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An Improved Optimal Electricity Distribution Algorithm for Xyz Electricity Distribution Zone

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ABSTRACT

An improved energy distribution algorithm is hereby presented by incorporating time of the day, morning, afternoon, evening or night that electricity energy is supplied to the districts of XYZ distribution zone. The earlier algorithms were developed based on an existing energy allocation model (OEAM) meant for effective utilization of energy. This improved algorithm is developed based on the current energy requirement forecasted by the application of the OEAM and the current minimum energy delivered to the districts of XYZ electricity distribution zone. The districts are grouped into four due to slight increase in the quantity of electricity supply to the zone. The energy distribution algorithm seeks to optimize the slightly improved amount of electricity energy transmitted to the various districts of the XYZ electricity distribution zone. The improved algorithm could allow better and improved power supply to consumers since the districts have been grouped considering the minimal amount of electricity energy delivered to the distribution zone.

Keywords: Algorithm, Efficiency, Order and Complexity.

INTRODUCTION

The low and inadequate electricity supply in Northern Nigeria amongst other factors is responsible for the collapse of most industries and lack of meaningful technological growth and development in that part of the country. This has led to the problems of unemployment, inflation, underdevelopment, insecurity, poor standard of living, etc. With the increase in population, there is also the increase in houses, schools, hospitals and other social amenities that have direct as well as indirect bearing on power consumption.

The delivery of adequate, steady and cost-effective electricity distribution is vital for the social and profitable growth and development of any country. The gross domestic product (GDP) has a positive correlation with the per capita power utilization [1], [2].

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

Nevertheless, in hastily developing economies where electricity energy is in short supply in comparison to the increasing load demand from consumers. Generator operators have adopted several methods to save the power plants from damage which has in turn affected the quality and quantity of electric energy supplied to customers [1],[2].

[1], have argued that in certain instances with the understanding of the system, some load distribution and allocation patterns are engaged. These methods have led to deprived quality electricity reaching the customers and no definite pattern of electricity distribution is recognizable.

[1], [2] presented algorithms which are similar in all respect to the improved algorithm presented here except for non grouping of the districts into four groups. The improved energy distribution algorithm presented here would facilitate the effective utilization of the scarce resource (electricity) in XYZ electricity distribution zone by considering time of the day, morning, afternoon, evening or night. XYZ is an electricity distribution zone consisting of 13 electricity distribution companies saddled with the responsibility of distributing electricity to customers and billing customer populations in the North West zone of Nigeria at the time of the research. The recognition of the pattern of electricity distributed to consumers in the various districts of XYZ distribution zone will be known thereby allowing for proper planning. This in turn will enhance the economy of Nigeria. This paper discusses the improved electricity distribution algorithm for better electricity distribution in the XYZ electricity distribution zone. The problems associated with the electricity industry in Nigeria and how these problems affects development in Northern Nigeria is discussed in section two. In section three the review of relevant literature of energy algorithms was made and a table of the forecasted energy for 2015 for each district is shown. The earlier energy distribution algorithms are presented in section four. In section five, the improved energy distribution algorithm is presented and a sample of the database for energy distribution is shown. The complexity analysis of the improved algorithm is presented in section six. In the concluding remarks, the improved algorithm was found to be *still* $\Theta(n)$

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PROBLEM DESCRIPTION

Nigeria as a developing economy is faced with the problems of: feeble and aged electricity infrastructure; poor transmission and transformation capacity at three hundred and thirty kilovolts and one hundred and thirty two kilovolts 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 among others [1],[2].

The increased in population has translated to the increase in small and large scale industries which have raised the level of electricity demand in the country. The rise in energy demand has equally resulted in the improvement of the existing energy plants and the construction of new energy plants. The above causes amongst others militate against the provision of high-quality uninterrupted electricity to the consumers. In view of the inadequate electricity supply in Nigeria, optimal electricity distribution algorithms earlier developed are hereby improved by incorporating time of the day, morning, afternoon, evening or night which consumers not only obtain utilizable voltage but can also forecast the pattern of the electricity distribution which will enable them to plan adequately.

REVIEW OF ENERGY ALGORITHMS

Understanding the efficiencies of algorithms is beyond academic importance. The choice of efficient software and non-efficient software in production industries and scientific environment can save a lot of money. The choice made could allow a decision to be taken on whether to execute a project or not. Two uniqueness of algorithm efficiency are noteworthy: the quantity of time desired to execute the algorithm and the quantity of memory room required when it is run. Some algorithms make efficient use of memory space than the others, compelling a trade-off that relies on the availability of resources to the client.

There is an increase necessity to understand and calculate the values of voltage, reliability, quality of energy, etc, in distributed generators due to their appearance in the electricity distribution systems.

In [3], a new energy distribution algorithm was presented based on the equivalent current introduction method. They claimed that the algorithm has been tested on the IEEE 90-bus by adding different DGs. The test results reveal the validity, robustness, and excellent computational competence of the algorithm in getting sufficient practicable solution to radial distribution system with several sources. However, it did not consider where energy is inadequate.

[4] developed a new transmission pricing algorithm using Bialek's Tracing Model. The algorithm has been used for pricing electricity units consumed. However, it was not for efficient allocation of scare electricity amongst competing districts.

In [5], a new method for the evaluation of loss amendment factors for sharing systems was described. Such factors are necessary for 'use of system' and wheeling calculations and mirror the quantity by which acquisitions of power at entry points to the system must go further than utilization at the point of use to clarify for the losses which happen in between. Renewed interest in cost-reflective methods of charging for losses has penalty from the deregulation of the electric energy supplied to industry in several parts of the world. An algorithm is illustrated which combines the utilization of graph theory with earnestly available load flow results, to assign the losses in every line or transformer within the system to the clients supplied by it. The resultant share is shown to account for the voltage level, position and utilization design of the customer in a way that is cost-effectively and efficient. A variety of method for allocating losses between many consumers at a given position can be put into practice as the algorithm is suitable for allocating both demand and energy losses. The algorithm improved is for allocating sufficient and insufficient electricity energy transmitted.

In this paper, an optimal electricity distribution algorithm was improved based on an earlier electricity distribution algorithms developed by [1], [2] and by the current energy requirement forecasted in [6] from an optimal electricity allocation model (OEAM) for efficient energy consumption. 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 forecasted electricity energy for 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.

TABLE 1: Forecasted Electricity Energyfor the XYZ Districts in KWh

DISTRICTS	ENERGY/MONTH
X1	16,031,016.54
X2	15,433,839.43
X3	19,891,215.75
X4	10,947,473.94
X5	12,075,732.82
X6	14,011,050.48
X7	23,635,458.24
X8	6,517,927.23
X9	4,406,355.36
X10	20,653,051.40
X11	14,215,134.30
X12	12,115,158.11
X13	10,300,435.44

TABLE 2: Energy in KWh obtained by the OEAM Model

DISTRICTS	ENERGY /MONTH
X1	9,954,000
X2	9,583,200
X3	12,350,880
X4	6,797,520
X5	7,498,080
X6	8,699,760
X7	14,675,760
X8	4,047,120
X9	2,736,000
X10	12,823,920
X11	8,826,480
X12	7,522,560
X13	6,395,760

Tables 1 and 2 are the forecasted energy for 2015 and the energy obtained by the OEAM respectively. Source [6].

The Earlier Algorithms for energy distribution

An algorithm is the list of procedures in solving a problem [7]. The earlier algorithms in [1], [2] 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. However, when energy delivered is inadequate, districts with energy requirement less than or equal to the amount of insufficient energy delivered to XYZ electricity distribution company will be selected for distribution of electricity if the time t_2 of energy utilized is equal for all the districts. On the other hand, if the time t_2 for energy utilized by the districts is not the same, then districts with least time t_2 for energy already utilized and the sum total of energy requirement for the districts is less than or equal the amount of inadequate energy delivered will be selected for distribution. In any possible scenario, the algorithm indicates the selected districts and records the current date, start-time, end-time and the time for each district that energy was utilized.

The Improved Energy Distribution Algorithm

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 by each of the grouped districts, indicates the districts group to be given electricity and records the current date, start-time, end-time, and time (t_1) for the period energy was actually utilized.

The Algorithm

Algorithm: Distribute Energy to four groups of districts for t_0

Input: Time of day t_2, Amount of Energy E and period t_0

Output: Distribution E to districts

Main() {

get Energy (E, t_0); /** The amount of energy E to be transmitted in kilowatts and the period of time t_0 are known*/

/**When E is sufficient for all the districts of XYZ*/

If (Energy is sufficient for all the four groups of the districts)

Distribute Energy to all the four groups (t_0) /** E is distributed for t_0 period*/

Indicate All four grouped Districts()/** All four groups of the districts are engaged for the distribution of E*/

Else

/**When E is inadequate for all four groups of the districts */

t_2 = Check time utilized by each group of the Districts and time of Day t_3 /** The previous time t_2 utilized by all four groups of the districts are retrieved from database and compared and the time of day t_3 (morning, afternoon, evening or night) is considered*/

If (t_2 is same for all districts)/**If previous time t_2, E was distributed is equal for all four groups of the districts*/

District group = = district group of first priority of time of day with Energy requirement <=E /**priority is given to the group of districts based on whether highly residential, residential, highly industrial, industrial or mixed, t_3 and the total E requirement must be less or equal to E*/

Distribute Energy (districts, t_0) /**E distributed to district group with highest priority for t_0 period

Indicate District group (districts)// district group that satisfy condition are engaged for the distribution of E*/

Else

/** E distributed to district group with the least t_2 period utilized and E requirement must be less or equal to E*/

District group = = district group with least t_2 and Energy requirement <=E

Distribute Energy (district group, t_0)

Indicate District group (district group)

/**The date, start time, end time and actual time energy was utilized is recorded into a database*/

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

TABLE 3: Sample from database

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#	DATE	STARTTIME	ENDTIME	TIMEUTILISED
7	2014-09-18	14:00:19	14:01:19	1
8	2014-09-21	21:26:59	21:27:59	1
9	2014-10-07	21:00:58	21:01:58	1
10	2014-10-07	21:10:42	21:11:12	0
11	2014-10-07	21:12:25	21:13:25	1
12	2014-10-10	14:45:32	14:46:32	1
13	2014-10-10	14:48:32	14:49:32	1
14	2014-10-10	15:01:21	15:02:51	1
15	2014-10-12	18:55:09	18:56:09	1
16	2014-10-12	18:56:58	18:57:58	1
17	2014-10-12	18:58:42	18:59:42	1
18	2014-10-12	19:00:26	19:01:26	1
19	2014-10-12	19:06:51	19:07:51	1
20	2014-10-12	19:11:30	19:12:30	1

Output

Table 3 is a section of the database showing the date, start time, end time and the period electricity energy was distributed to a district.

Theorem: Polynomial orders

$$\sup pose\ a_0, a_1, \ldots, a_n \text{ are any real numbers and } a_n \neq 0.$$
$$1.\ a_n x^n + a_{n-1}x^{n-1} + \ldots + a_1 x + a_0 \text{ is } O(X^s)\ \forall Z\ s \geq n.$$
$$2.\ a_n x^n + a_{n-1}x^{n-1} + \ldots + a_1 x + a_0 \text{ is } \Omega(X^r)\ \forall Z\ r \leq n. \quad (1)$$
$$3.\ a_n x^n + a_{n-1}x^{n-1} + \ldots + a_1 x + a_0 \text{ is } \Theta(X^n)\ [7].$$

Algorithm Analysis of the Modified Energy Distribution Algorithm

In forecasting the performance of algorithms their analysis is of principal significance in computer science. Numerous processes run at the same time on a computer and the execution time depends on exact 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 estimating the effect of a change on the size of the input that is the growth rate of the algorithms [7] and the complexity of an algorithm is the function which gives the running time of the worst case in respect to specific input size [8].

1. Calculating an Order of sum of time utilized t_2 nested loop segment. There are n additions for each loop. Consequently there are $4n$ additions for all the districts; by algorithm orders $4n$ *is* $\Theta(n)$ and so this algorithm segment *is* $\Theta(n)$.

2. The time complexity function $T(n)$ of the comparison 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 comparison 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: $T(n) = 4(n)$

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: $T(n) = 4(n)$

CONCLUSION

The consequences associated with low and inadequate supply of electricity in Nigeria were stress. And the measures taken by the Government as well as independent power producers to elevate the shortage in electricity supply in Nigeria have not been very effective. The need to improve on an existing algorithm for energy distribution was necessitated due to the inability of consumer to recognize a reliable pattern of distributing electricity to various districts of the XYZ distribution zone. In this paper, an improvement was made on the previous algorithm [2] with only a significant difference in grouping the districts into four groups which is due to a slight increase in the electricity energy received and the forecasted energy in [6] for the XYZ electricity distribution zone. In the improved algorithm the order of time utilized *is still* $\Theta(n)$.

Data Protection as a Service (DPaaS): A Novel Approach For Data Protection in Cloud

REFERENCES

1. Aminu, A. M., Abubakar, S. M., Peter, A., and Abdulkadir, S., (2013), "An Optimal Electricity Distribution Algorithm for XYZ Electricity Distribution Zone" International Journal of Advance Computer Technology (IJCT), ISSN: 2319-7900, pp. 25-29.

2. Peter A., (2015), "A Modified Optimal Electricity Distribution Algorithm for Xyz Electricity Distribution Zone" International Journal of mathematics and Computer research, ISSN: 2320-7167, 3(5), pp.983-987

3. Zhang, L., Zhao, Y., Wang, S., & Tang, W., (2010), "A Novel Hybrid Power Flow Algorithm for Distribution System with DGs". 2010 Asia-Pacific Power and Energy Engineering Conference, pp.1–5.

4. Ahiakwor, C. O., Chukwu, U. C., and Dike, D. O., (2008), "Optimal Transmission Line Pricing Algorithm for a Restructured Power System", ©2008 IEEE, pp.1–6.

5. Macqueen, C. N., and Irving, M. R. (1996), "An Algorithm for The Allocation Distribution System Demand and Energy Losses", 11(1), pp.338–343.

6. Peter A., (2015) "Short time energy forecasting for xyz electricity distribution company using fuzzy goal programming", Global Journal of Engineering Science and Research Management, ISSN: 2349-4506,2(5) pp32-40

7. Epp, S. S., (2004), Discrete Mathematics with Applications (Third Edition), International Student Edition ISBN: 0-534-49096-4, pp.526-527.

8. Liang Y. D., (2013), Introduction to Java Programming, Comprehensive Version (Ninth Edition), Pearson Education publishers Limited, ISBN 978-0-13-293652-1, pp.60, 880-888.

9. Lipschutz, S., and Pai, G. A. V., (2006), Data Structures, Tata McGraw-Hill Publishing Company Limited, New Delhi, pp.2.14, 2.17.