

# A Right of way Management of Electric Power line using Global Positioning System and Spot-5 Satellite Image

<sup>1</sup>Kamran Hafeez, <sup>2</sup>Waqas Ahmed

**Abstract**—The power system is considered as an essential part of the country prosperity. A 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. A Right-of-Way (ROW) is a corridor of land over which electric transmission lines are located. The maintenance of Power line is a very important factor in smooth transfer of electric power. Forced outages caused by falling trees on power Transmission lines is a common phenomena. This Paper clearly presents the right of way management (ROW) of an existing 12km long 132kv double circuit electric Power line from 500-kv Sheik muhammadi grid to 132- kv city grid Peshawar using Geographic Information System and Global Positioning system approach. GIS is used as a tool to extract features present on the ground surface. A spot 5 multispectral Satellite image having 2.5m resolution is used as an input data to GIS.

**Index Terms**—Power system, Transmission lines, Geographic Information System, Multispectral Satellite Image.

## I. INTRODUCTION

A Right-of-Way (ROW) is a corridor of land over which electric transmission lines are located. Transmission owners may own the land in fee, own an easement, or have certain license or franchise rights to construct and maintain transmission lines. It is the vegetation within the right-of-way that most concerns utility companies as these pose the most risk to the power line structures.

Typical vegetation management for power line deals with the scheduled maintenance cycle to identify hazardous trees that could fall and contact the transmission or distribution lines. Such trees are trimmed to obtain clearances that will last for the duration of the cycle, or they are removed altogether to provide the required clearance, improve access to the power lines, and reduce future costs. The instituted Right-of-Way of the utility company determines which trees the company has access to for this maintenance [1].

The aim of this study is to find out simple and less expensive solution for the right of way management of electric power line of shorter length i.e. 12km line. There are different solutions available to utility companies such as Lidar, Multiple viewing digital cameras proposed in [1]. But cost

Factor is also important for utility companies and their implementation when specialized technical staff is not available to them. Therefore we are proposing to use a multispectral satellite image having a high resolution along with point data taken from global positioning system together for the exact location of towers and thus created a corridor around which we can easily monitor vegetation management from time to time. The solution we providing is less expensive,

reliable and results are also not very far behind as compare to Lidar Technology and multiple viewing digital cameras. Satellite multispectral data have since long been widely used in the estimation of forest attributes (e.g., Hall et al., 2006; Kajisa et al., 2008). These data are much less expensive than LiDAR, they cover large areas, and in some cases they allow one to obtain convincing results. For example, Hall et al. (2006) estimated the above ground biomass and the stand volume with a model that generates empirical relationships between continuous estimates of forest structure attributes and spectral variables derived from Land sat ETM+ data. The analyzed area covered 2600 km<sup>2</sup>, an altitude range between 1070 and 1725 m, and the main species were coniferous. In the volume estimation, they obtained a R<sup>2</sup> close to 0.70. Kajisa et al. (2008) made a study in a mixed forest of coniferous and evergreen broad leaved species in Japan [2].

Remote-sensing techniques for vegetation classification and the estimation of plant physiological parameters are primarily based on the use of multispectral data. Over the last few decades, radar remote-sensing data have also been increasingly utilized for vegetation characterization, crop monitoring as well as yield prediction, mainly based on medium-resolution C- and L-band synthetic aperture radar (SAR) data. A new generation of radar satellite sensors offers images with pixel sizes as fine as 1 m on the ground. The TerraSAR-X (TSX) satellite delivers X-band SAR data in different modes, allowing the acquisition of images with different swath widths, resolutions and polarizations (Schreier et al. 2008) [3].

In [4] it is shown that another difficulty necessitated by the high accuracy of the LIDAR system is the volume of data produced by the system. Regions less than 100 km<sup>2</sup> in area can produce greater than 25 gigabytes of data points. Therefore, data reduction and algorithm order are very important factors in any algorithm used for processing the data. A case study has been taken of a 12km existing line from 500k-v sheikh Muhamadi grid to 132 k-v city grid Peshawar to get the results.

## II. BACKGROUND

The power line system is an interconnected network of generating plants, transmission lines, and distribution facilities (CFE, 2008). Utility companies seek to locate transmission lines in sites that are technically, economically, and environmentally acceptable to accommodate required facilities. Designating the Right-of-Way (ROW) is a significant factor when developing a transmission system. The ROW width is a function of several design considerations, e.g.

transmission tower height, distance between towers, conductor size, clearances, line security, and the condition of the terrain through which the line will pass. Other factors to be considered in planning a transmission system include: amount of power the line must carry, length of the line, potential impacts to the environment and communities, costs to build and operate the line, and how the line fits into the overall electricity network or grid. Electricity can be generated at a large scale from a number of sources such as coal, hydropower, wind, solar and nuclear power.

The main components of the power line network are:

**1. Transformer:** The current-flow while transmitting electrical power produces heat which is actually electricity lost in the transmission medium. To minimize the amount of heat generated in transmission lines, and thus electricity losses, electric power is transmitted at high voltage and low current. So after the electricity is generated, step-up transformers increase the voltage in order to carry electricity efficiently (with minimum losses) over long distances along the transmission lines. The line voltages can be as high as 735 kV. Transmission lines in Canada mostly carry electricity at 115 kV, 230 kV, or 500 kV however. At the other end where the electricity is used, step-down transformers are needed in the distribution system to lower the voltage to suitable levels for domestic, commercial and industrial uses.

**2. Lightning Arresters:** Lightning arresters are installed at strategic locations on the transmission lines, usually three or four spans apart. They protect the transformers and other electrical apparatus from voltage surges. Their ground wires are connected to the overhead ground wire and to the steel structure on tower lines, or to counterpoises where they exist.

**3. Shield wires:** Transmission lines may have smaller conductors called shield wires strung above them. These are connected directly to the transmission line towers and protect the main conductors from a direct lightning strike. The shield wires provide an easy or low resistance path to the ground through the transmission towers. If lightning strikes, it will hit the shield wires rather than the conductors (CFE, 2008).

**4. Insulators:** Insulators electrically isolate transmission lines from each other as well as from their supporting structure. Glass and porcelain were traditionally the insulators of choice but porcelain was usually more practical because it can withstand greater temperature differentials and does not break as easily as glass. More recently, polymer (in the form of fiberglass) has been favored over porcelain as an insulator for power lines and power line system equipment because it has better water and sleet shedding properties, and has a better strength to weight ratio. A polymer insulator also permits increased conductor and static wire line tensions, resulting in lower construction designs by permitting longer spans, fewer towers or lower tower heights.

**5. Power lines:** Power line conductors provide electrical circuits between the points of electricity supply and use. They vary in size according to the rated voltage, and the number of conductors strung on a pole depends on the type of circuits that are used. Most commonly, aluminum and copper had been used as conductors because of their low resistance. Now,

aluminum has replaced copper as the most common conductor metal for overhead transmission (Pansini, 2008). Power can be transmitted along overhead power lines or underground cables.

**6. Underground structures:** Foundations are necessary to support structures. They may be made of steel grillage, reinforced concrete, or steel or wood piles with suitable cap. The counterpoise is a buried conductor running parallel to the transmission line that reduces the resistance of the tower footing (Pansini, 2008). It reduces the susceptibility of the line to outages caused by lightning. The counterpoise is normally made of galvanized steel or copper.

**7. Transmission Towers:** The transmission towers support conductors at a safe elevation above the ground. Towers are generally fabricated of galvanized steel members. Their height may vary from 50 feet to 150 feet depending on the voltage of the transmission line, the standards of distances for the lowest conductor at the lowest point of sag to the ground, and clearances between conductors. There are several types of towers. Angle or corner towers are designed to hold the spans of conductors on either side that are at an angle with each other. These towers have great strength and may also be guyed to balance the uneven force from the conductors attached to the cross arm on the tower [1].



Figure. 1. Z-M1= NORMAL (Tower)

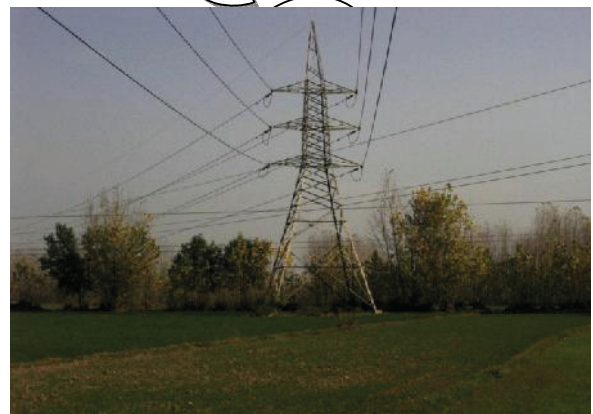


Figure. 2. Z-M 60 = ANGLE (Tower)



### III. STUDY AREA

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 [5].

Remote sensing data i.e. satellite imagery will be used for land cover 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 in this thesis is ILWIS developed by the International Institute for Aerospace Survey and Earth Sciences (ITC), Enschede, The Netherlands.

TABLE 1  
Digital Satellite Image Characteristics

Satellite platform	Spot-5
Launch date	May 2002
Orbit	Sun-synchronous
Local equator crossing time	10:30am
Altitude at equator	822 km
Spectral bands and resolution	2 panchromatic (5m) combined to form 2.5 m product 3 multispectral (10m) 1 short wave infrared (20m)
Instrument	HRG (across track)

A Satellite image taken from Spot-5 is shown in fig (3) and fig (4) as color composite image using image processing software.

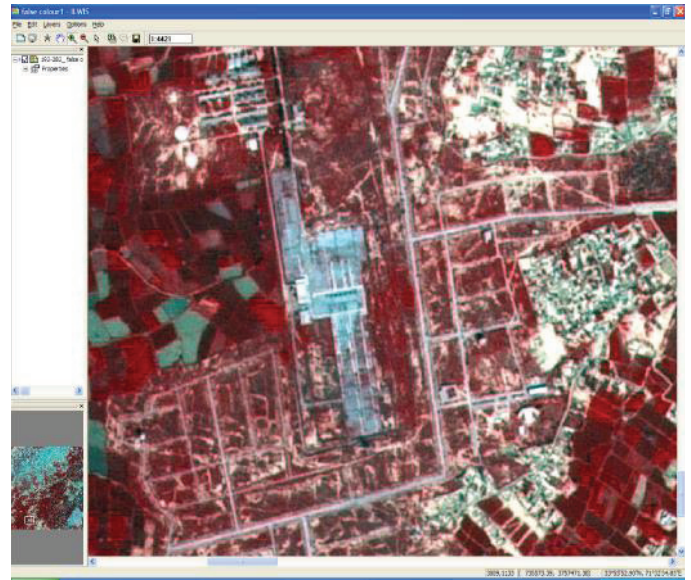


Figure 3. 500KV Sheikh Muhammadi Grid Station Kohat road

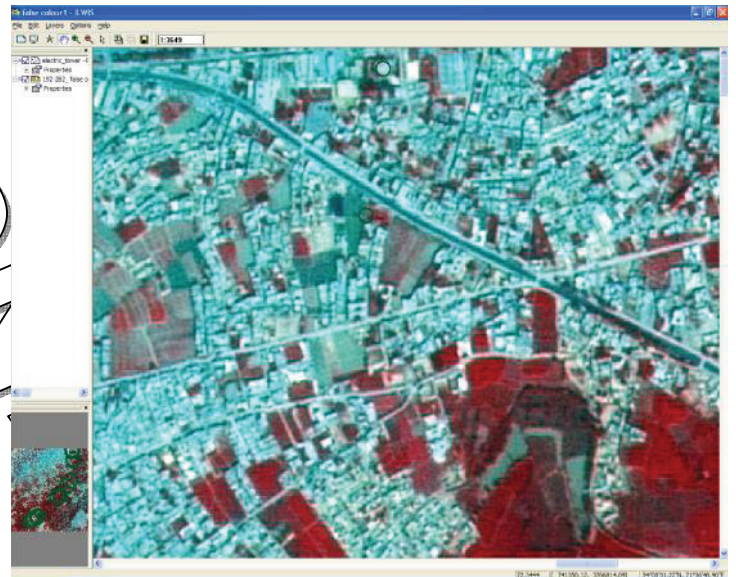


Figure 4. 132-kV city Grid near Gulbahar

### IV. ANALYSIS AND RESULTS

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 2  
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(5) these red circles shows exact locations of towers on satellite image if we zoom it then we can see their exact locations on ground.

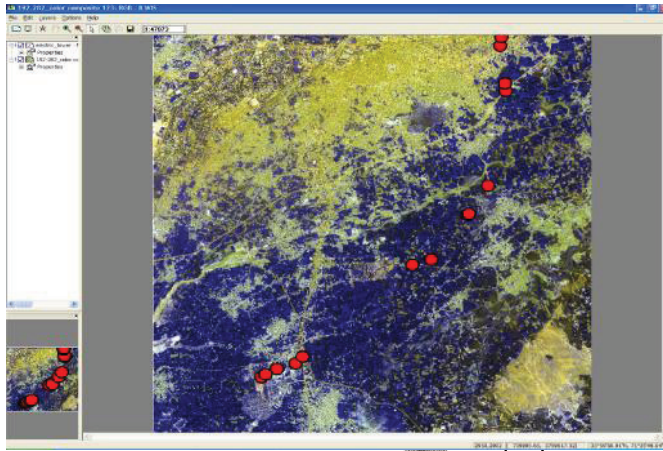


Figure 5. Towers Location on MaP

A final layout map showing all layers in digitized form is shown in fig (6). This map has been drawn using segment map and polygon maps by digitizing different layers present on ground surface.

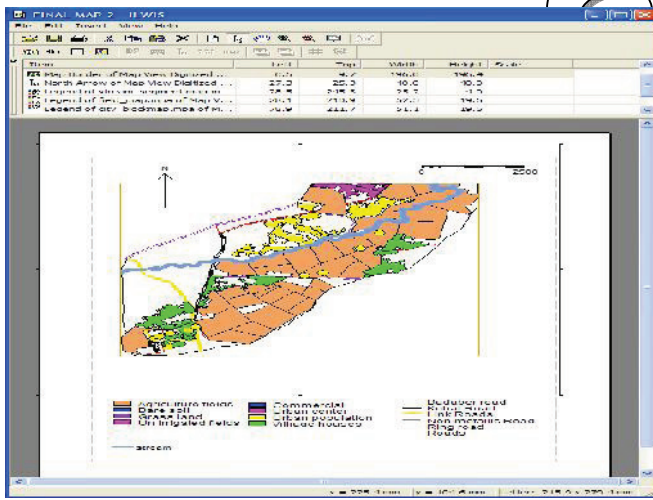


Figure 6. Final Layout Map

Final layout map is now placed on the satellite image shown in fig (7).

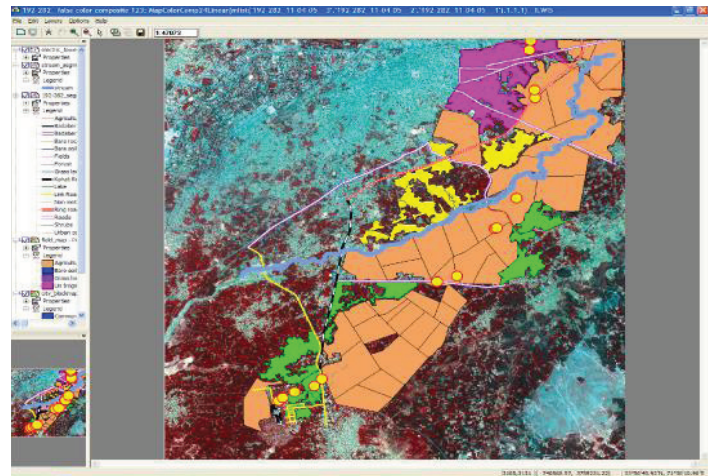


Figure 7. Areas Digitized on Satellite Map

## V.CONCLUSION

The outcome of this paper is by using GIS and Global Positioning system a complete digital map can be made which shows the 132k-v over head line marked on a satellite image and make easier for a planning engineer to do (ROW) management in a cost effective way of a small section of power line compare to costly methods being discussed in other papers as already mentioned. In fig(6) a complete layout map has been drawn which shows all the features present on ground surface like fields, village houses ,roads ,stream and bare soil. Each feature has its own area thus it's easier now to do right of way management of electric power line with this digitized map without going to the site.

## VI. DISCUSSION AND FUTURE DIRECTIONS

This paper clearly shows that for a small section of electric power line this approach is cost effective and reliable LIDAR has been emerging recently as a tool for power line corridor mapping. Combining the data from these two sensors – the LIDAR and digital camera – presents unique challenges, particularly with correctly fusing data from two independent sources. Tests need to be done to find the maximum flight speed that will be within both instruments' tolerance level for accuracy. There is 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, having a proper vegetation management program the important question always remain there for the utility companies to operate at the lowest reasonable cost .

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Currently He is working as an Assistant Professor in the Electrical department; IQRA National University Peshawar .He has written 8 technical papers so far which includes international conferences and journal papers. His major research areas Includes High voltage engineering, Geographic information systems AC and DC drives.

<sup>2</sup> **Waqas Ahmed Imtiaz** got his M.Sc in Electrical Engineering from Blekinge Tekniska Hogskola, Sweden in 2010, and BSc Electrical Engineering from the University of Engineering and Technology Peshawar, Pakistan in 2007. He is currently working as a Lecturer at IQRA National University Peshawar. His research interest is on Mobile Ad hoc Networks (MANET), Seamless Mobility and Sustainable Telecommunication.

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<sup>1</sup> **Kamran Hafeez** received the M.Sc. degree From the University of Engineering and Technology Peshawar in Electrical Engineering in 2008.