

GIS in Power Sector Management

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Abstract

For power sector management, selection of suitable areas, the optimum path finding, the profile analyses, the engineering design of towers and wires, and the cost estimation can be done using GIS. GIS is not only useful in developing accurate database, improve internal efficiency levels pertaining to power supply monitoring, commercial and customer services but also extremely useful for important functions like network analysis, facility management, energy audit, trouble call management, load management, theft detection etc. Digital system provides timely, accurate and easier way of acquiring information, which is very vital in taking prompt and accurate decisions necessary in the economic development of any enterprise/ industry.

Keywords: Power; GIS; DEM; monitoring; management.

1. Introduction

Conceptual model of a GIS provides a useful way to visualize it as a set of map layers or themes, all registered together to a common map base or geographic area. In the last few decades, the electric power industries have been developing power transmission systems to follow up with the rapid growth of the power demand. On the other hand, the suitable site for new transmission lines has been getting restricted, because of development of rural areas and the growing concern over environmental issues. Power industry consequently has to keep track of numerous poles, circuits, power lines, and transformers. Information of location [1-4], voltage, and distribution of electricity of these facilities seem to be very overwhelming. However, with the use of GIS, information can be better organized on a computer system linking the database to map. A GIS as well can make the information easily updatable and accurate and hence can cater to the needs of maintaining large power infrastructure.

GIS can effectively manage information on the distribution of electricity to customers and information describing the attributes of each customer such as location and electricity use. Electric companies are already finding GIS very useful in management of distribution. The electric utility industry has realized that GIS is a valuable tool not only for mapping facilities but to improve decision [5-6] making and better managing infrastructure. Although the needs and uses of GIS are slightly different in the power sector than other industries, GIS can be just as valuable an information technology in the electric utility industry. In automated mapping (AM), this facility helps the utilities to quickly create digital maps of their supply area using the digitization facilities of the software. These maps when so digitized contain detailed information about the land serviced by the utility, and the precise location and engineering information of the distribution network equipment of the utility that are installed in the field. In facilities management (FM), the digitized map files that are so created with all the required intelligence built into them can now be used to satisfy the facilities management needs. So, GIS in the field of electric power is used for the study and analysis for electrical distribution system, analysis and design, applications are also being developed for tackling problem of designing the electrical supply system [7-9] for new residential development, for process automation in order to provide their customers with high quality attendance, to rebuild the design of work procedures in electric utilities. GIS and GPS are also integrated for mapping and analysis of electric distribution circuits.

2. GIS in Information Retrieval

GIS play important role in information retrieval aspects. The maps created by using AM facilities can be made as intelligent as one can imagine. For example, if an engineer needs to know the date of installation of a given transformer, all that he has to do is to click onto that transformer symbol. The attributes attached to this transformer will appear in which one of the attributes will show him the installation date. Consider that the same engineer now wants to know more complex information. He only wants to see on the map, which are the 100 KVA transformers in a given area that were installed prior to a given date. The query facilities of the software will quickly process this requirement of his, and show on the map only those transformers that qualify his requirement, hiding all other transformers that do not qualify it. Let us assume that an engineer wants to know how many transformers are installed in a given locality. The software will quickly process his information need by taking the feeder network data and processing it within the buffer zone showing the locality of the engineer's interest and give him the results. At another time if he wants to assess the requirement of a cable to be laid along a certain road, the GIS will return him the results of processing considering even all the bends and turns the road may have. The cable length so shown by the GIS will be precise and will therefore help him procure the exact required quantity of the cable.

3. GIS in Maintenance & Monitoring

Geographical information system (GIS) also play important role in maintenance and monitoring system in power sector. Using GIS, the entire electrical network can be overlaid on a satellite image or a vector base map, with the facility for zooming, resizing and scrolling. In some GIS applications, even the consumers are mapped to the corresponding electricity network. The purpose of such application is to index all the consumers and categorize the complete consumer database with respect to their unique electrical address. A successful GIS implementation seamlessly integrates the spatial data with various utility applications - Customer Information System, Assets Management, Outage Management and Utility Billing System and provides interfaces for cross-application data portability. Availability of accurate GIS-based distribution network map showing the geo- coordinates and network configuration is an important prerequisite for analysis, planning, optimization and load flow studies. Proper GPS survey and creation of an accurate digital base map for the distribution network is essential for a successful GIS implementation. The survey requires a GPS Base Station at a pre-determined location, aided by adequate number of GPS Rovers/ Receivers. Surveyors walk along the feeders and capture the spatial position of the Pole, Transformer, Feeder and Sub-stations. Let us assume that the engineer has to send a cable jointer in the field who has to access a certain underground cable joint. The engineer can take the digitized map file of the area, mark a small portion of that area in the neighborhood of the joint, and print that small part on a piece of paper. This printed map of that small area will show, to the jointer, the location of the joint with proper distance and bearing references to the nearby identifiable objects. With these references so readily available with the jointer, his work will be easy and quick. There will be no need for him to have any guesswork or to constantly contact the office for knowing the joint location.

4. GIS in Site Identification

The interfaces between GIS and other utility software applications should be well-defined. Continuous updating and monitoring of data is critical in any GIS application. Therefore, it is important to have in-built process control checks, audit trail and exception reporting facility to ensure reliability and accuracy of data. The remote sensing technology is being used for the identification of suitable sites for locating new hydropower projects. The conventional method could not be directly adopted in the inaccessible areas like Himalayas where the water resource potential is high by means of glaciers and intensive rainfall. Similarly the geological, structural configuration is essential to study to understand the strength and weakness of the area so that the project will be implemented in the suitable terrain (ex. aseismic). For geologic mapping, reflectance information of the rocks in the SWIR and emissivity of the rocks information in the TIR are very important. Again, remote sensing data available in the near infrared region (0.8 μm - 1.1 μm) provides clearly the contrast between land and water features can easily be discernable. Satellite imagery may be used for the

identification of catchment boundary, drainage network, perennial streams, landuse and vegetation cover for these projects. Digitizing the elevation contours and spot heights from topographic maps and using capabilities of various GIS software may generate Digital Elevation Model (DEM) of these catchments. The catchment boundary, drainage network and location of major habitation may be overlaid on these DEMs for further analysis.

5. GIS in Information Processing

User can configure settings for GIS map query and has to select the layer for which query to be fired. User can display attributes of a particular feature of a layer by this option. The user has to first configure the settings for query i.e. select a layer to query. After this when the user clicks on the map, the system will display the attributes of the nearest feature from the mouse click. Development of geo-referenced consumer and network database has become a necessity for a host of power distribution applications like customer information system, asset management, trouble call management, billing system, energy audit and load flow studies. The Power Distribution Companies constantly engage in updating their consumer data and the corresponding electrical network attributes. Geographical Information System (GIS) technology plays an important role in mapping the information of consumers and electrical network assets, on a geographical base map, to help define the consumer's electrical connectivity. The attribute data of the distribution network is also collected in the process. Differential correction is then performed on the spatial data thus captured. The digital base map must show the important landmarks like Roads, Rivers etc. which is necessary for easier identification of network assets and plan new distribution network. For better visualization, the vector map of the network can be overlaid on the digital base map or a satellite raster image. Information processing is a key to improve productivity and cutting costs of excess work. Converting information to a computerized format in GIS is more useful and timely for electric utility. For example: GIS will allow to search and retrieve information stored on a server simply by pointing and clicking through user-friendly menus or typing requests in a Windows environment. GIS has a way of making work processes simpler through more productive use of time and information.

6. Data Management in GIS

Accurate and current information is vital to maintaining and improving customer service. With GIS, the electric companies will have the ability to improve customer service by better gathering and processing customer information. Through a computerized environment, a GIS can keep information on customers, accurate and current. Improving record-keeping, and making data accessible to more users in more useful forms is vital to improving customer service. Evidently, improving ways of record keeping and data access is possible with GIS; therefore, it can be a key to improving customer service. Remote Sensing is modern technique in mapping

sciences. It is now a major tool to map any area on earth's surface for transmission of power. The planning for installation of large transmission towers needs proper planning. For this, updated base maps are required. Remote sensing imageries can help in updating of the available topographic maps. The recently launched satellites like IKONOS, IRS-1C, 1D (PAN) having its very good spatial resolution of 1m and 5.8m through digital image processing techniques; it is able to identify even small features with the resolution as given above. To select site for putting new transmission towers and lines especially in hilly terrains, the density of trees, elevation differences has to be carefully studied in detail. In such cases, remote sensing is the main technology, plays a vital role for the preparation of database on landforms, landuse/landcover and related database. Integrating these information in GIS platform, it is able to generate three dimensional terrain model (DTMs) of the area, which can be further updated with the multi-dated satellite images and aerial photographs.

Digital Photogrammetry is the potential technology to provide the information on terrain elevation which has to be studied before locating site for transmission towers and lines. Besides Remote Sensing the hottest stuff today in the transmission sector is Airborne Laser Terrain Mapping (ALTM) or Light Detection & Ranging (LIDAR) Mapping. Laser mapping produces data with accuracies equivalent to traditional GPS land surveys. But the laser mapping produces these elevation measurements at a rate faster than traditional methods. Since laser mapping provides detailed and accurate elevation information, it can be used at places where access to the survey property is limited or prohibited. Its rapid turnaround time and operational flexibility give one the edge in competitive bidding situations. LIDAR data due their typical characteristics are finding many new applications, which were not thought feasible hitherto with other data collection techniques. One such area is monitoring transmission lines. Long stretches of transmission lines can be mapped with speed to determine the exact location of the transmission towers, accurate topography of the corridor, and the encroachment by vegetation for modification and repair purposes.

High resolution DEMs are suited for inspection surveys of power lines. From the randomly distributed points hitting the wires the wire-lines can be reconstructed by using 3-dimensional line detection and modeling software. However, inspection does not only include the determination of deformations of the wires, but also the identification of obstructions present in the corridors. For example, deformation caused by trees or illegal buildings standing too close to the power line path. Their rapid detection and evaluation allows maintenance crews to react fast and to prevent disasters. Also, the inventory of damage after bad weather circumstances can be done easily from Laser DEMs. The required high-resolution mapping necessitates the use of helicopters operating at low altitudes as recording platform. ALTM can also be used to map rugged terrain like Himalayas for hydropower generation where it is impossible to survey physically using traditional methods. ALTM can be really effective alternative in such case.

GIS technology used in utility sector is emerging as an efficient planning and decision making tool. The ability of GIS to integrate common database operations such

as query and statistical analysis make it different from other traditional information systems. It has unique visualization and geographic analysis benefits offered by maps. Therefore it is valuable in planning strategies for Transmission and distribution system. The advantages of using GIS in electrical engineering applications are manifold. Some of the advantages are: with GIS, one can manipulate and carry out tasks that are vital in management of electricity for proper and efficient results; when new facilities are installed, GIS database can be updated easily to accommodate new features. Thus map revision and digital mapping become easy in GIS environment; it is useful in planning of routine maintenance; customers' enquiries can be handled easily; sharing of data among different users simultaneously is possible; the results provide equally good information for other professionals such as Urban Planners to plan better, Construction Managers to reduce damages in construction work, Civil Engineers to locate problem areas quickly.

7. Conclusions

GIS applications are many; power companies can collect and store a large amount of data that can be readily accessed and analyzed. Strength of GIS is integrating data and preparing it for analysis or modeling apart from tying together data from various sources makes it an important tool for the planning and decision making. User can display legend of all layers displayed on the map. This legend will be represented by the symbol of each layer with colour and the name of the layers in a list. System will display coordinate of the current mouse position and the coordinate value will change with the movement of mouse pointer over the map area. User can see co-ordinate only when the mouse pointer is inside the map area. If the mouse pointer goes outside the map area then the system will not display the coordinate. User can query any layer of the GIS map to get the attribute data for a particular feature of that layer. User has to click on any feature of a particular layer to get the attribute of that feature. GIS provides a wide range of solutions encompassing the entire business value chain in the power distribution sector from setting up distribution network and load management to customer information, assets management, billing and customer services. Digital system provides timely, accurate and easier way of acquiring information, which is very vital in taking prompt and accurate decisions.

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