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GUI Based Network Reconfiguration System for Loss Minimization in Distribution Network

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Abstract: ***Network reconfiguration is a well-established method for power loss minimization in a complex distribution network. This paper presents a new approach on network reconfiguration based on genetic algorithm. For the same purpose a graphical user interface has been created which allows the operator to select IEEE bus system under consideration, the number of iteration and other vital parameters for the system .the complete system has been built and simulated using Matlab 7.12.***

Keywords: Network reconfiguration, power system, load flow analysis, genetic algorithm, graphical user interface.

1. Introduction

A very significant proportion of the power is consumed in the form of losses at distribution level. Feeder reconfiguration is a very effective and efficient way to decrease the power losses of a given complex distribution system. A usual power distribution system contains several feeders for supplying the power to the consumers' base station. These several localized feeders should be connected in a radial structure to protect and configure a distribution system. Radiality has to be maintained by using proper regulation of the switches which are installed on the distribution system at various points.

The traditional approach to network reconfiguration suggests relocating the switches used in a distribution network while maintaining the Radiality constraints of the system. Our approach focuses on reconfiguration of the entire network and then performing load flow analysis on each configuration and then sending this information to the genetic algorithm for optimization.

2. Past Research Work on Network Reconfiguration

A great amount of work has been done on the study of conventional constant load scheme for feeder reconfiguration problem in the past. The problem of network reconfiguration of the distribution system to minimize loss was first introduced by Merlin and Back [13]. They used a unique branch-and-bound-type optimization technique to accurately determining the minimal loss operating configuration for a given distribution system by the use of a spanning tree structure under a specific load condition. After this particular work a plethora of research work is done in this area. Shirmohammadi and Hong [14] have proposed an efficient and robust heuristic method which was based on solution proposed in [13]. This particular method suffers a shortcoming that the solution was not always optimum. A unique branch exchange concept has beengivenCivanlar [15]. In this unique and distinguished method loss minimization is accomplished by switching with respect to selected pair of switches, one for opening and the another one for closing and thus the system Radiality was maintained. Baran and Wu [16] proposed a very computationally attractive method for reducing loss in distribution system.

It follows the solution approach developed in [15]. Goswami and Basu developed a very computationally intense heuristic algorithm, based on the very concept of optimal flow pattern which based on KVL and KCL equations of the network. Nara [17] introduced for the first time an Artificial intelligence (AI) based effective genetic algorithm technique for solving the feeder reconfiguration problem in radial distribution system. Swarnkar and Gupta [18] developed a computationally efficient meta-heuristic based methodology that utilizes genetic algorithm for obtaining the optimal solution. This particular codification is based on the fundamentals of popular graph theory

3. Genetic Algorithm

Genetic algorithm is a Meta heuristic approach for solving optimization problem. This approach uses an optimum finding approach based on genetic mutation technique. An initial population need to be created that is optimized further by means of cross mutation. This cross mutation then selects and rejects parents on the basis of which new colony is made. The cycle is repeated either endlessly or by fixing the number of iterations for the cycle.

Problems concerning local optimization is solved best using genetic principles .There are several alternatives available for optimizing a fixed problem such as local optimization simulation, parallel processing algorithms , but in cases where number of iterations exceed the bounding of algorithm and complexity issues , genetic algorithm is preferred. Absic flowchart for genetic algorithm has been shown below:-

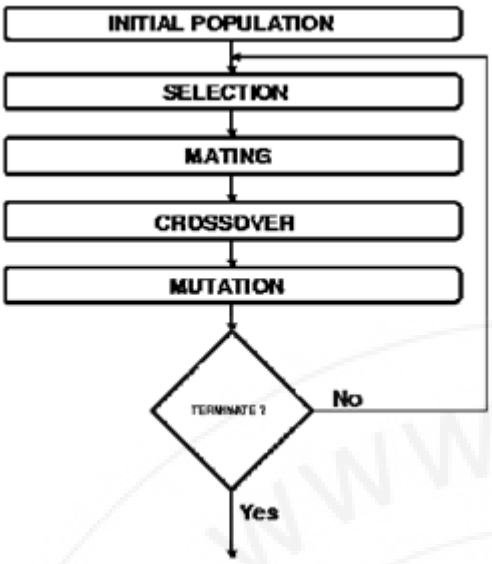

Figure 1: Basic Flow chart for Genetic Algorithm

4. Proposed System

Here we have proposed a network reconfiguration using genetic algorithm. The system works as follows, instead of configuring only switching in the entire distribution network the system instead changes the position of various busses in the system while at the same time maintain the radiality of the system.

Consider for example a six bus system as shown below:-

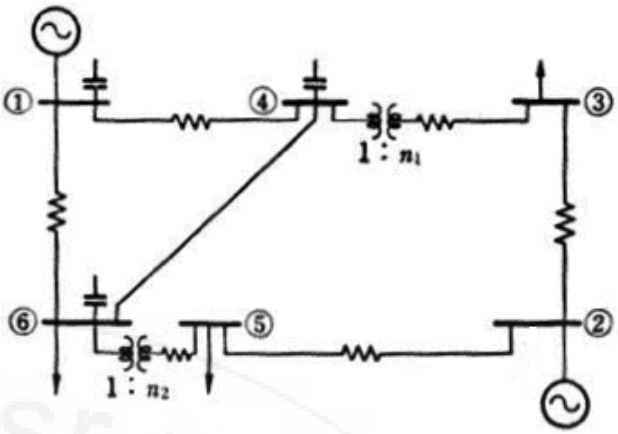

Figure 1: IEEE 6 Bus System

Now in this particular system, earlier research work has been focused on changing position of network switches to improve the efficiency of the system and to reduce the power loss. Our work has been focusing on changing the iteration of buses on the line such that Radiality is maintained and then calculating the power loss. This has been accomplished using genetic algorithm and the optimum function the power loss for a given configuration. A complete graphical user interface has been created that has been shown in the figure given below:-

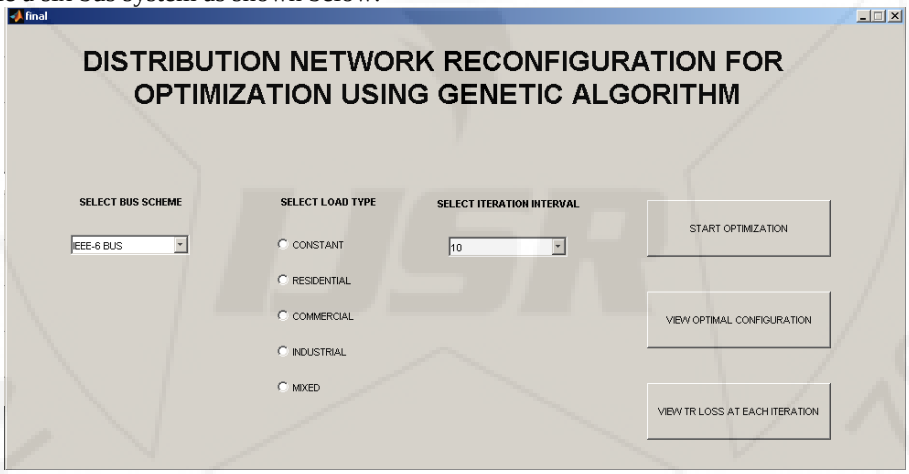

Figure 2: GUI for the proposed system

Now in the above proposed GUI, it has been given the following provisions for the user to select:-

1) Selecting the appropriate bus system for the network under test. The options available for the user are 6 bus, 14 bus, 30 buses and 54 bus system respectively.
2) The user can also select the load type for the network under test. The available load types are constant load, commercial load, industrial load, domestic load and mixed load.
3) After selecting the above parameters the GUI opts the user to select the number of iterations after which the genetic algorithm should start converging. Depending on the bus type and computation power available, tothe user can select the appropriate iteration. Usually it turns out that the larger the number of iteration more optimum is the result.
4) Then finally the GUI has button action group for selecting the optimization start function, graph viewing and finally seeing the optimum configuration after the genetic algorithm has been deployed for the system.

Below is the result for all the systems one by one:-

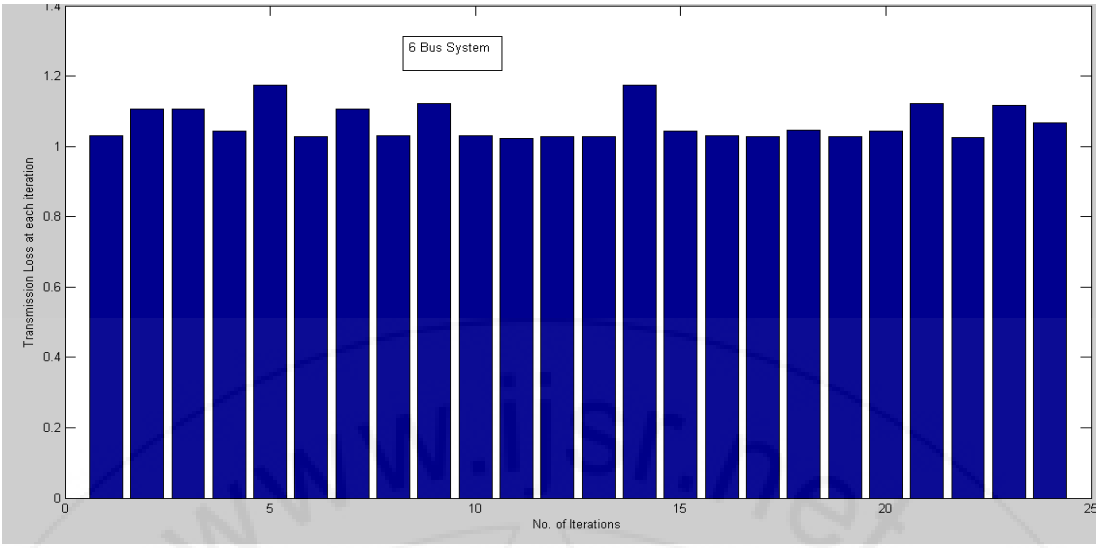

Figure 3: Graph Showing Transmission loss at each iterations taking no of iteration = 30 for a six bus system

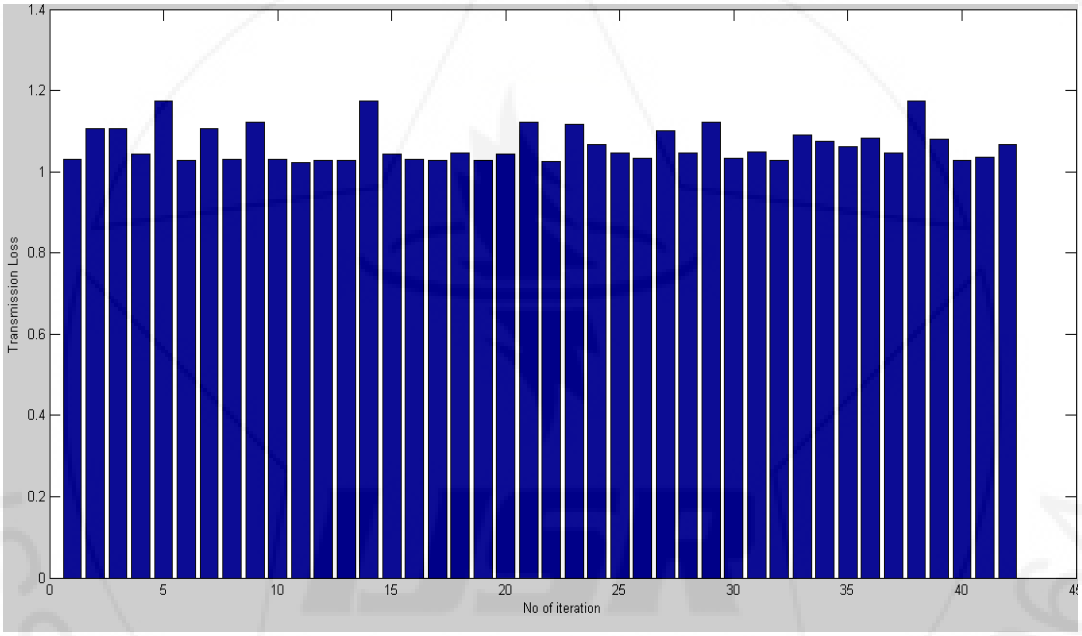

Figure 4: Graph Showing Transmission loss at each iterations taking no of iteration = 50 for a six bus system

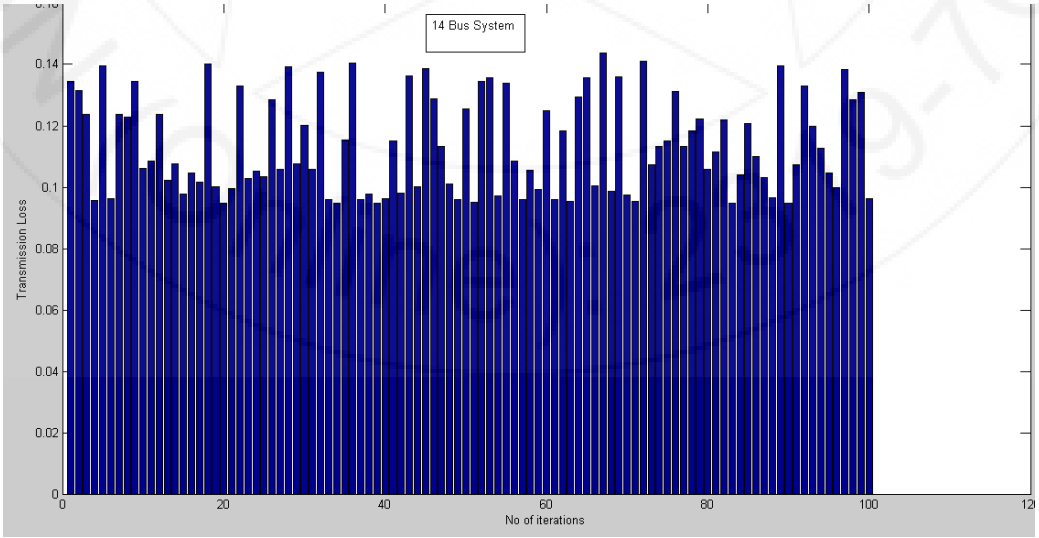

Figure 5: Graph Showing Transmission loss at each iterations taking no of iteration = 100 for a fourteen bus system

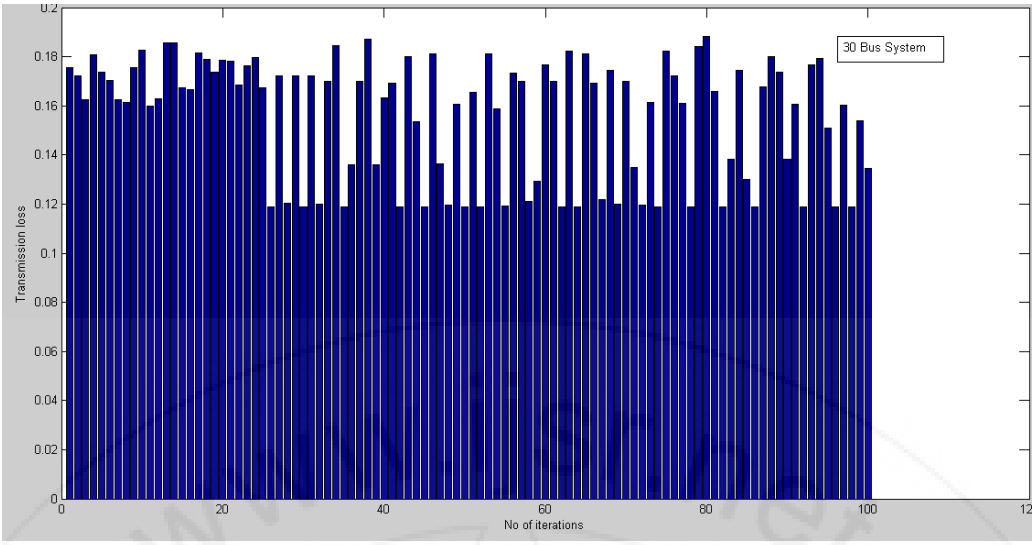

Figure 6: Graph Showing Transmission loss at each iterations taking no of iteration = 100 for a thirty bus system

5. Conclusion

From the simulation results performed using Matlab 7.12, it is quite clear that this approach is better than the earlier work done in this field. But the primary drawback for the said system is that for computing permutations and applying genetic approach for a large bus systems such as 30 and 54, it becomes increasingly difficult for a normal machine and hence the computational requirements levied on the software is much greater than it was expected.

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