Journal of Science Engineering Technology and Management Science
Volume 02, Issue 02, February 2025 *ISSN: 3049-0952*
www.jsetms.com *DOI: https://doi.org/10.5281/zenodo.14952696*

Positioning Capacitors and Distributed Gen Units for Multi-Objective Optimization

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To Cite this Article
Ashok Naidu and Deepak, "Positioning Capacitors and Distributed Gen Units for Multi-Objective Optimization", Journal of Science Engineering Technology and Management Science, Vol. 02, Issue 02, February 2025, pp: 18-20

Abstract*: The placement of distributed generation (DG), capacitors, and ULTC transformer tap settings can all be employed separately to lower loss, enhance the voltage profile, and raise the distribution network's available transfer capability (ATC). These devices will be more effective if they are placed and set simultaneously. This paper uses a multi-objective function to implement this strategy. Reducing loss, improving voltage, and raising ATC make up the objective function. The objective function is optimized through the application of Genetic Algorithm (GA) approach. The suggested approach is used on the IEEE 41 bus radial distribution network to demonstrate its efficacy. The outcomes demonstrate that this approach improves the objective functions more effectively.*

Keywords*: DG positioning, capacitor positioning, loss mitigation, enhancement of the voltage profile, Transfer capability available*

I. Introduction

Nonlinear optimization issues involving numerous variables and equality and inequality constraints include DG and capacitor placement. DG and capacitor installation can be done in a variety of ways for various uses. The addition of DG and a capacitor can enhance the operation of a distribution network. Additionally, it may be properly regulated using the technology that is already in place, such the ULTC setup. Three categories might be used to group the earlier research in this area.

II. Types of Placements

Capacitor Placement In the past, choosing the right capacitor size and placement was the first step in enhancing distribution networks. The location of capacitors has been the subject of numerous investigations. The following are the most recent works in this case: Genetically optimized-fuzzy optimization is used to determine the location and size of capacitor banks in distorted distribution systems.

The goal is to minimize loss and optimize the cost of power and capacitor placement while taking load voltage limitations and THD into account. An ant colony search technique is used to tackle the capacitor placement and reconfiguration problem for distribution networks that are experiencing loss. Furthermore, a heuristic constructive algorithm is used to arrange capacitors in distribution systems.

DG Placement Different types of DGs have been created in recent decades, and various techniques for DG installation have also been established. A technique for positioning a single DG within a distribution network has been put forth. The most susceptible buses with voltage collapse are identified using this strategy. The goal of the analysis was to raise ATC, enhance the voltage profile, and lower losses. A multi-objective optimization technique for DG placement was linked in [5].

Reducing network loss is one of the primary considerations in that research. The search space is greatly condensed by proposing a heuristic DG optimization approach for distribution networks. A technique for choosing the load buses for DG placement that takes into account the system's sensitivity to voltage enhancement and loss reduction has been introduced. Analytical techniques are used to minimize power loss in power systems by determining the best location for dispersed generating sources.

Simultaneous DG and Capacitor Placement These days, many distribution networks use a variety of DGs and capacitors at the same time. The positioning of DG and capacitors to lower losses and enhance the voltage profile with GA has been examined in [9]. Two optimization models are also suggested in order to enhance the voltage profile. In [10], the capacitor placement problem is simulated and resolved once the DG placement problem has been stated. The simultaneous positioning of capacitors, DG, and tap setting is suggested in this study.

The ATC increase, voltage profile improvement, and loss reduction are all included in the suggested multi-objective function. This goal is constrained by the apparent power passing through at each line and the voltage magnitude at each bus. It should be noted that other papers pay less attention to the simultaneous installation of the DG and capacitors with the ULTC tap settings. The efficiency and viability of the suggested approach are demonstrated using the IEEE 41 bus radial distribution network, which is located in [10]. According to the simulation results, more favorable outcomes are obtained when the DG and capacitor locations and sizes are determined simultaneously with the ULTC transformer's tap configuration. The findings demonstrate that all buses' voltages stayed within the intended range, loss decreased, and ATC rose.

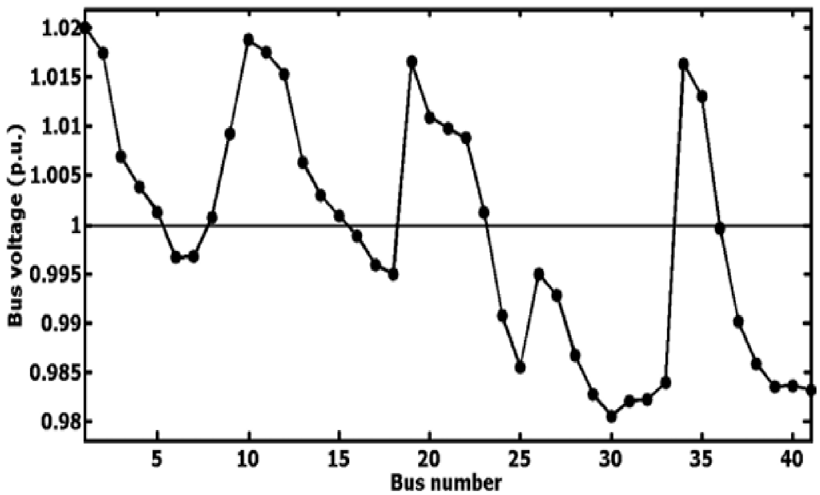

Fig 1: Proposed model for bus voltages

III. Multi Objective Function

In a multimodal search, GAs can enable simultaneous convergences to many optimal solutions. The genetic algorithm can be modified to find the global or nearly global optimal solution. This article applies GA to ULTC tap settings, DG, and capacitor layout. The active and reactive power levels of DG and capacitors are also ascertained using GA. The multi-objective function is optimized through the appropriate selection of all variables using GA. The multi-objective function is explained in this study.

IV. Results and Analysis

The IEEE 41 bus radial distribution network is used to test the suggested approach. The system's parameters and structure are described in [10]. The distribution network contains a substation bus, Bus 1. Transformer for ULTC at the first bus. There are 40 section lines and 41 load buses in this network. 4.250 MVar and 5.635 MW are the total reactive and active loads, respectively. Four capacitors and one DG are added to the network in this study. The properties of the DG, capacitor, and ULTC are displayed in Table I and II, respectively. The IEEE 41 bus distribution network was used to perform load flow in the first stage. In this simulation, the ULTC's voltage conversion ratio is set at one.

V. Conclusion

An enhanced GA-based technique for correctly positioning a DG and setting the tap settings for capacitors in ULTC transformers is presented in this study. To lower losses, enhance bus voltage profiles, and raise ATC, the suggested approach is based on a novel function that is paired with three mono-objective functions. Simulations are used to validate the suggested approach, and the results clearly demonstrate its effectiveness. The efficiency of the suggested strategy has been confirmed by the objective function simulation results.

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