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Minimization of Power Loss and Volatge Drop by Dg Placement in Distribution System by Using Bacterial Foreging Optimization Algorithm

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ABSTRACT: Distribution system integration of distributed generation (DG) is essential for achieving voltage stability margin and minimal power loss. Bus voltages need to be kept within reasonable bounds in order to guarantee the high quality of the supply in distribution systems. The major goals of this work are to reduce power loss and enhance the system's overall voltage profile. In order to use the DG units in the system as efficiently as possible while keeping within certain constraints and constraints, optimization techniques are tools that may be used to locate and size the units. Using the Bacterial foraging Algorithm Called (BFOA), the results of 15 and 69 bus radial distributed systems were obtained. The candidate buses into which the DG units will be installed on the system are first chosen in the suggested approach.
Keywords: DG, Optimization.

I. INTRODUCTION

1.1 Importance of Electric Power

Modern society has made electricity a necessity for daily living. Without electricity, everyone's life is impacted. The rising global per capita energy consumption is a reflection of the increasing level of living of the populace. a distribution system, a transmission system, and a generation system for electrical power. The fuel energy is transformed into electricity by the generating system. Some of the fuels that can be utilized to generate energy include the ones listed below.

- Water
- Coal
- Nuclear elements
- Diesel

Commercial fuels include the aforementioned ones. The generating stations are connected via the transmission system. The foundational component for supplying power to consumers is this transmission system. Power is delivered to consumers through the distribution system. Transmission and distribution systems differ in light of network structure. Transmission systems typically have a loop structure. Distribution systems can be set up as radial, loop, or networked systems. The majority, however, are radial in design, with only one path for power to travel from a distribution substation to end customers. The following advantages this configuration has over the other two offset its lower reliability.

- Improved control over power flow and voltage
- Lower price
- Simpler upkeep and restoration
- Less intricate planning.

The majority of power losses in the electrical power system will happen in the distribution networks. The main causes of the higher transmission and distribution losses include unauthorized extractions, inadequate billing, and metering mistakes. Long LV lines, excessive voltage transformations, overloading and under loading of transformers, poor equipment maintenance, loose joints, lack of maintenance, insufficient system operation control, ad hoc line sizing and routing, etc. are some of the factors that contribute to energy losses in India.

Due to frequent scheduled and unscheduled power outages as well as irregular voltage and frequency variations, the dependability and quality of power at the end user are reduced in India. These issues could result from the overuse of distribution equipment, the decision to perform break-fix maintenance rather than preventive maintenance, poor planning, the ageing of the sub-transmission and distribution network, widespread theft, an unfair tariff structure, a lack of technological advancements, a lack of accountability in distribution systems, etc. Several methods were used in the past by positioning distributed sources injecting reactive power, such as capacitor banks, to boost voltage and reduce power losses. Despite the fact that the placement of the capacitor is promising, the voltage profile improvement gained falls short of the target voltage level. Incorporating electrical sources based on renewable energy technology has been proposed for many solutions recently to address RDS's passiveness as well as to increase system dependability and voltage profile. Distributed or Dispersed Generation is the name given to these embedded generations in RDS (DG). Local generation at or close to the load center is referred to as a distributed generation unit in corporate. The encouragement of producing electrical power from renewable energy sources like solar, tidal waves, and wind is the result of the keen interest in all potential energy sources from which it can be generated. Studies on the integration of dispersed generation to the power grid have significantly grown recently as a result of the growing interest in renewable energy sources.

1.2. Literature survey:

Voltage instability in distribution systems, also known as load instability in the distribution system, has been recognized for a long time [1]. For instance, in 1997, the S/SE Brazilian system experienced a significant collapse due to a voltage instability issue in the distribution network that expanded to the related transmission system [2]. The demand for load in distributed networks keeps rising as the economy develops. As a result, the voltage instability limitations are being approached more closely by the distribution networks. One of the key constraints limiting the rise in load served by distribution firms is the declining voltage stability margin [3]. As a result, voltage stability must be taken into account when DG units are integrated into distribution systems. The impact of DG unit location and size on distribution network voltage stability enhancement was also looked into in [4]. The DG units were distributed and sized in order to reduce overall cost. The voltage stability should be taken into account as an objective function when determining the best site for DG units, according to this research [4]. Recently, approaches to locate distributed generation units were proposed in the work in [5] and [6] to enhance the voltage profile and voltage stability of a distribution system. In [5], the author installed DG units at the buses that were most susceptible to voltage collapse, which improved the voltage profile and decreased power losses. In order to maximize the load ability conditions in both regular and emergency circumstances, the author of [6] created the work in [5]. The algorithm for mixed integer nonlinear programming is taken from [7]. In order to increase the voltage stability margin, it begins by choosing potential buses into which to insert DG units. Then, take into account the probabilistic character of both the renewable DG units and the load when modelling the load and DG generation. Then, in order to increase the stability margin, placement and sizing are formulated using mixed integer nonlinear programming (MINLP). The MW distance between the operating point and the critical point can be used to establish the stability margin. The algorithm for bacterial foraging optimization is taken from [8]. When comparing the results obtained with and without a Jacobian matrix, a nearly undetectable inaccuracy was found [9].

II. DISTRIBUTED GENERATION

2.1. INTRODUCTION:

One of the emerging power system trends being employed to meet the rising energy demand is distributed generation (dg). Due to the scarcity of fuel supplies and the need to satisfy rising energy needs, alternatives to conventional power plants have received considerable emphasis in recent years. As a result, the use of renewable energy sources is seen as a better option than the use of current fuels. The size of generators powered by renewable energy is minimal when compared to massive fossil fuel-based power plants. They are suitable for rds with low voltage. Power sources with direct connections to client sites or distribution networks are referred to as dispersed generation. In order to meet consumers' rapidly rising energy demands, distributed generation, or dg, refers to the production of electricity inside a dispersed network. Dg may be seen of as small-scale power generation that can be directly linked to a distribution network in order to meet customer energy demands. The international energy agency (IEA) defines distributed generation (DG) as "The generating plant servicing a customer on-site or providing assistance to a distribution network, linked to the grid at dispersed level voltages," depending on its location and rating. Several dg technologies are now in use; however, they are mostly dependent on finite fossil fuels including coal, oil, and natural gas. On the other hand, dg that is based on renewable energy sources like solar and wind comprises of generating units. The majority of the advantages of

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utilizing dg in already-existing distribution networks are interconnected and have both technical and economic ramifications. Even if all of the advantages may be measured in terms of money, some of them are more strongly technological than others. Therefore, it is suggested that the advantages be divided into two categories: technological and economic.
These are the main technological advantages:
• reduced line losses;
• a better voltage profile;
• decreased pollution emissions;
• improved all-around energy effectiveness.

2.2. Need for distributed generation

The majority of the electricity in industrialized nations is currently produced in massive, centralized facilities like coal power plants, nuclear reactors, hydropower plants, or gas-powered plants. Although these facilities often transport power across large distances, they have significant economies of scale. Coal plants take this action to stop urban pollution. Cities are not regarded to be safe places for nuclear reactors. Dam locations are frequently both dangerous and purposefully far from cities. It is frequently believed that the coal and nuclear power facilities are too far away to utilize their waste heat for heating structures. Energy demand, namely in terms of dependability, voltage, intermittent loads, and unexpected supply outages, is the fundamental issue that many sectors are dealing with. The architecture of the central electrical supply was created to handle simultaneous system disruptions as well as an aggregate of escalating, regionally and chronologically diversified peak loads. With this design, utilities are required to maintain and develop a generating, bulk transmission, and local transmission & distribution (T&D) infrastructure that is substantially underutilized.

III. BACTERIAL FORAGING OPTIMIZATION ALGORITHM

New to the family of nature-inspired optimization algorithms is Passion’s Bacteria Foraging Optimization Algorithm (BFOA). The field of optimization algorithms has been dominated for more than 50 years by algorithms like Genetic Algorithms (gas), Evolutionary Programming (EP), and Evolutionary Strategies (ES), which are influenced by natural selection and evolution. Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO), which are inspired by natural swarms, have recently made their way into this field and demonstrated their efficacy. The core concept of this method is the use of the group foraging behavior of a swarm of E. Coli bacteria in multi-optimal function optimization**.** Because animals with bad foraging habits are culled, while successful ones have a propensity to procreate. As a result, for an animal or group of animals to survive, its foraging ability must be at its best. Bacteria, which use chemical sensing organs to sense the concentration of nutritive compounds in their surroundings, are some of the most effective foragers. Bacteria look for nutrients to get the most energy possible in a given amount of time. Each bacteria sends signals to other bacterium to communicate. After taking into account the two earlier considerations, a bacterium makes foraging decisions. Chemotaxis is the term describing the action of a bacterium moving slowly while in quest of nutrition, and the core concept of BFOA is to simulate the chemotactic movement of hypothetical bacteria in the problem-solving environment.
The foraging strategy is explained by four processes

A: Chemotaxis, B: Swarming, C: Reproduction, D: Elimination and Dispersal

A. Chemotaxis:

The properties of bacterial movement in search of nourishment are called chemotaxis processes. A E. coli bacteria can migrate in one of two ways biologically. These two methods are swimming and tumbling. If a bacterium goes in a specific way, it is considered to be "swimming," and if it moves in a completely other direction, it is said to be "tumbling." The process of swimming and tumbling is depicted in the following figure. After the fall, if the bacteria's health gets better, they'll keep swimming in the same direction for the designated number of steps or until their health gets worse. The crucial part of this step is the algorithm for optimizing bacterial foraging. The swimming and tumbling processes are shown in figures 2 and 3 above.

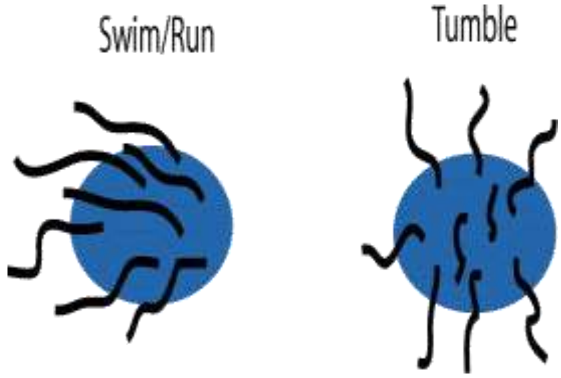

Fig 3.1. swimming and tumbling process

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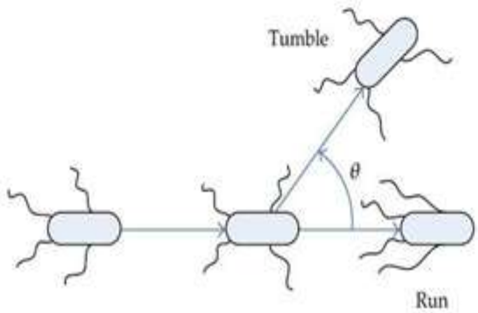

Fig 3.2 swim (run) and tumble of a bacteria.

B. Swarming:

E. coli and S. typhimurium are two motile species of bacteria that exhibit an intriguing group behavior where complex and persistent spatial-temporal patterns (swarms) emerge in semisolid nutritional media. When put in a semisolid matrix containing a single nutrition chemo-effecter, a group of E. coli cells organize themselves in a travelling ring by travelling up the nutrient gradient. When activated by a high succinate concentration, the cells produce an attractant called aspartate. This aids in their grouping and movement as circular patterns of swarms with a high bacterial density. i.e., healthy bacteria attempt to draw in other bacteria so that they can more quickly get at the intended place (solution point) while working together. Swarming has the effect of causing the bacteria to gather into groups and move in patterns with a high bacterial density.

C. Reproduction:

The population members who have received enough nutrients will multiply at this stage, while the bacteria with the worst health will perish. Due to their inferior foraging skills, the healthier half of the population replaces the other half of bacteria that are destroyed. As a result, the number of bacteria remains stable during the course of evolution.

The reproduction procedure is depicted in the accompanying figure.

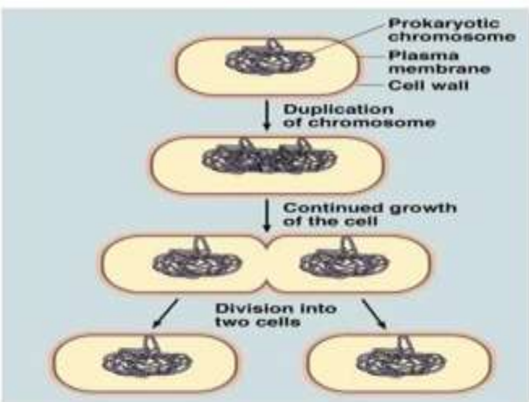

Fig 3.3. Reproduction process

The healthier bacteria asexually divide into two bacteria, which are then implanted in the same area, as can be seen in the above figure.

D. Elimination and Dispersal

A bacterial population's local habitat may change gradually or suddenly for a variety of reasons. For instance, a major local temperature increase may kill a group of bacteria that are currently in an area with a lot of nutritional gradients. Events may unfold in such a way that they eliminate all the bacteria in a particular area or disperse a population into a different area. In order to imitate this behaviour in BFOA, certain bacteria are randomly eliminated with a very low probability, while fresh replacements are initialised at random over the search space.

The illustration of the BFOA is explained in the above graphic.

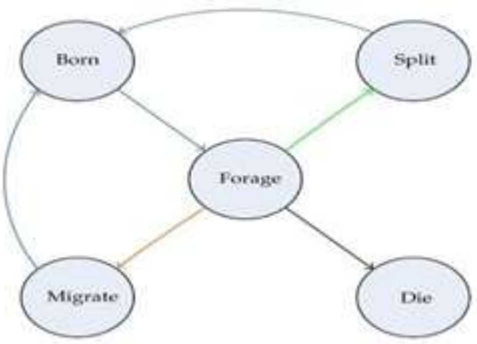

Fig 3.5 Bacterial foraging optimization algorithm

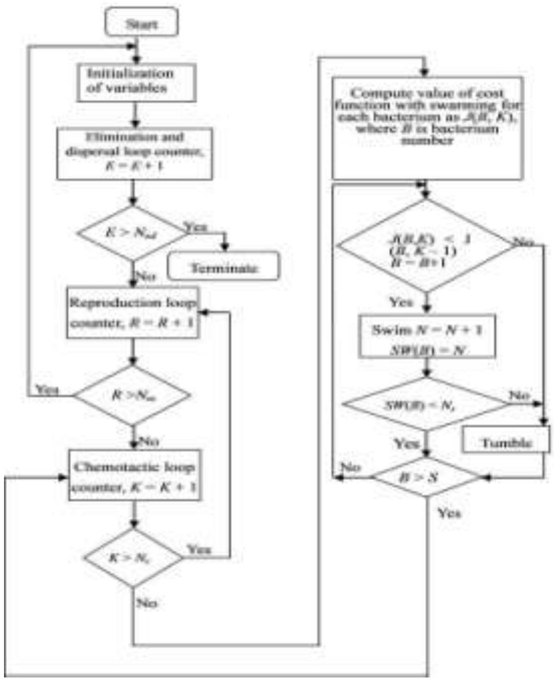

Fig 3.4. flow chart of BFOA

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IV. RESULTS

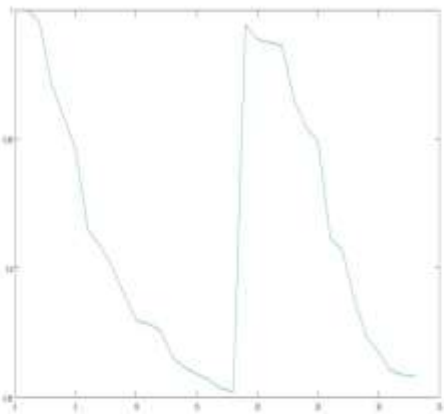

Fig4.1: Power Loss (before and after placement of DG) for 41-bus system

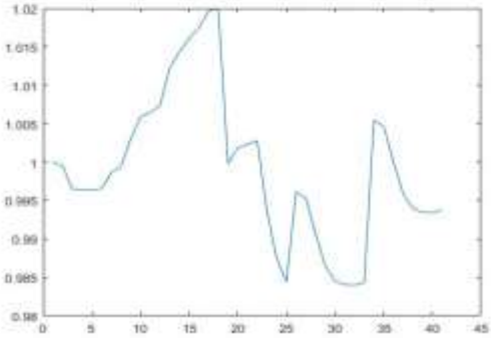

Fig4.2: Voltage profile (before and after placement of DG) for 41-bus system

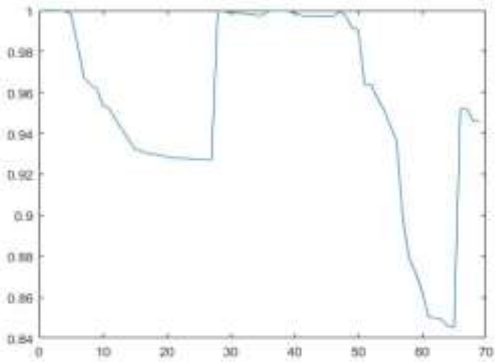

Fig4.3: Power Loss (before and after placement of DG) for 69-bus system.

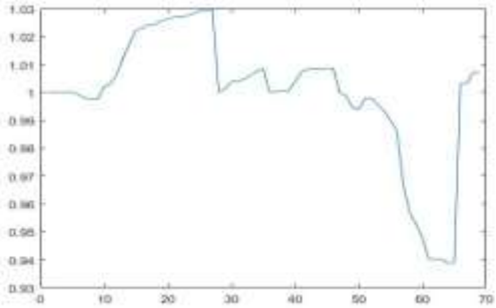

Fig4.4: Voltage profile (before and after placement of DG) for 69-bus system.

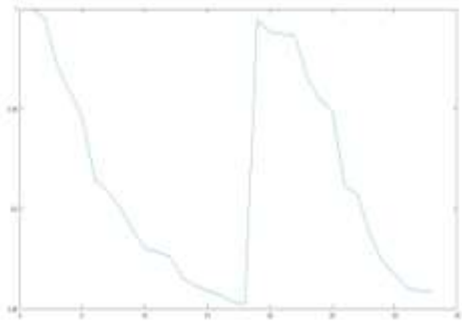

Fig4.5: Power Loss (before and after placement of DG) for 33-bus system.

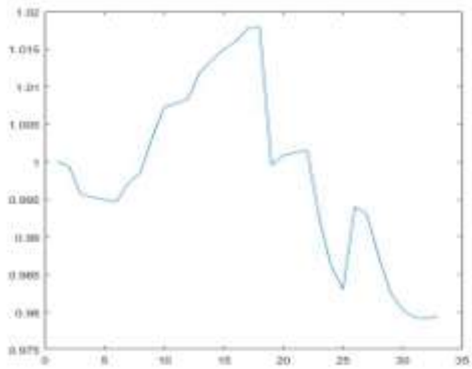

Fig4.6: Voltage profile (before and after placement of DG) for 33-bus system.

V. CONCLUSION:

The best placement strategies for DG units in distribution systems are examined in this research. With the help of the 33, 41, and 66-bus systems, the effectiveness of the suggested strategy is evaluated. The placement of the DG has a significant impact on the power loss and voltage profile of the system, as may be inferred from the aforementioned case studies. Based on the voltage's sensitivity, potential buses for DG unit installation are chosen. The position and size of the DG can improve the voltage stability margin. Therefore, to fulfil the goal of increasing the voltage stability margin, an optimization method can be utilised to estimate the placements and sizes of the DG units. In this study, we compare the outcomes of bacterial foraging algorithms with mixed integer nonlinear programming.

It is obvious that the outcome is more acceptable when the bacterial algorithm is used. The power loss in a 33-bus system is decreased by applying the BFOA approach from 362.3403 kW to 80.3852 kW, with a loss reduction percentage of 778.15. The power loss in the 41-bus system is decreased by utilising the BFOA approach from 801.0032 kW to 279.2770 kW, with a loss reduction percentage of 65.134. The power loss in a 69-bus system is decreased by adopting the BFOA approach from 405.4470 kW to 195.0641 kW, with a loss reduction percentage of 51.89.

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