OPTIMUM REARRANGMENT BY GA AND GIS IN DISTRIBUTION NETWORK

Azim NOWBAKHT Shiraz Dist. Co. – Iran F.nowbakht@gmail.com
Hojat MOSHTAGHIAN Shiraz Dist. Co. – Iran hojatmoshtaghian@gmail.com
Reza SEDAGHATI Azad University of Beyza – Iran Reza_sedaghati@yahoo.com
Vahid GHAEDI Shiraz Dist. Co. – Iran Vahidghaedi80@yahoo.com

ABSTRACT

The ability to provide the necessary power for consumer by the shortest and the safest route accompanying low cost is one of the most important engineers' duties in distributed networks. The purpose of this work is designing a distributed network based on geographic information system (GIS) and genetic algorithm (GA). This procedure has a considerable success in solving distributed network design problems as well as loop and link structured urban distribution networks optimization.

1.INTRODUCTION

Considering limitations of a system (such as net voltage area, lattice structure, amount and location of loads, cables types, conductor types, voltage reduction, etc.) through net optimization is vital in designing a distributed network [1].The location of equipments is a key factor in designing nowadays. However, considering the equipment placement data such as post locations, cables route and feeders (geography locations) in designing the network led to the complexity of optimization related equations. In the past years, placements data and computer nets have a considerable effect on power network optimization. It is now observed that GIS by reconciliation of the optimization algorithms such as GA provides a good tool for solving design problems [2]. Optimizing the electrical distributed networks based on placement data system and genetic algorithm are the purpose of this paper.

2.WHY GIS IS USED?

Generally, each database which has a reference geography capability is called GIS. This system has the ability of layering, placement data show and their relations to a net. GIS system also has the ability to merge the whole available professions in different concepts such as urban planning, service organizations, and etc [3]. Meeting the future needs satisfaction as well as territorial evolution and software patronage are purpose of geographic data system. This system also must have the ability of reference placement system creation in order to make a relation between placement (map) data and network descriptive data (database) to obtain the management resolutions in necessity situations.

3.DATABACE STRUCTURE

GIS system can edit end up date the data whereas others are not able. In this system gathered data save as numbers, and data from different sources are synthesized by different methods [4, 5]. The velocity of data processing in GIS media is increased by computers ability. As a result, it is possible to analyze many data comparer to than the other systems. This model is used for optimization of medium pressure networks [6]. Because of time and financial limitations, only some part of network is considered as placement data. Maps by 1:5000 scale and technical data system related to that equipment are used at selected zones (four electronic companies in Shiraz, Iran) for placement data system. The data structure based on their topology and properties are shown in table 1.The used maps must have signs for prime and secondary stations including punctual situation of those stations accompany cable routs of 11kv and 20kv situated in earth and airy feeders. Every cable and station must name by specific number. This data selection digitizes of background scanned map and compare with pilot zone map. In Shiraz electricity Distribution Company, provincial shape files for zones out of Shiraz and municipality shape files in hometown are used. Fig. 1 shows the layer structure of placement data system.

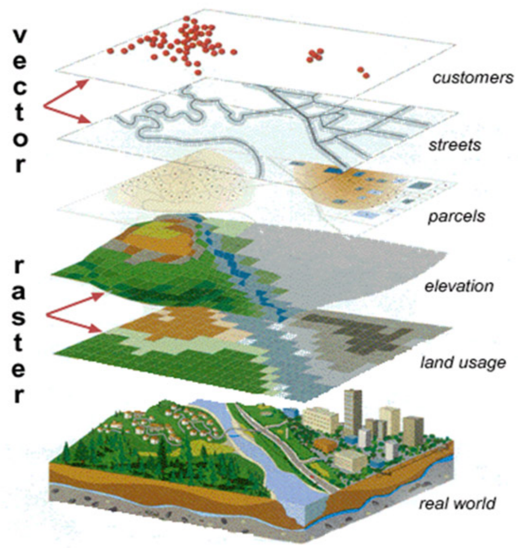


Fig. 1. Layered structure system for placement data system

The other data related to network, cables and network lines are selected from files and catalogues, and then these documents change to GIS database with a special process. Placement data is placed in the center of pilot zone for further support. Users can make a connection from different situations (even from further distances) through networks by extensive bands. The Small World software is used as shown in Figs. 2 and 3.

Table 1- the structure of data models based on topology type

Station x/66	Topologic type: node
Name and address	The year of construction
description	Number of HV connection
medium voltage	Number of MV connection
Station 33/11	Topologic type: node
Name and address	The Year of construction
description	Number of HV connections
high voltage	Number of MV connections
Second substation(consumer)	Topologic type: node
Name	Power rate of second transformer
Address	The year of construction
Type of substation	Number of reserved MV connection
First transformation	Number of LV connections
Power rate of first transformation	Number of reserved LV connection
Second transformation	Number of free LV connection
Cable section	Network topology: line
number	Year of laying cable in earths
length	voltage level
type	Number of cores
material	calculated length
line	topologic type: line
number	cross section
type(construction)	voltage level(construction)
material	Number of cores

4.OPTIMIZATION PROCESS BASED ON GA

At the end of each process, a designer can cease and then reprocess. Optimization is included several stages:

- Extraction of data as GIS.
- Processing and digitizing of geographical pilot zone.
- Nominating of original station feeder zone.
- Description of optimization limits.
- Preparation of genetic algorithm data input (GA).
- Defining a fitness or a formula in genetic algorithm for optimizing input data.
- Showing of geographical optimized results, accounts, modes and maps.

Optimization process can be divided into several phases:

4-1 Phase 1

Through check in/check out process, geographical placement data is replaced by data which called partition. Partition gathers necessary data for better analyze of network.

4-2 Second phase

Data relevant to the optimization process (name, cable routes, 1st and 2nd substations location, identity number, voltage, length, structure type, cross section, material and the year of situated cables in earth) are extracted from partitions called Data Flow and then is situated in a media called clipboard. After this process, almost everything takes place on clipboard.

4-3 Third phase

A designer can choose between optimization of a loop and link network structure by considering the nature of the distribution network at the observed area. During the optimization process, 1st substation is referred to as supply substations or supply nodes and 2nd station are referred to as consumer substations or consumer nodes. The preprocessed information are displayed and the planner selects the supply area for optimization and all of the needed network elements (substations, cables, centerlines of the streets representing possible cables' routes and existing trenches) by graphically defining the polygon of desired extent. This selection process differentiates, according to the number of selected supply substations, between loop structured network (only one supply node within the polygon) and link structured network (more than one supply node within the polygon). In fact, by this procedure the planner sets servicing area(s) of the selected supply node(s). Contrary, if the subjected range relates to two or more original stations, feeder node service limitation has to be nominated in feeder zone in order to prevent overlapping. These results are saved in Data Flow.

4-4 Forth phase

In this phase, requirement data for optimization must be chosen from available Data Flow. Calculations in this part are done by some cases such as the year of cable situated in earth, conductor kinds, cable cross section area and operating voltage. Considering the optimized case, distribution network can have one or both voltages of 11 kv and 20kv.

- Optimization of absolute new network (of 11 kv or 20kv operating voltage)
- Optimization of available and developed network by selection of operating voltage of 11kv.
- Optimization of available and developed network by selection of operating voltage of 20kv.

It is clear that it is possible to optimize the new network by favoring the usage of existing 10 kV and 20 kV cables. This rule must be applicable for available cables in network with appropriate cross section area and those which are placed in earth recently.

For optimization of 11kv network, available cables could not be used in new network because of size restrictions, whereas for optimizing of 20kv network, canals and corridors for placement of 20kv new cable with standard cross section and standard material can be used.

4-5 Fifth phase

All data are assigned as available algorithm data input in

GIS system which can analyze the network easily. All cases which used in network analyses must have this ability to connect to essential modulus which is a node connected to network topology, where 1st and 2nd stations nodes, available cables and possible routes for new cables (including 11kv canals) are. Optimization menus relate to available cables and possible routes which use in the scattered network design. In this algorithm, a designer connects the new station to the optimized route from the centerline of streets. The most important item for analyzing the network route in GIS is the shortest route with lowest cost. All these cases are included in genetic algorithm and guide the system to the best choices.

4-6 Sixth phase

Finally, GIS exhibitor shows the whole data and optimized routes which reassign by the designer after proper consideration. Based on design and comparing of different solutions for similar geographical zones, some cases can be done as bellow:

- The designer can use new adjustment for optimization as well as their use in similar feeder range for original stations.
- The designer can change the feeder range by original stations considering the optimization results.

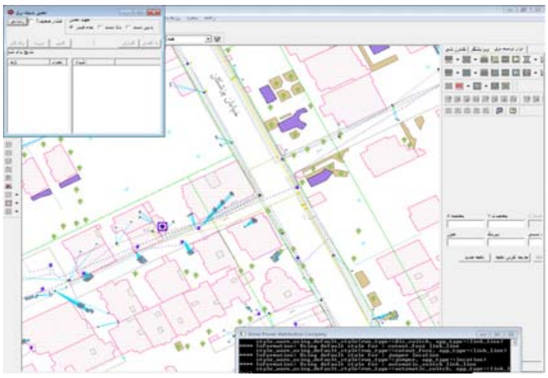


Fig.2- feeder discovery by researching the feeder tree in Small World software

In solution of radial network optimization problem, it is better for optimization process to act in two separate sections based on genetic algorithm. In optimization process, each feeder and consumer station relates to the capacity and covered zone respectively.

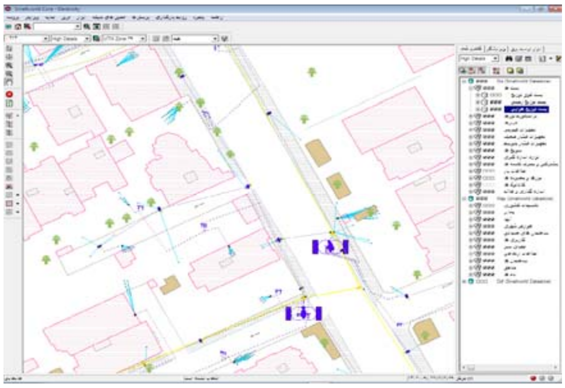


Fig.3- a section of pilot area in Shiraz

Genetic algorithm is able to connect radial network to different stations by coding and genetic functions. This procedure can solve the optimization problems in radial networks with excessive number of feeder station. It is necessary to mention that many previous algorithms are not possible to solve the problem.

5. GENETIC ALGORITHM

For solving complicated nonlinear optimization problems, genetic algorithm is a good choice because it is not depend on gradient and has the ability to reach the optimized response. Solving this problem by genetic algorithm could be done in following steps:

1- Fabrication of connection matrix
2- Put data to genetic algorithm parameters (population, parent numbers and repeated numbers)
3- Fabrication of a random original binary population that is the candidate of final response.
4- Change of original population in order to satisfy the limitations (relation 1)
5- Save the best response in every step.
6- Parent production from original population and forming for new population fabrication.
7- Gens jump randomly (selecting of a number of shins randomly in every process and changing their positions as 0 or 1)
8- If the numbers of repeated are not sufficient go to the step 4 otherwise this algorithm is finished.

Flowchart related to network optimization is shown in fig. 7. The Mutation Probability and the Crossover Probability are P_{mut}=0.01 and P_{cross}=0.7 respectively. For coding of each parameter, 16 bytes are used. The Initial population is 50. The Initial population is generated randomly with monotonous distribution. It is necessary to know about network topology (ie. The method of bus connections and copulative routes) and bus kinds. The condition of bus connection of different systems is shown by network connection matrix; ie Which buses are connected to each other by a line?

If the numbers of network buses are n-bus, then the connected matrix will be n-bus × n-bus (A) , which their items are as bellow:

$$A_{ij} = \begin{cases} 1 & if \quad i = j \\ 0 & if \quad i \neq j \end{cases} \qquad (1)$$

The purpose of problem solving is that for each bus in matrix there is at least a feeder station on it, or on a connected bus there is the shortest available route. If bus "i" is connected to a feeder station y_{ij} variable is 1, otherwise its value is 0. The scale of coordination for each member of population is determined by below relation (L is the line length).

$$l + \min \sum_{i=1}^{n-bus} y_{ij} \geq 1 \qquad j = 1,2,...,n - bus \qquad (2)$$

The Initial population is 50 and genetic algorithm to 70 generation is done because after 70 generation, it is convergence as shown in fig. 4.

Finally, proposal formulation results accompany specification and route length in a network is shown idealistically. The studied network is IEEE 34 buses system which is connected to 12 buses network [6]. In fig. 5 diagram of transformation 12 buses with qualification of ref. [7] is considered. Diagram of linearly feeder standard 34 buses IEEE is shown in fig. 6.

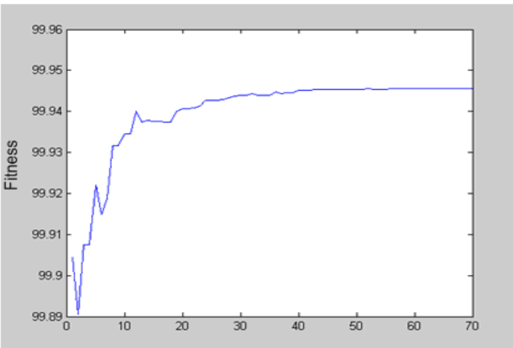


Fig.4- Rate of Fitness for the best member of the population

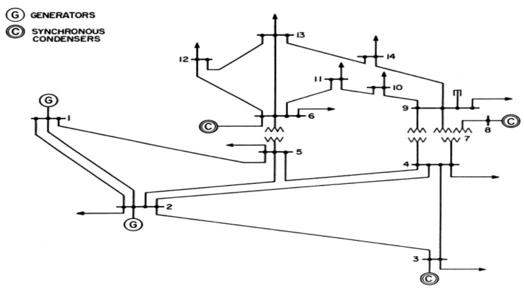


Figure5: Diagram network for 12 buses IEEE

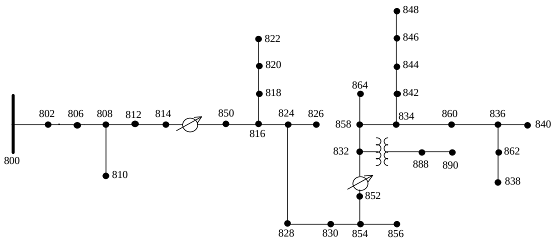


Figure6: Diagram network for 34 distribution buses IEEE

6. CONCLUSIONS

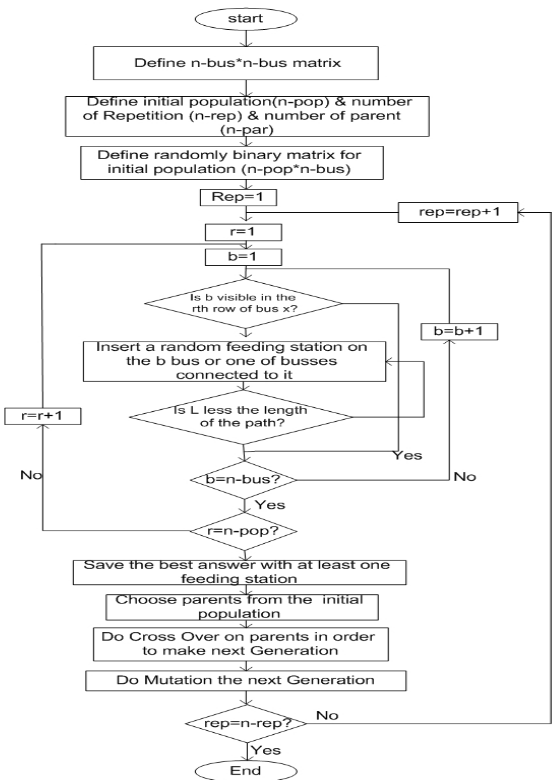
This paper investigate the optimization process based on placement data system and genetic algorithm for solving problems related to loop and link network designs. In addition, the best route for cable situation and feeder cables are shown. Considering the distribution network of Shiraz is assigned its GIS platform system based on SmallWorld software, and this software has the ability to schematize by Magic, reconciliation of these two algorithms including GA and GIS is beneficial in optimizing of this network.

7. REFERENCES

[1].Chan Weng Tat 2003 "*Using GIS and genetic algorithm in highway alignment optimization*", Intelligent Transportation Systems, 2003. Proceedings. 2003 1563 - 1567 vol.2

[2].Skok, M. "*Genetic algorithm and GIS enhanced long term planning of large link structured distribution systems* ",Power Engineering 2002 Large Engineering Systems Conference on, LESCOPE 02 55 – 60 7396177 vol.2

[3].Zhang Ke 2009 "*Optimal Spatial Searching Based on Advanced Genetic Algorithm and GIS*", Computer Science and Engineering, 2009. WCSE '09. Second International Workshop on 524 – 528 10.1109/WCSE.2009.724



[4].S. Blagajac, ***S.*** Krajcar and D. Skrlec,1996 "*Electric distribution network modeling - a simple procedure of loading existing data to GIs*", in Proceedings of the 18th International Conference on Information Technology Interfaces, Pula, Croatia, 1996, pp. 28 1-

[5] M. Filipec, D. Skrlec and S. Krajcar, 1997"*New approach for MDCVRF: Genetic algorithms with specially developed built-in heuristic techniques*", in Proceedings of the IASTED Interactional SO '97, Singapore, 1997, pp. 35-38

[6] M. Filipec, D. Skrlec and S. Krajcar,1997 "*New approach for MDCVRF: Genetic algorithms with specially developed built-in heuristic techniques*", in Proceedings of the ASTED Intemational Conference Modelling, Simulation and Optimization MSO '97, Singapore, 1997, pp. 35-38 1997, pp. 421-426

[7] IEEE test feeder,Washington university , available at,http://ee.washington.edu/test feeder