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Application of Geographic Information System for the Installation of Surge Arrestors on over head 132 k-v Power Line.

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Abstract— **Power system consists of generation, transmission and distribution of electrical energy. Transmission lines transport the desired amount of electrical power from one place to another. The Protection of Power line is a very important factor in smooth transfer of electric power. Lightning is a major cause of overhead line faults.It is necessary to protect the power apparatus from over volts in electric system, namely lighting over voltages & switching over voltages .The objectives of this study is to protect the power system equipment's from lightning using geographic information system approach A Geographical Information System (GIS) is a collection of software's that allows you to create, visualize, query and analyse geographic data.This paper presents the idea of installing line surge arrestors by marking the exact location of towers using a multispectral satellite image and image processing software with the help of gps points taken on the ground. A case study of 132 k-v existing double circuit line from Sheik Muhammadi 500 k-v grid to 132 k-v city grid Peshawar is considered for results where as input data to GIS is in the form of spot-5 satellite image having 2.5m resolution.**

Keywords—**Power system; Lightning; Electric system; Surge arrestors; Satellite image.**

I. INTRODUCTION

Lightning is a major cause of overhead line faults. Between 5% to 10% of the lightning-caused faults are thought to result in permanent damage to power system equipment. Lightning has been one of the important problems for insulation design of power systems and it is still the main cause of outages of transmission and distribution line. A complete awareness of the parameters of lightning strokes is essential for the prediction of the severity of the transient voltages generated across power apparatus either by a direct stroke to the power line apparatus, or by an indirect stroke. However, no two lightning strokes are the same. Because of lightning traveling waves are produced in the system. These traveling waves cause the temporary increase in voltage in the transmission line system. The increase in voltage is harmful for the insulator of lines and devices connected to the transmission line. Therefore, it is necessary to analyze such increase in voltage in order to design the surge arrester (or the insulator) suitable for the investment, the good performance of the system and the reliability of transmission line system. During the seven years between 1998 and 2004, 81 direct lightning strokes to phase conductors were observed. The number is based on the first stroke for multi stroke events and excludes some data for which parameters could not be estimated. All of the lightning strokes were observed in the summer. It is essential for electrical power engineering to reduce the number of outages & services &electric supply. Therefore it is necessary to protect the power apparatus from over volts in electric system, namely lighting over voltages & switching over voltages. Lighting over voltages is a natural phenomenon while switching over voltages originates in the system itself by the connection &disconnection of circuit breakers contacts or due to initiation or interruption of faults. Switching over voltages is highly damped over voltages. The magnitude of over voltage's appearing on transmission lines does not depend on the line design & hence lightning performance tends to improve with increasing insulation level ,i.e. with system voltage on the other hand, switching over voltage's are proportional to operating voltage.

Lightning strokes hitting towers, conductors or any object line the neighboring of a transmission line can produce abnormal current /voltage waves along conductors (phase and/or shield wires) as well as along steel towers. Due to these phenomena, over voltages are produced and electric arcs (between two or more conductors as well as between phase conductors and the tower structure) may appear, if insulation breakdown voltage is reached. Back flashover occurs when lightning stroke terminates on the overhead ground wire or tower. A stroke that so terminates forces currents to flow down the tower and out on the ground wires. Thus voltages are built up across the line insulation. If these voltages equal or exceed the line critical flashover voltage (CFO), flashover occurs. Study on back flashover is very important to evaluate lightning performance as majority of lightning Strokes terminate on shield wire than phase conductor [1].

II. Objective

The objectives of this study are to use of geographic information system for the protection of power system equipment's from lightning and determine the suitable location of surge arrestors on a 132k-v power line. A geographic information system (GIS) is a system for capturing, storing, analyzing and managing data and associated attributes which are spatially referenced to the earth. In the strict sense, it is a computer system capable of integrating, storing, editing, analyzing, sharing, and displaying geographically-referenced information. In a more generic sense, GIS is a tool that allows users to create interactive queries (user created searches), analyze the spatial information, edit data, maps, and present the results of all these operations.

Modern GIS technologies use digital information, for which various digitized data creation methods are used. The most common method of data creation is digitization, where a hardcopy map or survey plan is transferred into a digital medium through the use of a computer-aided drafting (CAD) program, and geo-referencing capabilities. The primary requirement for the source data consists of knowing the locations for the variables. Location may be annotated by x, y, and z coordinates of longitude, latitude and elevation or by other geo code systems like ZIP Codes or by highway mile markers. Any variable that can be located spatially can be fed into a GIS.A GIS can also convert existing digital information, which may not yet be in map form, into forms it can recognize and use. For example, digital satellite images generated through remote sensing can be analyzed to produce a map-like layer of digital information about vegetative covers [2].

III. Data Used

Remote sensing data i.e. satellite imagery will be used for analysis in this paper. Satellite image is from spot 5(French commercial earth observation satellite launched in May 2002) having resolution 2.5 m. GIS software used is ILWIS developed by the International Institute for Aerospace Survey and Earth Sciences, Enschede, The Netherlands.

Fig.1 500KV Sheikh Muhammadi Grid Station

Fig.2 132-kv city Grid near Gulbahar

IV. Management and Analysis

Line profile of 132kv double circuit line from sheikh Muhammadi 500 k-v grid to 132 k-v city grid is given below. Length of line is 12km having rail ACSR conductor. Since it's a double circuit line so total length is 24 km.

TABLE I
LINE PROFILE DATA

Type of Conductor	Rail ACSR
Clearance from Ground	7.8 m
Clearance from Road	300 m
Span Length	250 m
Road Extension Height	3 m

132 k-v existing line from sheikh Muhammadi to city grid is marked by red circles as shown in fig(2) these red circles shows exact locations of towers on satellite image if we zoom it then we can see their exact locations on ground.

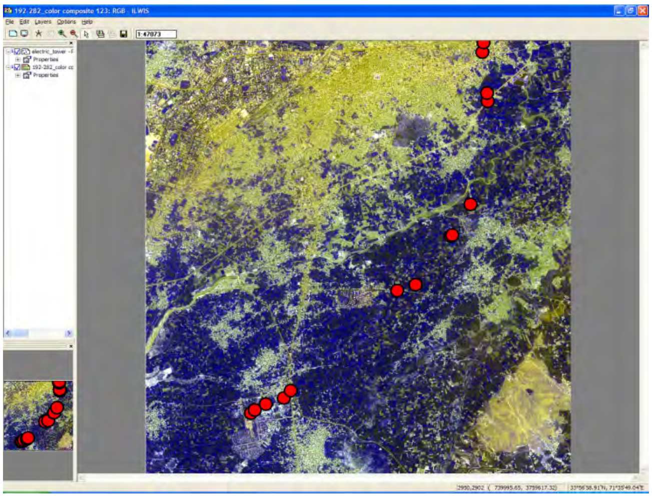

Fig.3 Towers Location

The following data in Table (2) is taken from the 132 k-v overhead line as a case study.

The Global Positioning System (GPS) is the only fully functional Global Navigation Satellite System (GNSS). Utilizing a constellation of at least 24 medium Earth orbit satellites that transmit precise microwave signals, the system enables a GPS receiver to determine its location, speed, direction, and time[3].

TABLE III
TOWERS AND THEIR GPS COORDINATES

Towers	Elevation	GPS Co-ordinates
1	1248 feet	N 33.932, E 71.546
2	1232 feet	N 33.9326 ,E71.547
3	1193 feet	N 33.934, E 71.550
4	1173 feet	N 33.9353, E 71.554
24	1107 feet	N 33.95926 , E 71.585816
27	1091 feet	N 33.97143, E 71.600466
37	1092 feet	N 33.978583, E 71.606
49	1052 feet	N 34.002083, E 71.6113
57	991 feet	N 34.01338, E 71.6102
60	980 feet	N 34.0155833, E 71.6105833

V. RESULTS

Table.3 shows the results for different arrester positions. Surge Arrester is placed 30m, 60m and 90m away from transformer. The output voltages 387.5KV, 409.67KV and 425.53KV respectively [1].

TABLE III
SIMULATION RESULTS

Surge arrester is set at	Arc current	Discharge Voltage (kV)
Before the	(kA)	303
Transformer	9.91	387.85
30m away from the	9.91	409.67
Transformer	10	425.53

The figure (4) given below shows distance between towers on a digital map where as each tower location is represented by a small circle.

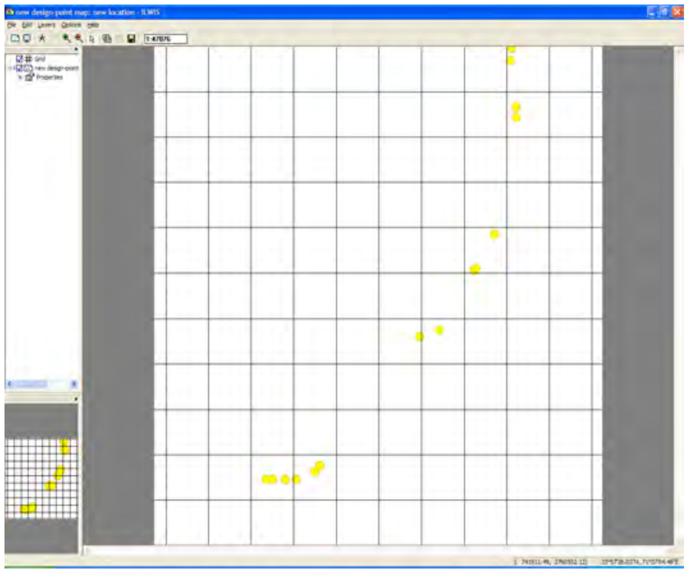

Fig .4 Towers Distance

VI. CONCLUSIONS

The outcome of this paper is by using GIS a complete digital map can be made which shows the 132k-v overhead line marked on a satellite image and make easier for a planning engineer to find the best possible location of surge arrestors for the protection of power system.

VII. DISCUSSION AND FUTURE DIRECTIONS

This paper clearly shows that surge arrestors location is very important for the protection of power system equipment's. LIDAR has been emerging recently as a tool for digital mapping. A Laser Altimetry (LIDAR) system aboard an aircraft can yield highly accurate data about the ground surface and vegetation below. Raw LIDAR points must be processed to generate a digital elevation model (DEM), i.e. a digital map of the terrain surface. But there is a difficulty in processing the data produced by LIDAR system. There is also currently widespread interest in the development of using POLSAR sensors for the extraction of surface and buried targets. Apart from providing a safe and reliable electric service to customers, the important question always remains there for the utility companies to operate at the lowest reasonable cost.

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