Numerical Simulation of Impoved Soft Computing Based Optimization Based Capacitor Placement in distributed generation system

Shashikant Ola [1] and Bharat Bhushan Jain [2]

[1]M.Tech. (Scholar) Department of Electrical Engineering, JEC, Kukas, Jaipur, Rajasthan, India
2 Professor, Department of Electrical Engineering, JEC, Kukas, Jaipur, Rajasthan, India

Abstract**—**Important exploration has been performed on the arrangement of ideal capacitor arrangement in the appropriation structures for power factor adjustment assignments, enhancement of voltage profile and loss reduction assignments. In particular, a mechanical plant with variable load conditions has enormous inductive loads and an extremely low power factor. In most situations, keeping a strategic distance from retribution in the power bill is the primary reason behind why a consumer introduces a capacitor bank. Power factor is a proportion of the actual power to the apparent power, which speaks of how much electrical gear uses genuine power. Inductive or capacitive reactance and harmonics in the circuit[2] are induced by a power factor of some importance other than solidarity. In the urban areas, the expansion in power demand and high load thickness renders the operation of power frameworks muddled. The framework must be expanded by extending the substation cap and the quantity of feeders in order to fulfil the load requirement. Notwithstanding, due to various specifications, this might not be easily done for certain services. The framework will ensure longer life expectancy and have more influential reliability by limiting power misfortunes. Different techniques have been used to minimise power misfortunes financially through the capacitor bank's ideal choice of scale, area and cost. The problem of capacitor allocation in electrical distribution systems involves decreases in energy expansion and pinnacle power misfortune by methods for capacitor facilities. This paper introduces a novel method that uses inexact thinking to determine the framework of competitor hubs in a capacitor arrangement conveyance framework. There are two parts of the arrangement technique: to some degree, the misfortune affecttability factors are used to pick the up-and-comer areas for the capacitor situation, and to a small extent, the genetic algorithm technique is used to identify the capacitor's measures to reduce energy losses and increase the voltage profile by placement of capacitors. The device implemented worked successfully for the objective purpose of loss reduction and voltage profile enhancement for the test case**.**

Keywords- *Optimization, DC Power Converters, Photovoltaic Cells, Capacitor Placement, Particle Swarm Optimization, Genetic Algorithm*

I. INTRODUCTION

Ideal condenser arrangement is an increase in the area of the condenser bank and the scale of the condenser banks on the competitor's transport systems. A nonlinear improvement problem is the capacitor status problem. Condenser situation optimization can be accomplished for virtually any type of circulation system, e.g. spiral system or interconnected work frame. The ideal state of the condenser leads to reduced power misfortunes, which can increase the lifespan of the frame. The arrangement of the ideal condenser system in the circulation structures for power factor revision, voltage profile improvements and misfortune decreases have been studied significantly. In particular, for mechanical plants with variable load conditions and extremely low power factor, there are large inductive loads. The condenser banks profit most from these organisations. This bank provides an increased power factor, higher voltage and a reduction in energy bills. Moreover, programmed condenser banks may be able to dispose of kVA r in light charge times and disturbing over-voltages. In most cases, the reason behind why a consumer creates a condenser bank is to stay away from retaliation in the power bill. The distributor device condensers need to make very real efforts, with different techniques, to streamline their size and area. In the past, this analyst has developed numerous techniques for the condenser situation from which consumers gain simultaneously[1-3]. New innovations in the traditional power system are the development of Distributed Generation (DG). Dissemination Generation plays an important role in the transportation system by increasing the performance of the frameworks, minimising power misadventures and enhancing the voltage profile. In the world of energy crisis, power production or productive usage can be accomplished by reducing the loss of transmission and distribution in the grid to meet the energy requirements. Distribution losses are percent of the total power produced. There is a broader field of research in the distribution system, which decreases power losses and improves efficiency. The total loss within the delivery system is due to both active and reactive control. By installing compensatory equipment on sufficient buses the losses will be reduced. Connection of condensers to distribution feeders, which also enhancings the voltage profile and reliability of the system, is a common method of eliminating reagent power losses. The size and location of condensers therefore play an important role in the overall improvisation of supply systems. Significant factors such as ideal placement, size and number of condensers can be taken into account for the optimum profitability.

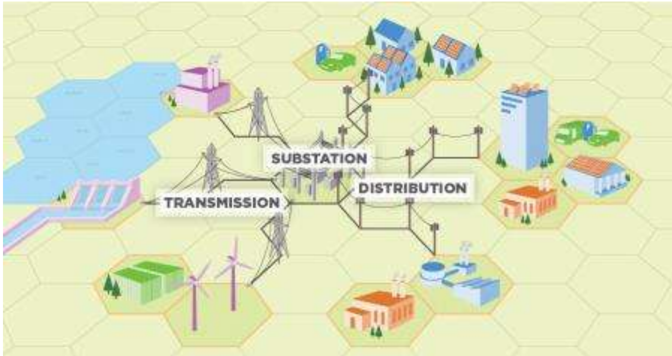

Figure 1.1 Distributed Generation System

In order to attain the goal, it is important to locate the capacitors in the RDS at the optimum scale. In previous research for loss minimization by putting the capacitors correctly in RDS, traditional approaches as well as heuristic methods were implemented.

A feature of the current which flows through the lines is the active and reactive losses in the radial distribution system. By optimising the overall voltage profile and regulating reactive power in the distribution systems, complete power losses can be minimised. In radial distribution systems, different methods have been used, such as linking distributed generations, reconfiguring the system and balancing the load, and adding shunt capacitors. The loss of power and/or the degradation of voltage profiles would be increased by worse position or capacitor size.

II. CAPACITOR PLACEMENT

Condensers can be used in radial distribution systems for power factor correction as well as reactive power compensation. The positioning of condensers in radial distribution systems, such as reducing total power losses and improving voltage profiles, is considered in order to achieve maximum benefits from condensers. In Figure 2.1, the two-bus structure appears. The line's loss is indicated by—

$$P_{loss} + jQ_{loss} = I_s^2 (r + jx) \quad (2.1)$$

Where: the current of the line is, Ploss is a true power loss, Q is the loss of reacting power, r the strength of the line and x the reacting power.

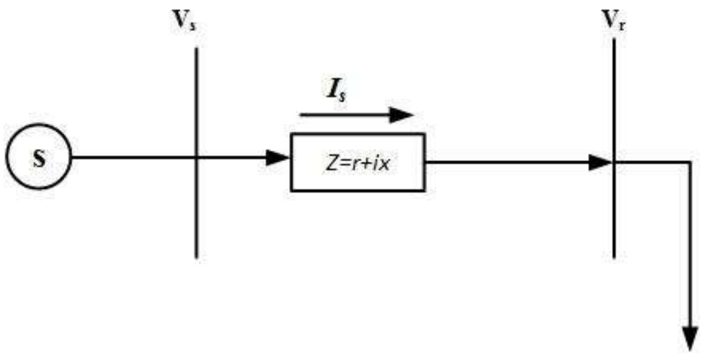

Figure 2.1 Two Port Network

The injected reactive power increases the power fraction and reduces the flow of current through the lines, decreasing the drop in tension and reducing the loss of the liner when a condenser is added to the receiving end. The proposed condenser positioning solution takes into account the following limitations in this paper. The voltages of the network bus are kept between the lower bound (Vmin) and the upper bound (Vmax). Each bus must have an injected reactive power from the lower (QCimin) to the top (QCi Max) limit. The reaction force compensation of the complete shunt capacitor (Qc) must be equal to qt. The apparent capacity must be as much as possible (Si max) for each branch (Si). The power factor enhancement condenser can be installed at the system bus, distribution point and at the load itself. However, decisions should be taken in terms of expenditure and utility. The whole load is switched on or off for certain loads, often in industrial loads, depending on needs. It is recommended that a condenser bank be installed in these situations with a feeder that provides the entire load. The condenser branch banking scheme is known as this scheme. The losses in the primary system from which the branch originates would not help because the condenser bank is directly linked to the feeder or branch. The individual condensers with the separate load feeder are connected by the ON and OFF, along with the load feeder, to each system. Thus the scheme provides more control of reactive resources, but the scheme is expensive.

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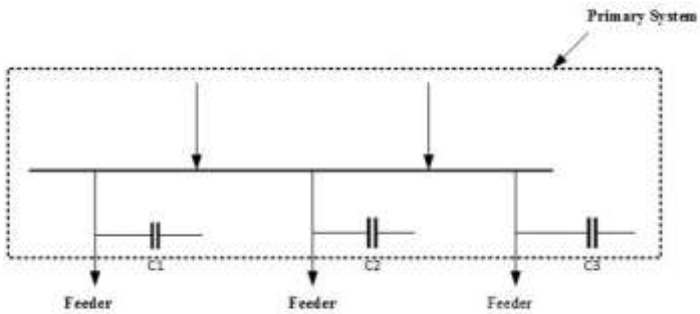

Figure 2.2 Capacitor Placement

Although the installation of a condenser bench at each loading point compensates for the reactive power of each load individually, it improves the voltage profile, improves the reduction of individual load losses and reduces the energy bill of customers more effectively, but it is still not feasible because the system is complicated and expensive. In this case the main reasons for difficulty are the installation of the condenser bank's different dimensions and capabilities depending on each load's demand. A large-voltage bus system condenser bank should always be mounted instead of a smaller condenser bank being mounted at every loading point to overcome this problem. While reactive system control is little affected, it is still a very practical approach in terms of complexity and cost. In primary systems, however, both the condenser bank and the condenser bank have their own advantages. Depending on the system's demand, both schemes are used. A high voltage grid, feeders and an individual Capacitor Bank distribution system can be mounted in the form of a TH system. The reactive strength of that unique feeder is compensated for by a pole in the distribution feeder condenser bank. Usually, these banks are positioned on one of the poles where the feeders operate. The designed condenser shelves are usually interconnected with overhead feeder conductors by an independent power cable. The cable's size depends on the voltage rating of the device. For a pole-built condenser bank, the system can be mounted at a voltage range of 440 V to 33 KV. The rating for a condenser bank can be between 300 KVAR and MVAR. The pole-mounted condenser bank can either be set or moved to a device depending on load conditions.

The soft computing technology provided on the basis of the genetic algorithm designed for capacitor placement selection in power systems has been successfully implemented in order to achieve the goal of minimising power loss and improving voltage distribution. The increase in the reduction of losses after improved capacitor positioning for the test case is clarified. It is evident that the voltage profile is significantly improved and that the losses in the test system are reduced after using the suggested soft computing technique to position the capacitor unit. This figure of merit demonstrated a significant improvement in the stability and process of the system.

III. IMPROVED PARTICLE SWARM OPTIMIZATION

Fish and birds and other biological Fish and birds swarm this method and other biological education practises induced to promote social line are swarmed by this technique. PSO offers a population-based search service, which is referred to by the user as a partial shift in their position over time. Particles travel in the multi-dimensional search space in the PSO-based method. Each particle changes its location during its flight according to its own experience and experience of neighbouring particles using its own best position and its neighbours. Find in multi the best dimensional space solution to transfer each particle in the set point by adding optimal position speed. Three variables influence particle velocity: inertia, perception, and society. The inertial portion simulates the previous direction of the inertial action of birds flying. The cognitive aspect mimics the best place and social memory of the bird, which mimics bird memory, which is the best place for certain felines. Particles look for multidimensional space to travel across the room before the best solution is found. Each change's velocity will use the current velocity and measure the distance between the agent and Pbest and gbest as follows.

$$V_i^{k+1} = w \times V_i^k + c_1 \times r_1 \times (Pbest_i^k - X_i^k) + c_2 \times r_2 \times (Gbest^k - X_i^k) \quad (3.1)$$

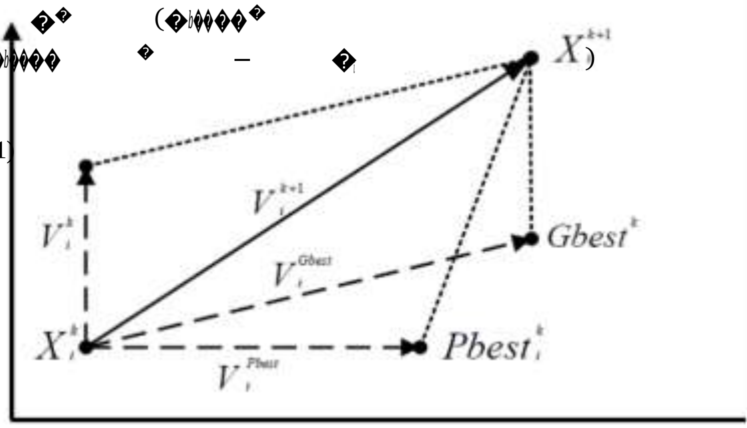

Figure 3.1 Particle Swarm Optimization Search Engine System

The process of implementing PSO is as follows

The PSO implementation process is as follows:

Phase 1 Create an initial population of people to resolve a random location and velocity in the space.
Phase 2 Measure the value of each fitness function of the person.
Phase 3 In each Pbest, the ratio of everybody's wellbeing. If the current solution is better than Pbest, replace the existing solution with Pbest.
Phase 4 Ratio contrasted the health status of each individual gbest. If the health of any person is better than Gbest, then substitute Gbest.
Phase 5 All individuals are modified with velocity and location.
Phase 6 Continuous steps until the conditions are met from Phase 2-5.

The use of truncated Gaussian and Cauchy probability conveyances to build irregular numbers to haphazardly refresh PSO conditions was suggested by Coelho and Krohling. In this article, the dissemination of the strategy depends on the PSO Gaussian probability and the technique of Cauchy probability circulation. The irregular number using a Gaussian likelihood work and/or a Cauchy likelihood work in the district between [0, 1] age in this new technique.

Gaussian distribution (Gd), also known as the standard distribution, the continuous probability distribution family is significant. Each family can be described as members by two parameters: location and scale. The meaning of the Gaussian distribution therefore lies in the theorem of the local to central limit. Since the mean and variance of the regular Gaussian distribution is zero, searching faster allows local convergence. The Cauchy distribution Cd is used to produce this. The portion of the social area between [0,1] of the random number generated by the Gaussian distribution and Gd. Cognitive interval [0,1] The random number of regions in between.

The updated equation of velocity is given by

$$v_i^{K+1} = K.(\omega . v_i + c_1 r_1 (pbest_i - x_i) + c_2 r_2 (gbest - x_i))$$

(3.2)

$$K = \frac{2}{|2 - \varphi - \sqrt{\varphi^2 - 4\varphi}|} \quad (3.3)$$

where $\varphi = c_1 + c_2, \varphi > 4$

The system will regulate system convergence. In order to ensure certificate stability, obtaining shrinkage factor analysis (CFA) must be greater than 4.0 However, with the enhancement factor K, the multi-like reduction of the slower reaction produced is reduced. The shrinkage factor is usually set to 4.1 in use, i.e. C1 and C2 should be a constant multiplier K of 0.729.

IV. SIMULATION & RESULTS

In order to achieve the aim of minimising power loss and improving voltage distribution, the soft computing technology provided based on the genetic algorithm designed for capacitor placement selection in power systems has been successfully implemented. The improvement in loss reduction after the optimised positioning of capacitors for test case is explained. It is obvious that the voltage profile is substantially improved as well as the losses in the test device are minimised after the capacitor unit is placed using the proposed soft computing technique. This merit figure showed a substantial change in the system's stability and process.

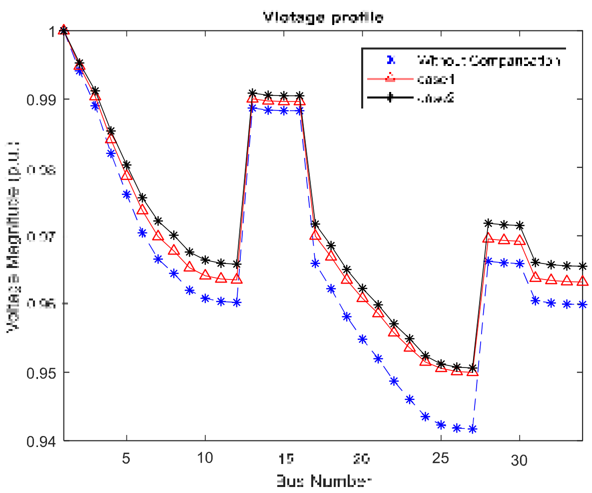

Figure. 4.1 Voltage Enhancement without compensation and with compensation for different loading condition

Table-1 Value of Parameters

Parameters	Value
Total active loss	162.80
Minimum Voltage	0.950 at bus 27
Maximum Voltage	0.99 at bus 2

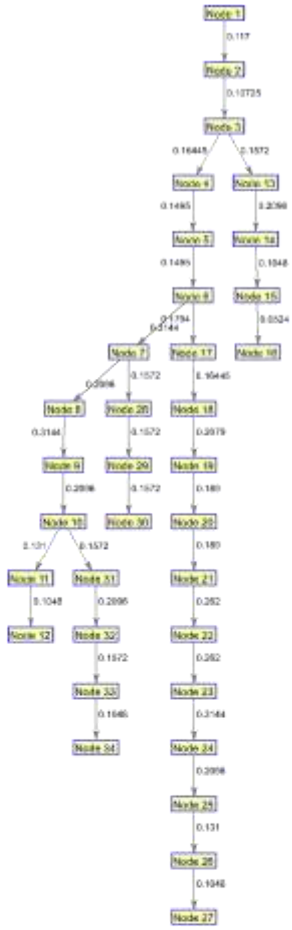

Figure 4.2 Node Representation of IEEE-34 bus system

A specific soft computing technique focused on particle swarm optimization with improved parameters designed to select capacitor placement was also introduced to improve the voltage curve. The voltage profile enhancement achieved for the bus system IEEE-34 is shown . It can be clearly seen from the figure that after using the enhanced algorithm to optimally position the capacitors, the active power loss in the test system is significantly reduced. In order to achieve the objective of minimising reactive power loss and enhancing voltage distribution, the soft computing technology provided based on the genetic algorithm designed for the selection of capacitor placement in power distribution The comparative assessment of the enhancement of the voltage curve and the minimization of power loss before and after capacitors are installed in a given test system is shown in Table 1. In order to achieve the aim of minimising reactive power loss and enhancing voltage distribution, the soft computing technology provided based on the enhanced pso algorithm designed for selective capacitor placement

V. CONCLUSION

The improved acceleration coefficient driven particle swarm optimization soft computing method of arranging and positioning capacitors in the IEEE-34 test case radial system is described in this research. The object of the problem is to limit the actual loss of power and optimise the voltage curve. Soft computing algorithms take advantage of this no algorithms for boundary control are needed, and they are difficult to implement. By the method presented in this work, two objective functions are simultaneously solved. The proposed methodology is applicable to the IEEE 34 bus test system test method. The reformulation is complete under MATLAB programming conditions. The results of the obtained entertainment suggest that the methodology proposed is adequate to minimise misfortune and achieve goals. The introduced theory can be easily applied in a common-sense, decentralised framework for planning and operational inquiries.
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