efficiency, voltage and transient stability, as well as power quality and reliability, has gotten worse due to the quick rise in electricity demand, the need for greater economic efficiency, and the substantial investment needed to build new power networks. It has been demonstrated that FACTS devices are effective in improving power system performance in several ways. Numerous studies using various optimisation strategies have been conducted in recent years to determine the best placement, kind, and capacity of FACTS devices. This work aimed to handle the problem of FACTS device allocation optimally by providing a retrospective analysis of the existing optimisation strategies. Furthermore, an attempt was made to classify these methods.

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