MANAGEMENT AND OPERATION OF ELECTRICITY DISTRIBUTION NETWORKS ON GEOGRAPHIC INFORMATION SYSTEM PLATFORM

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ABSTRACT

A result of development of computer technology, geographic information systems (GIS) is now being used in the operation of power distribution systems. GIS is a special-purpose digital database in which a common spatial coordinate system is the primary means of reference. Comprehensive GIS require a means of: data input (from maps, satellites, surveys, and other sources), data storage, data transformation, analysis, modelling, and data reporting (such as maps, reports, and plans). This paper presents a new methodology for perform distribution operation based on GIS. It uses a programming model for power distribution's dynamic data. This model, using static network information (network location, path lines, and geographic conditions) and the use of dynamic information network (at the moment, line voltage and current) will apply to the computation time. Customer's loads is calculated. By the proposed method, using the program modules, the customers load can be updated according to load balancing. To demonstrate the effectiveness of the integrated GIS system with application programs for distribution operation, a zone at East Azerbaijan electric power system distribution Co. is selected as a real case study.

INTRODUCTION

A result of development of computer technology, geographic information systems (GIS) is now being used in the operation of power distribution systems. GIS is a special-purpose digital database in which a common spatial coordinate system is the primary means of reference. Comprehensive GIS require a means of: data input (from maps, satellites, surveys, and other sources), data storage, data transformation, analysis, modeling, and data reporting (such as maps, reports, and plans). An important difference GIS and other database applications is that all information in a GIS is linked to a spatial reference. Other databases may contain locational information, but a GIS database uses geo-references as the primary means of storing and accessing information. In this model, Information distribution network is comprised of two parts, the first part of the static data, such as lines, transformers, switchgear profiles and location of them, which is located with GPS. The second part includes dynamic information such as current and voltage transmission lines, power factor and networks power transmission lines that, is produced by data logger, fast recorder and advanced metering infrastructure (AMI).

This paper presents a new methodology for perform distribution load operation based on GIS. It uses a programming model for power distribution's dynamic data. However, distribution load transfer operation was mostly completed by manual work and experience in the past. The computing and visual representation capacities of GIS are exploited for the selection of economic corridors, keeping the total costs under a threshold imposed by the user. Several analysis program modules, such as network analysis and connectivity analysis, are adopt to deal with outage of distribution network on the basis of distribution GIS. By the proposed method, using the program modules, the customers load can be updated according to load balancing [1, 2].

Therefore the lack of geographical database of network with tree feeder profile and customer information reduces of ability to managing system [1- 4]. The GIS software is powerful tools that have an ability to display static and dynamic information simultaneously [5]. To demonstrate the effectiveness of the integrated GIS system with application programs for distribution operation, a zone of power system at East Azerbaijan electric power system distribution Co. is selected as a case study. Importantly, all electricity distribution network's equipments in this area are modeling at GIS.

GEOGRAPHIC DATABASE DESIGN

In order to have an intelligent electricity distribution network, the first step is a static information system. The following steps are offered to provide the database:

1. Located the Equipments network by GPS or city map
2. Produce attribute of equipment such as capacity of transformer or type of line.
3. Produce topology of network and modeling in GIS software
4. Add city map in GIS software [1, 5]

LINKED GIS SOFTWARE WITH ANOTHER DATABASE

Distribution of power system information in different

database is one of the problems in Power Distribution System Company. Therefore GIS determine as a gatherer of this information. This software linked to call manager, outage manager for have best service to customers. At Fig. 1, how the relationship between GIS and other participating banks distribution is shown. Also desired output is also provided.

One of the important databases is billing. Energy consumption of customers is integrated in this database. This database has information of customer such as number of phase and consumption history of customers. The location of each customer determines in GIS software and linked to billing by unique cod. Due to existence consumption of each customer and kind of customer, the ability to network analysis is provided [4].

Fig. 1. GIS and other datababses

ADVANTAGE OF USING GIS IN POWER DISTRIBUTION NETWORK

GIS Software have important role in managing of power distribution networks. As regards, the GIS software have static information such as type of transformer and line, can using this information for analyzes in Digsilent such as load flow, short circuit and capacitor placement [6].

The voltage equipment in power distribution system divided to low and middle voltage. One of the ability of this software is possible for trace downstream or upstream in network for each voltage level [5]. By this way, can select part or all of the system and send to Digsilent by interface. Also by GIS software, customer‘s loads is calculated from load calculation of energy from billing and data loggers for send to Digsilent by interface. Then output of this study send back to GIS software for display. Fig. 2 shows this interface.

This communication between GIS and Digsilent can be done in two ways:

1. This communication is continuous and in short interval time. This way is proper for small power distribution system.
2. This communication is not continuous but when restructuring occur in network, only this part of network send to Digsilent. This way is proper for wide power distribution system.

By this way, always existence update network in GIS and Digsilent.

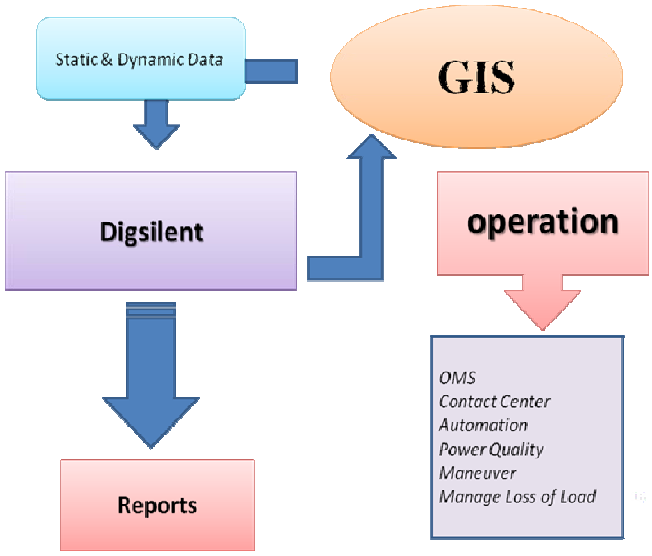

Fig. 2. Interface between GIS and Digsilent for operation

CASE STUDY

In this article use the part of power distribution network of East Azerbaijan Company for study. Table 1 shows specification of this system.

Table I
Details of case study

Equipment	*unit*	*value*
Area	km^2	74
Number of customer	No	42000
Length of middle voltage line	km	840
Length of low voltage line	km	3700
Number of distribution substations	No	2500
Total of transformer capacity	MVA	534

City map and GPS technology is used for determining of accurate location of equipment. Finally the single line of network is modeled in GIS software. This software has three dataset that are middle voltage equipment (20 kV), low voltage equipment (400V) and city map. Fig. 3 shows

these dataset in case study area. For example by this ability can determine that in top of the view, only show middle voltage equipment and city map dataset.

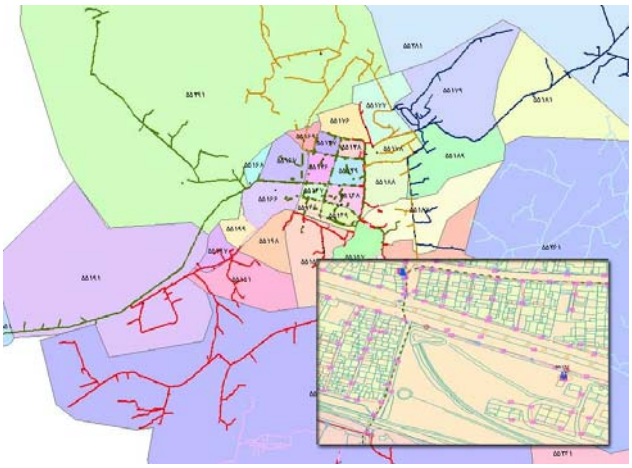

Fig. 3. Case study on GIS platform

ANALYZE OF POWER LOSSES IN CASE STUDY

By linked between GIS and Digsilent, can be determine the power losses in Digsilent and then send this report to GIS software [6]. In this way, the dynamic information such as load information sends to Digsilent from GIS. Table II shows power losses in different condition.

Table II
Case study analysis

Case study	*Maximum of power losses* ***percent***	*Maximum of energy losses* ***percent*** *in 12 hours*
The current condition	20.32	12.2
After restructure and change the conductor	17.56	11.01
After restructure, change the conductor and install of capacitor	16.1	10.03

Calculation of energy losses is done in 12 hours interval. As regards, current condition of system and locating determine of switchgear, can be changed topology of network and then reanalyzes the network.
By restructure of system, the losses of power and energy in 12 hour interval Losses are reduced to 2.33 and 0.5 percent compared to the initial state, respectively.
In second study, as regards the conductor profiles are in GIS database, can be optimized conductor type. In this study, by change low voltage conductor from 25mm^2 to 35mm^2 and in middle voltage conductor from Weasel to Fox, the losses of power and energy in 12 hour interval are reduced by 0.53% and 0.69% compared to initial state respectively. Finally, by install capacitor in low voltage level reduce power and energy losses to 16.1% and 10.03% respectively.

OPTIMIZATION OF TRANSFORMER'S CAPACITY

This issue is done by downstream tool that is one of the GIS ability. By this ability can be determining number of customer, length of line and finally load of transformer by linked GIS to Billing or data-loggers. Also the capacity of transformer is determined according to forecast load growth. Therefore GIS is best tools for optimization transformer's capacity.
Table III shows number and capacity of transformer in study area before and after optimization by GIS. It is also optimized for the next 5 years with 3% growth in load per year. Study in this case is done for one thousand customers. In this study derate factor of transformer is considered 0.7.

Table III
Number and capacity of transformer in study area before and after optimization by GIS

Number of transformer in next 5 year	*Number of transformer after optimization*	*Number of transformer before optimization*	*Capacity of transformer*
2	1	0	100 KVA
2	2	2	250 KVA
2	3	3	315 KVA
1	1	2	500 KVA
1	0	1	800 KVA
1	1	0	1250 KVA

OPTIMIZATION OF LIGHTING SYSTEM

One of the important issues in power distribution system is a lighting system of city. In this model, information of lighting system is integrated in GIS database, then this information are classified according to type of lamp, light and install information such as altitude. According this classification, Intensity curve of each group is produced. Fig. 4 shows one of these. In this figure the value of intensity is showed in its curve. Then by GIS application can be optimized the lighting system by adding this curve and analyzes them. In Fig. 3 the points of 1 and 2 have not sufficient lighting. Therefore by GIS application can be optimized lighting system and easily find this location.

RELIABILITY STUDY BY GIS

Different types of map such as weather map or environmental map are useful for managing system in critical condition such as storm. By this map can be analyzes impact of environmental on power distribution network. On the other hand, reliability of power system is

Dependent on environmental conditions. Also preventive maintenance (PM) has impact in this issue that GIS software is used for preventive maintenance. So can be used GIS for evaluation of system's reliability with WM model (Weibull-Markov) [7, 8]. Fig. 5 shows this issue (With details).

Fig. 4. Lights on GIS

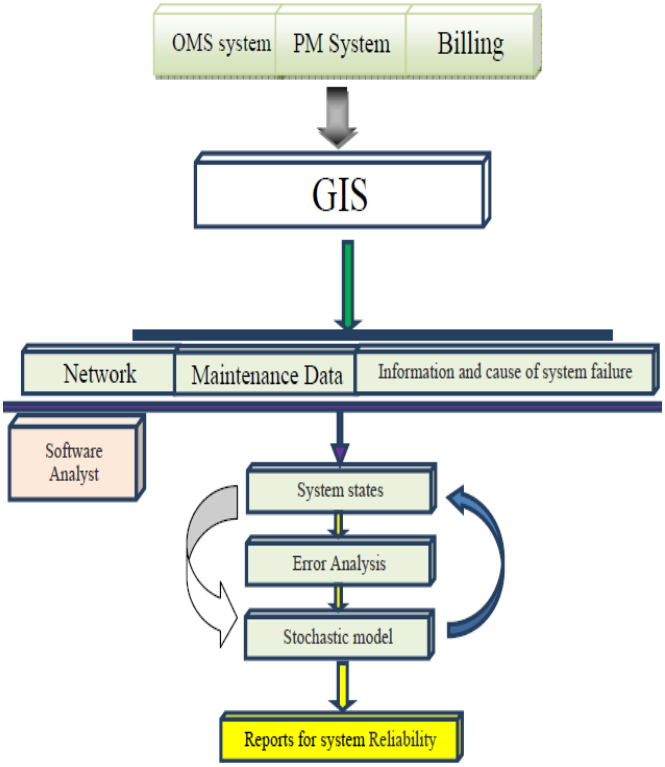

Fig. 5. Study on distribution system reliability (GIS as platform)

CONCLUSIONS

In this article, application of GIS technology in power distribution network was introduced and communication between GIS and another database in Power Company was defined. Finally it was shown that the GIS technology was one of the best ways to managing of electrical system.
In the case study, the power distribution system of Azerbaijan Company modeled in GIS software. Then by ability of GIS and communication between this software and Digsilent is used for study power losses of electrical system. Also optimization of transformer's capacity and lighting system is done by GIS.

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