Research on Online Data Mining of Smart Grid Reliability Based on Cloud Computing

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Abstract
In this paper, the author researches on the online data mining of smart grid reliability based on cloud computing. All of these scenarios were run separately with each done several times and the algorithm converged to the same solutions at different iterations. The results of each of these cases have shown to be very good. As shown in this research, Genetic Algorithm is more effective in finding the optimum reconfiguration in the shortest possible time as compared to other techniques. The method proposed in this research is very promising and useful in both theoretical and practical situations. It reduces the cost of investment in new installations and operational cost as well as improves the life span of equipment.
Keywords: ONLINE DATA MINING, SMART GRID RELIABILITY, CLOUD COMPUTING

1. Introduction

Distribution systems are the most extensive part of a power network as such they contribute a greater portion of the losses in the system. This is due to low voltage levels in the network. It becomes almost impossible to avoid distribution losses and this contributes a huge strain on the revenue of the distribution company thus making it a major controlling factor when evaluating alternative planning and operational strategy. One major concern of distribution utilities is to reduce them losses in the distribution systems according to the standard level. There are number of factors which influence the level of losses, technical and operational, which include network configuration, load characteristics, substations in service, and power quality required. It is important to manage these factors by appropriate incentives and thus keep the level of losses at the minimum. Losses in distribution networks can be broken down into technical losses and nontechnical losses.

Technical losses are of two kinds: variable losses and fixed losses. Variable to sees (load losses) are proportional to the square of the current that is, depending on the power distributed across the network. They are often referred to as copper losses that occur mainly in lines, cables, and copper parts of transformers. Variable losses can be minimized by increasing the cross sectional (CSA) area of the lines and cables for a given load, reconfiguring the network, (for example, by providing more direct and/or shorter lines to where demand is situated or by altering the network topology through changing the status of switch), managing the demand to reduce the peaks on the distribution network, balancing the loads on three-phase networks, encouraging the customers to improve their power factors and locating the embedded generating units as close as possible to the demand center.

Distribution Feeder Reconfiguration has been a major area of interest by Distribution and Operation Engineers. In the past it has been an important tool for planning and operating an electrical distribution network so that the system can adequately supply reliable power to customers with minimum loss and outage. Many researchers have worked in this area because of its vital role in loss reduction, load balancing and overload elimination, network reliability and security improvement, operational cost reduction, fault isolation, system restoration, etc.

In order to minimize losses in an electrical network, there must be a technique adopted. As a matter of fact there have been many methods used to minimize losses in a distribution system. These methods include increasing conductor size, constructing new feeders, shortening circuit length, adjusting transformer tap, installing capacitors, etc. Feeder reconfiguration is one technique that is used by distribution system operators during normal or emergency operational planning and it has proven to be one very efficient method that reduces system losses.

The primary goal of feeder reconfiguration is to find a radial operating structure to minimize system losses. Other goals include load balance, operational cost reduction, power quality improvement, etc.

Radial Networks lower short circuit current level and are simpler switching and protection equipment as compared to mesh network but they provide lower overall reliability. Considering these in mind and trying to overcome the difficulties, distribution systems are designed as interconnected systems with normally open tie switches and normally closed sectionalizing switches but are always operated as a radial system.

According to graph theory, a distribution network can be represented with a graph of G (N, B) that contains a set of nodes N and a set of branches B. Every node represents either a source node (supply transformer) or a sink node (customer load point); while a branch represents a feeder section that can either be loaded (switch closed) or unloaded (switch open). The network is radial, so that the feeder sections form a set of trees where each sink node is supplied from exactly one source node [1-2].

Therefore, the distribution network reconfiguration (DNRC) problem is to find a radial operating structure that minimizes the system power loss while satisfying operating constraints [3]. By changing the on/off statuses of switches in the system gives a different topology of radial configuration. It then becomes the prerogative of the distribution engineer to minimize the number of switching operations to obtain the best results in terms of reducing the system losses and operational cost as well as balancing the load in the system. In times of fault, the distribution engineer is also tasked with the responsibility to isolate the fault and restore the system by avoiding huge customer outage for a greater period of time.

2. Distribution Networks

Distribution networks are the most extensive part of a power system. They are directly connected to the end users as such provide the greatest fraction of the total system losses. The distribution system typically starts with the distribution substation that is fed by one or more sub-transmission lines. In some cases the distribution substation is fed directly from a high-voltage transmission line, in which case there is likely no sub-transmission system. This varies from company to company. Each distribution substation will serve one or more primary feeders.

With a rare exception, the feeders are radial, which means that there is only one path for power to flow from the distribution substation to the user. A basic power supply system is shown in fig. 1.

Generally, distribution voltages can be classified as primary or secondary distribution voltages. A complete distribution system begins when the primary feeder leaves the distribution substation and terminates when the secondary service enters the customers' premises by way of service drop. The voltage choice depends on the type of load (residential, commercial, industrial), load size, and the distance at which the load is located. Every utility has its own standards in selecting its voltage range. For example, Ghana's primary distribution voltages are 33 kV, 11 kV, 6.6 kV, 433V, and its secondary distribution voltages are 380/220V, 400/230V, 433/240V, while in Liberia, the primary distribution voltage is 22 kV and the secondary distribution voltage is 400/230 V.

The use of higher distribution voltage comes with its associated advantages and disadvantages:

Advantages: The system can carry more power for a given capacity and has less voltage drop and less line losses for a given power flow. Consequently, the system can cover a much wider area. Because of longer reach, the system needs fewer substations [4].

Disadvantages: More customer interruptions because the circuits are longer, that is, less level of reliability. Therefore, a major concern is to keep reliability at the desired level depending on the load category. From the cost point of view, the system equipment (transformers, cables, insulators, etc.) is more expensive.

Distribution Network Reconfiguration is the process of altering the status of switches. Normally, there are two kinds of switches that exist in a distribution

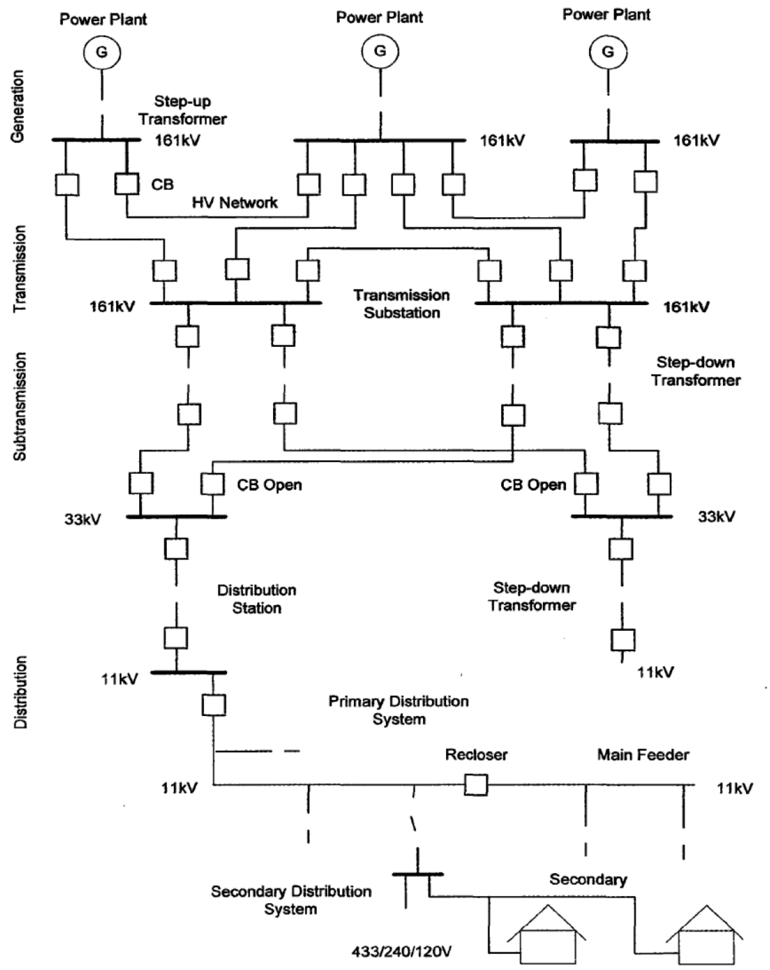

Figure 1. A basic model of power supply system

network; sectionalizing switches and tie switches [5-7]. Distribution networks are reconfigured for different purposes: Loss Reduction, Load Balancing, Operational Cost Reduction, Voltage Deviation, Service Restoration, etc.

Distribution Network Reconfiguration for Service Restoration: focuses on restoring power to outage portions of the network within a very short period of time. This is to ensure that the deficit of power supply to customers is minimized.

Distribution Network Reconfiguration for Operational Cost Reduction is directly linked to the reduction of system losses. The ultimate goal is to find an optimum configuration of the network that gives the minimum loss thereby reducing operational cost.

Distribution Network Reconfiguration for Loss Reduction: focuses on reducing the total system losses. This objective is further discussed in the next section.

Distribution Network Reconfiguration for Load Balancing: focuses on maintaining a minimum load balance to enhance operational efficiency. It is also discussed in the next section.

Distribution network reconfiguration is associated with its own constraints that should not be violated at any stage of the reconfiguration process .The most common constraints are: Electrical Constraint, Operational Constraint, load constraint and topological constraint. These constraints are discussed in the next section. These constraints are very vital in obtaining a very good solution. There are other constraints that may be used depending on the objective of the research. The figure 2 shows the radial distribution network. The power flow calculation is very vital to power system analysts. It provides valuable information for power engineers with the ability to quickly simulate the operation of the system. Several methods such as Newton-Raphson and Fast Decoupled methods have been used but they have proven inefficient for the

Distribution networks: This is due to the high R/X ratio associated with distribution lines. To date several methods of load flow calculation for distribution networks have been developed. Most popular of these methods is the Backward Forward Sweep Method for radial distribution network. In this thesis the Back-

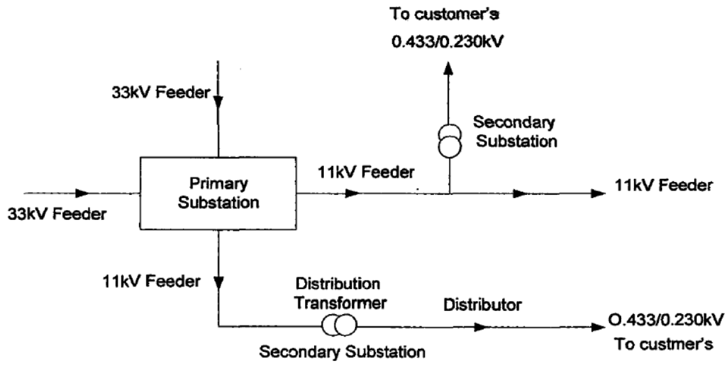

Figure 2. The radial distribution network

ward Forward Sweep method is adopted to solve the load flow.

The distribution network losses make up a greater fraction of the total losses produced in a power network; technical and nontechnical losses. Distribution networks can be constructed as interconnected networks but operated as radial networks.

Distribution networks can be classified as either primary or secondary distribution systems.

Reconfiguration of distribution networks are done for different purposes; popular among these are for loss reduction, load balancing, operational cost reduction and service restoration. The most important constraints in distribution network reconfiguration can be classified as, Electrical Constraint, Operational Constraint, Load Constraint and Topological Constraint.

These are a special load flow technique unique to distribution networks. The Backward Forward Sweep load flow technique is preferred over the other techniques because of the high disparity in the R/X ratio of a distribution Line. Other techniques, in most instances when applied to distribution networks, don't converge to a single solution.

3. Gene Algorithm

Genetic Algorithm is a population based search algorithm. Each individual in the population is a potential solution to the optimization problem. There are different ways one can encode the individuals in a population; fixed string binary, real value, character-based encoding etc. and these individuals are an analogy with an actual chromosome. The initial population is always randomly or heuristically generated.

The GA often involves some basic operators that guide the search to a global optimum. These operators are Selection (recombination), Crossover and mutation.

The selection procedure implements the natural selection or the survival-of-the fittest principle and selects good individuals out of the current population for generating the next population according to the assigned fitness. The existing selection operators can be broadly classified into two classes: (1) proportionate schemes, such as roulette-wheel selection and stochastic universal selection and (2) ordinal schemes, such as tournament selection and truncation selection. Ordinal schemes have grown more and more popular over the recent years, and one of the most popular ordinal selection operators is tournament selection. After selection, crossover and mutation recombine and alter parts of the individuals to generate new solutions.

Mutation is another important operation in genetic algorithm. The GA literature has reflected a growing recognition of the importance of mutation in contrast with viewing it as responsible for reintroducing inadvertently lost gene values. The mutation operator is more important at the final generations when the majority of the individuals present similar quality. A variable mutation rate is very important for the search efficiency. Its setting is much more critical than that of crossover rate. In the case of binary encoding, mutation is carried out by flipping bits at random, with some small probability usually in the range [0.001; 0.05]. For real-valued encoding, the mutation operator can be implemented by random replacement (i.e., replace the value with a random one). Another possibility is to add/subtract (or multiply by) a random (e.g., uniformly or Gaussian distributed) amount. Mutation can also be used as a hill-climbing mechanism.

The good mutation is always kept, while the bad mutation is discarded. Generally, the individual with smaller fitness has a bigger mutation probability. Similar to crossover, there are one point mutation and multipoint mutation.

To be more specific, it is assumed a population be $PL = \{pl_i \mid 1 \le i \le N\}$, where N is the number of individuals. An individual pl_i is composed by gene bits, fitness value (fitness) and potential energy (potential) in algorithms. The potential energy represents the fitness improvement of individual in each generation, that is:

$$pl_i(t)_{potential} = pl_i(t)_{fitness} - pl_i(t-1)_{fitness} \quad (1)$$

Where t represents the evolution iteration.

Based these definition, a new operation called "Potential Detection" was added into IGA and the original crossover and mutation operations are then changed into adaptive. The specific process of the new improved algorithm is given below.

First, to dynamically escape the local convergence in IGA, potential detection operation is applied before selection. In potential detection, the potential energy of each individual is calculated according to Eq. (4). If the potential energy is negative, it indicates that the individual is degenerated in this generation. Then the individual will be regenerated with probability X_p and here is defined as

$$X_p = \exp\left(-A \times pl_i(t)_{fitness} / pl_{best}(t)_{fitness}\right) \quad (2)$$

In the above equation, pl_{best} represents the best individual in population and A is a control parameter. The pseudo code of potential detection operation is shown as follow.

```
Potential_Detection (PL)
for i = 1 : N
if pl_i(t)_potential < 0
 X_p = exp(-A × pl_i(t)_fitness / pl_best(t)_fitness)
Randomly generate 0 < λ < 1
if p > X_p
Regenerate a new pl_tmp(t)
 pl_i(t) = pl_tmp(t)
 pl_i(t)_potential = 0
end if
end if
end for
```

In this operation, X_p changes in every generation. The worse the individual's fitness value, the less X_p is, and then the higher probability of individual regeneration is. Therefore, individuals can be changed according to their own situation. Its time complexity is $O(N)$, which is far lower than niched strategy.

To further balance the diversification and intensification in IGA, a new parameter adaptive strategy is introduced into crossover and mutation based on individual's potential energy. Let X_{cp} and X_{mp} be the crossover probability and the mutation probability respectively. Then X_{cp} and X_{mp} are adaptively changed according to each individual's potential energy in every generation. The pseudo codes of the specific adaptive strategy are listed as follow.

```
for i = 1 : N
 X_cp = 1/(1 + exp(B × pl_i(t)_potential))
 X_mp = 1/(1 + exp(C × pl_i(t)_potential))
if X_cp < 0.5
 X_cp = 0.5
else if X_cp > 1
 X_cp = 1
end if
if X_mp > 0.5
 X_mp = 0.5
end if
Perform crossover operation in probability X_cp
Perform mutation operation in probability X_mp
end for
```

Here, B and C are control parameters of the adaptive strategy. In the new adaptive strategy, $X_{cp} \in [0.5, 1]$ and $X_{mp} \in [0, 0.5]$. When the individual's potential energy is smaller, X_{cp} and X_{mp} become larger to improve the global searching ability of algorithm. If the individual's potential energy is larger, then X_{cp} and X_{mp} become smaller to adapt the local search in algorithm. Compared with the traditional adaptive method [8], it removes the calculation of individuals' average fitness of population in iteration, so the time complexity is a bit lower.

Conclusions

In this paper, the author researches on the online data mining of smart grid reliability based on cloud computing. All of these scenarios were run separately with each done several times and the algorithm converged to the same solutions at different iterations. The primary goal of feeder reconfiguration is to find a radial operating structure to minimize system losses. Other goals include load balance, operational cost reduction, power quality improvement, etc. Radial Networks lower short circuit current level and are simpler switching and protection equipment as compared to mesh network but they provide lower overall reliability. Considering these in mind and trying to overcome the difficulties, distribution systems are designed as interconnected systems with normally open tie switches and normally closed sectionalizing switches but are always operated as a radial system. The results of each of these cases have shown to be very good. As shown in this research, Genetic Algorithm is more effective in finding the optimum reconfiguration in the shortest possible time as compared to other techniques.

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Secondary Prediction Mode Selection Algorithm Applied in Video Coding in wireless transmission system

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Abstract
Aimed at the higher coding efficiency of video compression, this paper proposes a novel concept named "Secondary Prediction" onto the traditional hybrid video coding scheme. To achieve higher efficiency of predictive coding, "Secondary Prediction" combins multiple high efficient prediction techniques together, thus enables a kind of spatio-temporal three-dimensional prediction into the hybrid coding scheme and can benefit from latest developments of both infra-prediction and inter-prediction technique.
Keywords: WIRELESS TRANSMISSION SYSTEM, MODE SELECTION ALGORITHM, VIDEO CODING