



Satellite Imagery for the Identification of Interference with Overhead Power Lines

Final Project Report

Power Systems Engineering Research Center

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of Interference with Overhead Power Lines**

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PSERC Publication 08-02

January 2008

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Power Systems Engineering Research Center

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Acknowledgements

The work described in this report is for research sponsored by the Power Systems Engineering Research Center (PSERC) project “Satellite Imagery for the Identification of Interference with Overhead Power Lines”, project T-37. We express our appreciation for the support provided by PSERC’s industrial members and by the National Science Foundation under grant NSF EEC 0001880 received under the Industry / University Cooperative Research Center program.

The authors thank industry and government collaborators including Clark Love (Forest One), James Crane (Exelon), Charles Priebe (Exelon) and Phil Overholt (U.S. Department of Energy).

Executive Summary

In recent years, renewed emphasis has been placed on vegetation management of transmission right-of-way to avoid tree contacts that could put system reliability at risk. At the same time, new approaches to vegetation management have been sought to be able to achieve the needed tree clearances as cost-effectively as possible. One possible approach is to process satellite images to prioritize tree maintenance work. For this approach to work, new computational tools would be needed to convert satellite image data into useful information for vegetation management scheduling.

This project's objective was to develop such computational tools for determining the location of trees interfering with overhead transmission lines. The input data were derived from satellite images, and the GPS coordinates and altitudes of transmission towers. The tools determine the location of healthy trees that are penetrating a danger zone or safety envelope (e.g., 20 ft radius) surrounding the conductors. Two tools were implemented and tested:

- a transmission line scanning computer program and
- a tall tree identification program.

This work is significant because it shows how satellite images that are already commercially available can be used for the large-scale assessment of vegetation encroachment on transmission lines.

Transmission Line Scanning Computer Program

The Transmission Line Scanning Computer Program uses *multi-spectral satellite images* of the transmission line. The input data are GPS coordinates of the transmission line towers, the width of the right-of-way, and the satellite image data. The program is used to scan the satellite image along the right-of-way from one tower to the next following a straight line; spectral analysis of the scanned satellite data is used to identify areas covered by healthy vegetation. Areas with healthy vegetation represent a potential danger for the line because of possible contact between the line and trees. The output of this program is the GPS coordinates of the healthy vegetation. The code was written using the Java (JDK 1.4) programming language with Java Advanced Imaging (JAI) Application Programming Interfaces. The source code is included in the report.

Tall Tree Identification Program

By knowing the location of the healthy trees along transmission line right-of-way, it is possible to use another tool, the Tall Tree Identification Program, to establish where the healthy trees are endangering the transmission line. Danger zones are areas surrounding the transmission line conductors where trees can produce flashover or a ground fault. The Tall Tree Identification Program is designed to identify healthy trees that penetrate the danger zone.

This program uses a *stereo pair of satellite images* of the transmission line. These stereo images are obtained from commercial outlets of satellite images. The input data are 1) the GPS coordinates and altitudes of the towers, and 2) the location of the healthy trees discovered by the Transmission Line Scanning Computer program. The program calculates the dimensions (i.e.,

the width and height) of the danger zone for different voltage levels. The program scans the danger zone pixel by pixel and calculates the elevation of each pixel using stereo matching. The height of each pixel is measured by using the altitudes of the transmission line towers. The comparison of the location and height of the healthy vegetation pixel with the dimensions of the danger zone identifies where trees are penetrating the danger zone. The program outputs are the GPS coordinates of healthy trees in the danger zone and the distance from these trees to the transmission lines.

Case Studies and Next Steps

Case studies were conducted using a transmission line in the San Diego, California area. This line crosses an area with heavy vegetation and pine trees in the vicinity of the San Diego River at Mission Bay Park. Visual observation of the right-of-way along the line verified the proper operation of the Transmission Line Scanning Computer Program in identifying areas of healthy trees. The Tall Tree Identification Program was then used to identify the closest five trees which ranged from 24.3 to 30.1 feet from the transmission line.

The case studies indicate that the developed programs were able to identify trees endangering a transmission line. However, the programs were not fully tested in a utility environment. They are research-grade programs that require additional testing and development. The following is recommended future work to improve the tools:

- Test using the other image files of a different, larger site (such as 60 miles)
- Compare the results from commercial off-the-shelf photogrammetry packages
- Visualize the Digital Elevation Model data in 3D view
- Add query functions to the extracted trees
- Add more control units to allow the users to change the attributes of transmission towers and lines flexibly and interactively.