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Transmission Lines Monitoring from Satellite Images

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Abstract

This paper presents a technique for the identification of the transmission line in improving the vegetation management for the maintenance of vegetation corridor along the transmission line. A satellite image is scanned pixel by pixel to identify the transmission tower in the image. After successful detection of towers, area of interest is interpolated in the image. This area of interest, only contain the right of way of transmission line in vegetation field. Timely vegetation management can reduce outages. Outages occur due to encroachment of trees. These encroachment cause substantial damages and become reason of electric outages for residential and Industrial areas. The objective of this paper is to enhance vegetation monitoring system based on satellite image. The final outcome is to reduce substantially the amount of information to be processed for vegetation management along the transmission line, especially for remote area where the co-ordinated information is difficult to obtain.

Keywords: Transmission line; encroachment; satellite images ; google image, vegetation management; area of interest; right of way.

I. Introduction

HV power lines consist of conductor which is predisposed to blackouts. Overgrown trees under HV transmission lines may interfere with the circuit operation of the line, which produce the short circuits and may cause blackouts. Blackouts result in heavy economical loss of the power companies. It gives a bad impact on the plant operation in the industrial area and destruct the belief of reliable continuity of electric supply under the electricity ordinance. One example of Blackout is 2006 blackout in the Western United States and Canada .This blackout occurs because of lack of tree trimming and at the same time the high voltage conductor was sagging [I]. Another Example of blackout scenario was in 2003 North America and Europe, facing the electric outages because of the poor management of tree in its transmission Right-Of-Way (ROW) [II]. There are more blackout events which are related to poor

vegetation management [I], [II]. PECO, one of the vegetation management company from Pennsylvania claimed that trees are causing one third of the power outages per year.

Therefore, it is necessary for the electric supply companies to monitor, investigate and manage the vegetation along the power line, in order to reduce similar incidents cause by these power lines against vegetation or other encroachments that can damage the supply of power.

The main object of the vegetation management for transmission line ROW is to prevent vegetation from penetrating into the danger zone. The distance consider as danger zone depends on the voltage level of the transmission line. For example the distance is around 1 foot for a normal distribution line and 24 feet for a 500 KV line [I].Those Trees must be cut or trimmed whenever they encroach into danger zone.

The most common practice around the globe for Vegetation management is ground inspection. In ground inspection a group or team is assigned to visually monitor the condition of over headed power lines. This inspection can be done either by using vehicles or foot patrolling. Ground inspection is labor intensive and time consuming. In highly competitive environments, the ground inspection is not an economical option in carrying out vegetation management. Therefore, some utility are practicing other method in vegetation management. Examples of other methods are video recording from helicopters and LiDAR technology. These methods are still time consuming and at the same time are very expensive. People are looking for better ways for vegetation management. A group of researchers from UTP (University Technology Petronas) are suggesting using satellite image in performing vegetation management [II].

II. Motivation

The major object of this research is to modernize a technique, which includes no airborne, no vehicle or foot patrolling methods of monitoring power lines. Here we are talking about the technique to identify the transmission tower to interpolate the transmission line by using “Image”. These images can be taken by satellite. The object is to identify the transmission towers in satellite image in order to interpolate the transmission line for which an algorithm is designed.

The algorithm is applied on images taken from Google maps for testing purpose. Google Map is one of the revolutionary projects existing in 21st century technologies; it is a web mapping service application provided by Google. In this project, Google map is used to get a sample of Image having a transmission line and with help of algorithms the given sample image will be scanned pixel by pixel to identify the transmission line.

II.a Current Practices for Power Line Monitoring

Vegetation management companies are currently following different practices at different locations. Commonly used methods for monitoring the power lines are ground inspection and helicopter patrolling. In ground inspection as shown in figure 1(a) normally a lineman inspects the power line from ground or climbs the wood pole and holds a piece of mirror on insulation bar or stick for inspection of

power line. These line mans are equipped with device such as computer which carry all information and summary of line. Helicopter patrolling is aerial inspection approach, were they used trained inspectors to fly aboard helicopter to monitor and inspect the line with mounted cameras and binoculars as shown in figure 1(b).The above monitoring techniques are mentioned by few researchers in the literature [I],[II][III],[VI].

Figure 1(a). Ground inspection Figure 1(b). Aerial inspection

LiDAR (Light Detection and Ranging) is another monitoring technique used for identification of the right of way tree trimming. It is an optical sensing system that uses the light to detect and calculate the range of the object distance. LiDAR imaging method gives efficient result but it is very expensive [I]. LiDAR has three components which are most common in all techniques.

- DGPS (Digital Global Positioning System) to locate the location of the aircraft in space.
- LRF (Laser Range Finder) use to define the distance between object and aircraft.
- INS (Inertial Navigation System) to define the positioning of aircraft in space.

LiDAR technology uses active laser signal to detect the object which is fired from the aircraft towards the ground. It records the distance between the surface and aircraft by the time delay between the send and receive of the fired signal [I], [V].

The information spawned by the LiDAR system is plotted in the GIS to extract the coordinated of the target. These methods of monitoring has been graded or ranked according to time accuracy and cost in the given below Table 1[II].

Table1.Techniques For Monitoring Vegetation In Transmission Line

Methods	Cost	Time	Accuracy
Airborne	Very high	Moderate	Low
Field survey	High	Very high	Low
Videography	Very high	Modertae	Moderate
LiDAR	Very high	Moderte	Very high

The use of Satellite images for the detection of the encroachments trees in transmission line can be a good improvement for the identification process. This encroachment can be reason of outages and black out of power line distribution. Satellite images provide improvements over direct monitoring by airborne or helicopter. These image processing based on concept of

- Wide area coverage
- Restricted areas can be viewed
- Frequent overhead passes
- Lower in cost because of processing large geo-data.

Satellite images can be used for identification of ground features, but the important issue relates is the utilization of stereo image processing. Processing of these stereo images allows us to extract the information for the observed terrain. A satellite is infinitely far from the ground surface so it's necessary to access more than one image that can be two or more separate images with different angles. The cost to achieve acceptable level of resolution is an unresolved issue, because of high cost of stereo, multispectral satellite image. Because of the wide coverage and fast processing the demand of satellite image is increased which has decreased the cost of satellite images, especially in the purchase of large quantity of images [VII].

Satellite images can be bigger image according to its size; it can be either 10 miles by 10 miles or less or more. Our part of interest and object is to reduce the size of the image to our aim that is the transmission line, were the area covered by the transmission line can be less than 1% of the total size of the image.

III. Methodology

This paper investigate and study the identification of transmission line from the satellite images. Satellite images are one of the revolutionary achievements achieved in past few decades. It contains wide information which can be used in various fields; our object is to interpolate the transmission line by identifying the transmission tower in the view of encroachment tress affecting the transmission line in the right of way corridors. Google Images instead of Satellite images are used for the testing purpose of the algorithm. An image is extracted from the Google images

which are used as sample image for the identification of the transmission line in field of vegetation management.

Figure 2: Sample image from Google Maps.

Reason of using Google image rather than satellite image is satellite images are not easy to access. These images are online and updated with interval of time which makes them costly and not accessible for ordinary view. The algorithm designed for the identification purpose will work better on the satellite images because of its high resolution.

To achieve the output the process can be illustrated in few steps. An image of vegetation field having transmission line in there right of way corridor is taken for the identification purpose. Since transmission lines are not easy to be visible so we approach transmission tower to interpolate the transmission line. First of all a Google sample image is extracted from the Google map. These images contain transmission line which is our object to detect with the help of algorithm. The core motivation of the paper is to help the monitoring system using satellite image in the vegetation management. The process of tower detection can be illustrated in the following stages.

I. Algorithm that can scan satellite images to detect the transmission towers to interpolate the transmission line.
II. A technique to introduce AOI in the image to overcome the delay issue in processing time of image by eliminating the un-necessary data.

Following list describes the general steps that are performed by the algorithm for identification of transmission towers to interpolate the transmission line.

- Load and display satellite image containing Transmission line.
- Filtering of image to minimize and limit the data of image.
- Creating tower library.

- Scanning the image for transmission tower.
- Displaying detected objects in image.
- Eliminating non tower detections.
- Introducing area of interest i.e. transmission line and its right of way

There are many several computers programming available that can be used to implement different algorithms and techniques, these techniques can be used to processes large scale satellite images and can be used as image processing tools.

III.a Load and display satellite image

The very first step is the reading of the images .These images contains wide information in form of pixels. The algorithm read the image and extract the information i.e. size colors & layers. The feature used works on gray scale method so the image is first converted in to the gray scale.

III.b Filtering of the image

The converted gray scale image of terrain contains a lot of non-relevant data i.e. trees and roads. This data on scanning pixel by pixel delays the processing time of simulation. In order to remove the non-relevant data from image a method of filtration is introduced in algorithm.

Figure 3: Filtered image that contain towers

III.c Creating tower libraray

Tower images as known as reference images are loaded into algorithm to extract the transmission tower information. The reference images are scanned pixel by pixel and all the data is extracted and saved in tower library. The algorithm calculates the histogram of each tower presented in the library and takes

the average of the histogram of each tower one by one. With the help of obtained histogram of each tower a threshold value is introduced. This threshold value is further used for the identification of the tower in the image .

III.d Scanning of Image.

After loading the satellite image and tower library in the algorithm, the image is scanned pixel by pixel. The scanning of the image is done either horizontal or vertical. The sample image is divided into sequence of sub images, these sub images are scanned one by one in the horizontal technique and average histogram is calculated for each sub image. These histogram values are further used for the detection purpose. During scanning of image a limit is set between low and high values of threshold which is obtained from tower library.At every scan of subplot these threshold values are monitored, every average histogram value between the lower and higher threshold is considered as match i.e. tower. The location of the detected towers is stored in matched point's library in term of coordinates and remaining non relevant values are discarded.

III.e Detected Objects

After successful completion of the scanning process, an image is shown as result which contains all the detected objects in the sample image. A polygon box is placed on the detected location to highlight it for better visibility.

Figure 4. Detected objects in the image

III.f Detected Tower

In order to overcome the issue of detecting non-relevant objects and to increase the accuracy of the detection of towers another filtration method is implemented on the algorithm. In this technique the algorithm subtracts the average histogram of the each tower with the average histogram of the scanning of the image. The subtraction gives the minimum value once the scanning image overlaps the tower image; this minimum value is set as threshold value for filtration. Any value bigger then threshold value is discarded and the value less than or equal to is considered as perfect match.

Figure 5: Towers detected in the image

III.g Line Interpolation

Discovering of the transmission line in the image is carried out by connecting the towers with each other. To obtain the line on the image, detected tower coordinates are extracted from the matched point's library. A set of commands are introduce in the algorithm to draw line on the image with help of location points. These commands help to enhance the visibility of line on image like increasing the width and color of the line.

Figure 6: Line interpolation in the image

III.h Area of interest

Area of interest is the only area under and around the transmission line. In other words it is the right of way of transmission line corridor. After successful interpolation of line in image between transmission towers area of interest is introduced. By area of interest it is cleared that only the transmission towers and transmission lines are visible and the rest of image is set as blank by making it black.

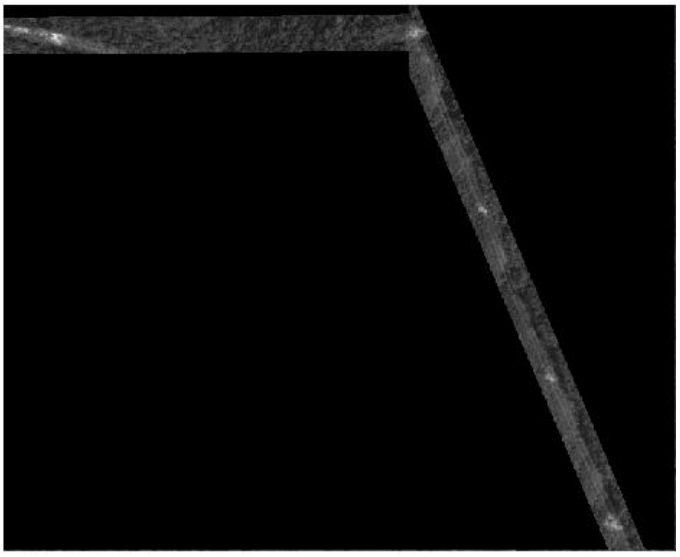

Figure 7: Final result; image with area of interest

The above shown image is the output result of the sample image taken from the Google map. This image is extracted and the information is minimizing to our requirement and interested area according to right of way is obtained.

By extracting the image to the limited condition and area of interest, it can save a lot of processing time for the purpose of the identification for vegetation management. Using the area of interest, then less work will be required to identify the kind of vegetation existed along the transmission line.

IV. Conclusion

This paper contains a comprehensive technique for the detection of transmission line from satellite image. The algorithm is tested on sample images obtained from Google map, which will expectedly work same on satellite image. The purpose of this paper is to help the vegetation management to monitor the encroachment trees which are becoming the reason of blackouts.

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