Advanced Image Processing for Automatic Pipeline Right-Of-Way Threat Detection

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Advanced Image Processing for Automatic Pipeline Right-Of-Way Threat Detection

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Varying illumination (cast shadows, sensor artifacts)
Varying viewpoint and orientation
Partial occlusions (objects are occluded by overhanging trees)
Different scale due to various altitudes of the flights
Varying resolution due to image capturing systems

Cast Shadows  Low illumination  Over exposure
Oclusion  Small scale  Low resolution

Objectives
- To prevent human-caused damages to subsurface pipelines
- To detect machinery threat on pipeline Right-of-Way
- To detect and classify various types of construction vehicles and machinery on the Right-of-Way

Challenges

Background Elimination

The key idea of developing the background elimination technique was to segment out undesired information in aerial imagery for faster threat identification. Our segmentation technique can be categorized into two phases: Local Textural Feature-based Segmentation (LTFs) and Adaptive Perception-based Segmentation (APS).

Part-based Model for Object Recognition

The purpose of developing a part-based model was to cope with partial occlusion and large appearance variations. The following graph shows the main concept of our part-based model.

Machinery Threat Detection Results

Performance Evaluation

Ongoing Work and Future Objectives

- Classification of the objects using a deterministic-probabilistic Bayesian model for improving the detection rate
- Optimization of background elimination using probabilistic HLP-SVM
- Preparation of a complete software package for machinery threat detection

Projected Detection Rate

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Threat Detection Methodology

The threat detection procedure is broken into twelve steps. Additional processes can be incorporated to improve the object recognition rate.

1. Raw Image
2. Local Textural Feature-based Segmentation
3. Local Phase Extraction
4. HLP-SVM Training
5. House Elimination
6. Trees Elimination
7. Other Objects Elimination (grass, roads, etc.)
8. HLP-SVM Training
9. Part-based Model Construction
10. Object Classification
11. Threat Priority Assignment
12. Detection Output

HLP: Histogram of Local Phase  SVM: Support Vector Machine