Power Distribution System Planning Using Q-GIS

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ABSTRACT

This article focuses on the usage and advantage of incorporating Geographical Information System for advancing the power distribution system. Geographical Information System-based electricity distribution system planning strategies are applied to determine optimum routing. Existing and proposed layouts have been drawn using GIS-based software Q-GIS 2.12.3. This software helps attach data with the corresponding geographic. A comparison between the Newton-Raphson load flow study of existing and proposed layouts of distribution systems has been performed to find the technical viability of the proposed route. The information obtained from the power flow study is voltage at each load and the real power flowing in each line. The voltages found by the load flow analysis of existing and proposed layouts are compared to show the voltage increase. The developed system is tested on a 12 bus system substation of Sikkim Manipal Institute of Technology, Sikkim, India.

KEYWORDS

Distribution System, Load Flow Analysis, QGIS (Quantum Geographical Information System)

1. INTRODUCTION

The distribution system is a portion of power systems which is devoted to delivering electrical energy to the end user. The distribution system planning is important to fulfill the growing demand of electricity in a best possible way. The optimal distribution system planning problem has become an issue due to the number of variables for a network arrangement which is, in practice, related to its geographical features. The design of electrical distribution networks is a constant development process from both the consumer and management point of view, also in growth of load demand and in research and development.

Power Generation followed by transmission at high voltage (440, 220 or 132 kV), and distribution networks of medium voltage (e.g. 33KV or 11KV) and of lower voltage (0.4 KV), have a very complex network. This network has the purpose of transmitting power from the points of generation to the points of consumption. Lowering cost and losses in electrical distribution power system is the major reason for introducing new tools, like Geographic Information System (GIS) that carries out complex power system studies by combining it to other power system analysis software for designing and examining electrical distribution network (Hassan and Akhtar, 2012). GIS could help in assessing distribution system losses (Triplett, Rinell and Foote, 2010) and improve the consistency of Energy

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Outage System (Davor, Slavko and Snjean, 1994; Rezaee, Nayeripour, Roosta and Niknam, 2009; Liu and Qiu, 1998).

Choosing an optimum location of a distribution sub-station and grouping the various load points to be fed from a particular distribution sub-station has always been a concern to the distribution planners. Authors have used a Fuzzy c-means clustering method applied to various loads which are at different location to form a cluster so that a sub-station could be placed for each cluster for the distribution of power. Context Aware Decision Algorithm based on the Analytical Hierarchy process (AHP) is then applied on each cluster comprising of load points to be fed and an optimum feeder layout is obtained depending on some reliability factors (Shabibiruddin and Chakravorty, 2011).

An expert system was proposed for power distribution system planning. Here in this paper authors have presented a hybridization of K-means clustering method with fuzzy context aware decision algorithm for choosing the optimum location of distribution substation and its feeder layout. K-means clustering has been applied to various loads which are at different location to form a cluster with load points in closer proximity so that a substation could be placed for each cluster for the distribution of power. Fuzzy Context Aware Decision Algorithm based on the AHP is then applied on each cluster to decide on the feeder layout connecting the load points in each cluster (Shabibiruddin, Ray, Sherpa and Chakravorty, 2016).

GIS platform is used to locate the load points in terms of coordinates. Soft computing based clustering algorithm is further used to divide the load points into different clusters with suitable optimum location of each substation (Shabibiruddin, Sherpa, Chakravorty and Ray 2016).

Few researchers have worked on the field of distribution planning for the improvement by reducing cost and losses (Boulaix, Papadopoulos, 2002). GIS based primary router for concealed residential distribution plan is presented where an automated tool for improving the routing of primary cables in underground residential distribution networks was proposed by Dixit, Sharma and Singhal, 2008. Similar work has also been carried out by Gomez, Khodr, Oliveira and Urdaneta, 2004. Without proper record keeping and observation of the transmission and distribution system, efficient operation of the generated power cannot be accomplished as suggested by Tor and Shahidehpor, 2005. GIS can help to minimize losses and increase energy efficiency through its impact in different areas of Distribution reforms (Trussell 2001). Optimum routing can be examined through the combination of spatial modeling and GIS (Rigaux, Scholl and Voisard, 2002; Jankowski, 1995). GIS ability for spatial data processing and analyzing tools available can be used to achieve a wide range of information (Openshaw, 1991). GIS has the tools which can be used to map complete Power System network, consumer supply points and transformers with spatial locations which are drawn on satellite image (Igbokwe and Emengini, 2005; Kumar and Chandra, 2001).

GIS simulates the useful infrastructure. It seizes the inventory of possessions, their location, their condition and associations of asset to each other and to their environments (Dangermond, 2008).

A method to solve the design of a distribution network for bottled drinks company is introduced. The distribution network proposed includes three stages: manufacturing centers, consolidation centers using cross-docking, and distribution centers (Marmolejo, Rodríguez, Cruz-Mejia, and Saucedo, 2016).

An adaptive random search approach is presented to address a short-term generation scheduling with network constraints, which determines the startup and shutdown schedules of thermal units over a given planning horizon (Marmolejo, Velasco and Selley 2017).

1.1. Findings

The proposed methodology will help power system planners to make a complete solution of planning problems from finding optimum route to load flow analysis. The method proposed can replace the traditional way of planning by mathematical calculations. Use of GIS will help to consider all the geographic impacts.