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A Modified Optimal Electricity Distribution Algorithm for Xyz Electricity Distribution Zone

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ABSTRACT

In this paper, an optimal electricity distribution algorithm was improved by incorporating the time of the day electricity energy is supplied to the districts of the XYZ distribution zone. The electricity distribution improved is computational more efficient over the earlier distribution algorithm developed from an optimal electricity allocation model (OEAM) for efficient energy consumption. This was done by considering the optimal electricity results generated by the application of the OEAM model on the data obtained from the XYZ electricity distribution company and PQR transmission station as well as the analysis of the complexity of the algorithm. The electricity distribution algorithm aims at optimizing the scare amount of electricity energy transmitted to the various districts of the XYZ electricity distribution zone. The improved algorithm is of order $\Theta(n)$ while the former algorithm is of order $O(n^2)$. Quadratic algorithm increases rapidly as the dimension of the problem grows The algorithm improved could allow for planning by customers since the time of day is considered in its development. The improved algorithm developed was implemented using Java programming language on the JDK 1.7 platform.

Keywords: Algorithm, Efficiency, Order and Complexity.

INTRODUCTION

Supply of sufficient, consistent and economically priced power supply is very important for the socio-economic growth and development of any nation. It is observed that the gross domestic product (GDP) increase rate of a nation is proportional to the growth in the per capita electricity utilization [1].

The enhancement of several sectors of the economy of any country namely industry and commerce, agriculture, health, education, information, banking, tourism, etc relies greatly on consistent, sufficient and economically priced power.

However, in hurriedly developing economies where electricity is inadequate compared to the increasing load demand from consumers, and the load demand is already in excess of what the generators can produce, generator operators have adopted methods to save the power plants from damage which has in turn affected the quality and quantity of electric energy supplied to customers [1].

In [1], they argued that in certain instances with the comprehension of the system, certain load distribution and allocation patterns are employed. These approaches have led to poor quality of electricity reaching the consumers as well as no definite pattern of electricity distribution is recognizable.

In an earlier paper an algorithm which is similar in all respect except for the time of the day was presented. The modified energy distribution algorithm would facilitate the effective utilization of the scare resource (electricity) in XYZ electricity distribution zone by considering the time of the day. The pattern to optimally distribute the available electricity supply to the various districts of the XYZ electricity distribution zone will be recognize which will improve the economy of Nigeria is hereby presented.

PROBLEM DESCRIPTION

Nigeria a developing economy is faced with problems of feeble and aged electricity infrastructure; poor transmission and transformation capacity at 330KV and 132KV voltage levels; insufficient fortified systems; insufficient control and communication system; old and outdated switchgear and protection equipment; damaged lines and substations; filled to capacity distribution transformers; deficient raw materials for Power plants; lack of power supply and proper preservation culture; effect of vandalization; unplanned Network etc [1].

The problem of increasing energy demand by consumers has increased urgency in building new power plants by Independent Power Producers (IPPs) and the upgrading of the existing power plants by Power Holding Company of Nigeria (PHCN) Plc due to the socio-economic importance of electricity in the country.

The abovementioned causes amongst others, militate against providing high-quality uninterrupted electricity to the consumers can be minimize if consistent load distribution patterns are adopted in which voltages that reaches the consumers are utilizable and not brown outs. In view of the inadequate electricity supply in Nigeria, an optimal electricity distribution algorithm earlier developed is hereby modified by incorporating time of the day which consumers not only obtain utilizable voltage but can forecast the pattern of the electricity distribution which will enable the consumers to plan adequately.

REVIEW OF ENERGY ALGORITHMS

Comprehending the virtual efficiencies of algorithms planned to perform the same job is of much more than academic interest. In manufacturing industries and technical environments, the option of an efficient over a non efficient program can save many thousands of dollars or the choice of being able to undertake a project or not to execute the project if necessary at all.

Two characteristic of algorithm efficiency are significant: the amount of time needed to execute the algorithm and the amount of memory space required when it is run. Sporadically, one algorithm makes extra efficient utilization of memory space than another, forcing a trade-off that depends on the resources available to the consumer.

With the emergence of distributed generators (DGs) into the electricity distribution systems, there is the rising requirement to comprehend and quantify their values on distribution systems such as voltage, reliability, energy quality, etc. In [2] a novel power flow algorithm was presented based on the equivalent current injection technique. They claimed that the algorithm have been tested on the IEEE 90-bus by adding different DGs. The test consequences show the validity, robustness, and outstanding computational efficiency of the algorithm in getting a good enough feasible solution to radial distribution system with multi-sources. However, there was no analysis of the algorithm complexity and it did not consider where energy is in short supply

Proceeding to this present era of privatization and commercialization, attempt towards energy costing was geared towards assigning cost only to production and sharing subdivisions. In light of the present inclination of transformation of the energy sectors in several part of the world there is now the straight requirement for the provision of fair and effective machinery for suitable pricing of all units in the energy industry that is production, delivery and sharing.

[3] developed a novel transmission pricing algorithm using Bialek's Tracing Model. The algorithm was use for pricing electricity units consumed and not efficient allocation of scare electricity amongst competing districts nor was it analyzed to know its complexity.

In [4] a new technique for the assessment of loss modification factors for sharing systems was described. Such factors are required for 'use of system' and wheeling computations and mirror the quantity by which purchases of power at entrance points to the system must go beyond utilization at the point of use to explain for the losses which happen in between. Renewed attention in cost-reflective techniques of charging for losses has consequences from the deregulation of the electric energy supplied to industry in several parts of the world. An algorithm is illustrated which merges the use of graph theory with enthusiastically obtainable load flow results, to allocate the losses in every line or transformer within the system to the customers supplied by it. The resulting share is shown to account for the voltage level, position and utilization design of the customer in a way which is cost-effectively efficient. A diversity of approach for allocating losses between many customers at a given position can be put into practice. The algorithm is suitable for allocating both demand and energy losses. The algorithm modified is for allocating sufficient and insufficient energy transmitted.

In this paper, an optimal electricity distribution algorithm was improved based on an earlier electricity distribution algorithm developed by Aminu et al. (2013) from an optimal electricity allocation model (OEAM) for efficient energy consumption. This was done by considering the optimal electricity results generated by the application of the OEAM model on the data obtained from the XYZ electricity distribution company and PQR transmission station. The electricity distribution algorithm optimizes the amount of energy to be delivered to various business units of the XYZ electricity distribution company based on the amount of electricity received by the XYZ electricity distribution zone and the time of day. The algorithm improved was implemented using Java programming language on the JDK 1.7 platform.

The Energy Distribution Algorithm

An algorithm illustrates the way a problem is solved by a step by step action that need to be taken and the order of their execution Liang (2013). The earlier algorithm developed in figure1 inputs the energy delivered (E) to XYZ electricity distribution zone, and the time (t_0) for the anticipated period electricity is to be utilized. When energy delivered is sufficient it is distributed to all districts. Districts with energy requirement less than or equal the amount of insufficient energy delivered to XYZ electricity distribution company will be selected for distribution if time t_2 of energy utilized is equivalent for all the districts. On the other hand, districts with least time t_2 for energy already utilized and the sum total of energy requirement for the districts less than or equal the amount of inadequate energy delivered will be selected for distribution. In any possible scenario, the algorithm indicated the selected districts and records the current date, start-time, end-time and the time for each district that energy was utilized.

Figure1. Electricity Distribution Algorithm

```
Algorithm:  Distribute Energy to n districts for period t0
Input:       Amount of Energy E and period t0
Output:     distribute E to districts

      Main () {
            get Energy (E, t0);
             If (Energy E is sufficient for all districts n)
                  distributeEnergyToAll (t0)
                  indicate Districts All ()
            else
                  t2 = checkTimeUtilizedForAllDistricts ()
                  If (t2 is the same for all districts)
                     districts = districts with energy requirement <= E
                     distributeEnergy (districts, t0)
                     IndicateDistricts (districts)
            Else
                  districts = = districts with least t2 and energy requirement <=E
                  distributeEnergy(districts, t0)
                  IndicateDistricts (districts)
                              Record (Date, start time, end time, time utilized)
       }
```

This algorithm accepts as inputs Energy and Time, and output as Electricity to various districts of XYZ distribution

The Modified Energy Distribution Algorithm

An algorithm is a well-defined list of steps for solving a particular problem. This algorithm determines the time of the day, morning, afternoon evening or night. Inputs the energy delivered (E) to XYZ electricity distribution zone, and the time (t_0) for the period to be utilize; sum the times (t_2) of the energy previously utilized, indicates the districts to be given electricity and records the current date, start-time, end-time, and time (t_1) for the period energy was actually utilized.

Figure2. Modified Electricity Distribution Algorithm

```
Algorithm: Distribute Energy to n districts for period t0
Input:  Time of Day t1, Amount of Energy E and period t0
Output: Distribution E to districts
        Main () {
              get Energy (E, to);
               if (Energy is Sufficient for all districts n)
                 Distribute Energy to All (t0)
                 Indicate District All ()
Else
                 t2 = Check time Utilised for AllDistrict  and time of day t1 ()
                 if ( t2 is same for all districts)
                 Districts ==districts o f first priority of time of day with Energy requirement<=
                 Distribute Energy (districts, t0)
                 IndicateDistricts (districts)

Else
                 Districts==districts with least t2 and Energy requirement <=E
                 Distribute Energy (districts, t0)
                 IndicateDistricts (districts)
                 Record (Date start time, end time, time utilized)
}
```

This algorithm accepts as inputs Energy, Time of day and Time for the distribution of energy, and output as Electricity to various districts of XYZ distribution

Theorem: Polynomial orders

Suppose $a_0, a_1, a_2, \ldots, a_n$ are real numbers and $a_n \neq 0$.

$$1.\ a_n x^n + a_{n-1}x^{n-1} + \cdots + a_1 x + a_0 \text{ is } O(x^s) \text{ for all integers } s \geq n.$$

$$2.\ a_n x^n + a_{n-1}x^{n-1} + \cdots + a_1 x + a_0 \text{ is } \Omega(x^r) \text{ for all integers } r \leq n. \qquad (1)$$

$$3.\ a_n x^n + a_{n-1}x^{n-1} + \cdots + a_1 x + a_0 \text{ is } \Theta(x^n)$$ [5].

Algorithm Analysis of the Modified Energy Distribution Algorithm

In predicting the performance of two or more algorithms their analysis is of paramount importance in computer science. Several jobs run at the same time on a computer and the implementation time depends on definite inputs. The execution time of some algorithms implemented on the same job might be the same; but to solve this problem a theoretical technique has been developed to analyze algorithms autonomously of computers and specific input. This is accomplished by approximating the effect of a change on the size of the input that is the growth rate of the algorithms [6] and the complexity of an algorithm is the function which gives the running time of the worst case in respect to specific input size [7].

1. Computing an Order of sum of time utilized t_2 nested loop segment. There are n additions for each loop. Therefore there are $13n$ additions for all the districts; by algorithm orders $13n$ *is* $\Theta(n)$ and so this algorithm segment *is* $\Theta(n)$.

2. The time complexity function $T(n)$ of the comparism of the time utilized t_2 when it is equal for all districts is: $T(n) = n - 1$

3. The time complexity function $T(n)$ of the worst case for the comparism of the time utilized t_2 when it is not equal for all districts: Worst case: $T(n) = n - 1$

4. The time complexity function $T(n)$ of the worst case for the distribution of electricity to districts where t_2 is equal for all districts and energy requirement less or equal to E.

   Worst case: $T(n) = 13(n)$

5. The complexity function $T(n)$ of the worst case for the distribution of electricity to districts where t_2 is not equal for all districts and energy requirement less or equal to E.

   Worst case: $T(n) = 13(n)$

CONCLUSION

In this paper, an improvement was made on the previous algorithm with only a significant difference in the order of time utilised t_2 nested loop segment. In the modified algorithm the order of time utilised *is* $\Theta(n)$ as compared to $O(n^2)$ that is a quadratic time algorithm in the time complexity earlier computed from the algorithm developed. Quadratic algorithm increases rapidly as the dimension of the problem grows. In a quadratic algorithm when the input size double, the time is quadrupled [6]. Consequently, the modified algorithm has a computational advantage over the earlier distribution algorithm.

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