



VISUAL LEARNING
SYSTEMS

Automated Feature Extraction and Change Detection Software for Disaster and Emergency Management

The Feature Analyst™ Extension for ArcView®,
ArcGIS™, and ERDAS IMAGINE®

Visual Learning Systems, Inc.

We put the information in GISsm

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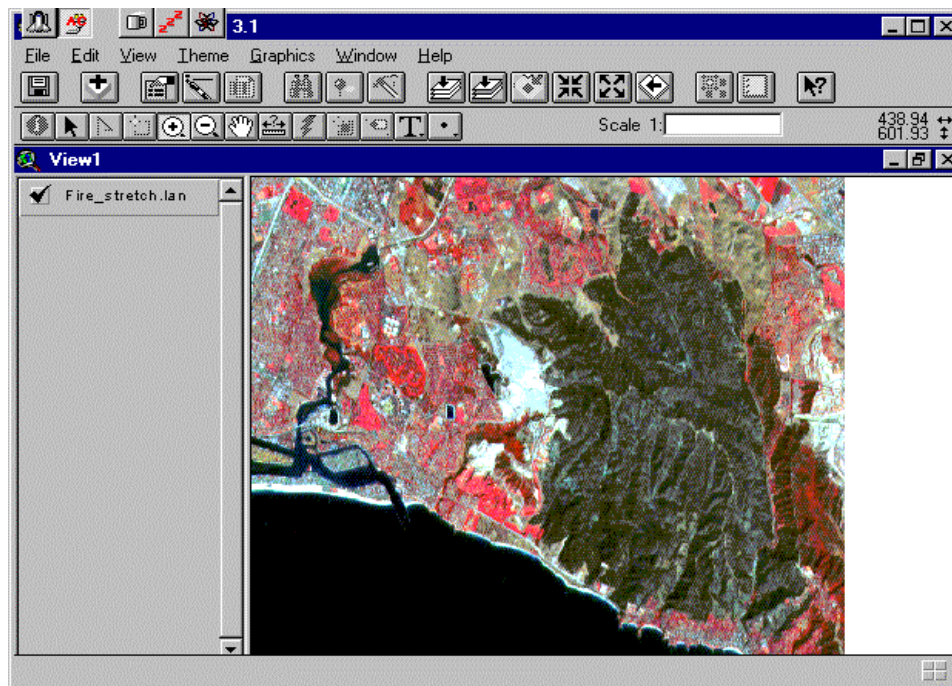
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FEATURE EXTRACTION

Airborne and satellite imaging of the earth provide disaster and emergency services (DES) managers with an “eye in the sky” view for rapid assessment of infrastructure damages caused by catastrophic events such as wildland fires, earthquakes, or terrorism. Extracting information from images to support geographic information systems (GIS) represents a major bottleneck in the race against time. Communication centers and responder teams increasingly rely on GIS technology to map the current condition of features such as roads, buildings, bridges, and structures. At stake is the Golden Hour, the narrow window of time when emergency medical services can mean the difference between life and death for victims.

The Feature Analyst extension for ArcView® 3.x, ArcGIS™ 8.x, and ERDAS IMAGINE® 8.X software provides you with a powerful new tool for extracting object-specific geographic features from aerial and satellite imagery. Traditional methods for capturing geographic information from imagery, such as heads-up digitizing, are time-consuming and often fail on complex scenes. The Feature Analyst integrates machine learning technology into the GIS database creation and maintenance workflow, providing tremendous cost savings in labor. The result is a new workflow for maintaining the temporal currency of geographic data.



Satellite multi-band image of burn area for DES management

CHANGE DETECTION

Closely related to the need for automated feature extraction to support GIS analyses is the need for timely and accurate damage assessments. Change detection is the process of comparing digital images collected at different times over the same geographic area to determine change. Current techniques require expert image processing and user-defined thresholds which arbitrarily measure change. Errors are easily introduced into the current change detection processes as a result of image-to-image registration problems, shadows from buildings, and look-angle.

Automated change detection using multi-temporal images is a core technology of the Feature Analyst Professional version for ArcView, ArcGIS, and IMAGINE. Ongoing research with the NASA Jet Propulsion Laboratory and University of Montana Wildlife Spatial Analysis Laboratory shows the tremendous advantages of using multi-date imagery to determine categorical change parameters such as the change in the number of structures after a fire or hurricane.

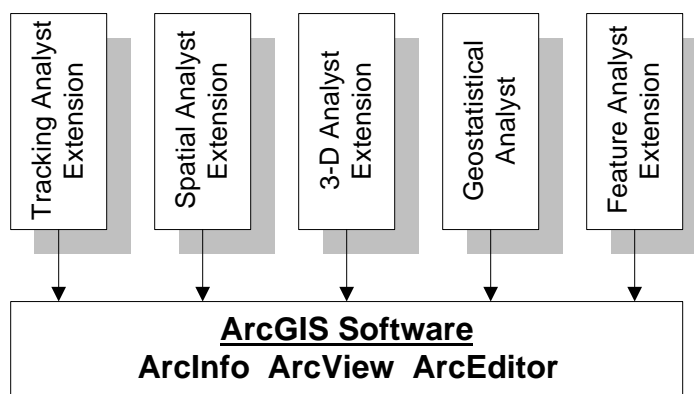
PRODUCT DESIGN

Key design elements of the Feature Analyst extension for ArcView, ArcGIS, and IMAGINE software include:

- A suite of machine learning algorithms that learn how to classify the geographic features based on examples specified by the user.
- Hierarchical learning methods for mitigating clutter. This innovative method (patent pending) is essential for accurate extraction of features in complex scenes such as urban landscapes.
- The ability to use spatial context when extracting features. The Feature Analyst uses spatial context and spectral information to extract features. For example, in order to recognize roads and not parking lots, one must be able to see the sides of the road.
- An adaptive user interface that hides the complexity of the underlying machine learning system from the average GIS user. Our software is designed for GIS and image analyst technicians who may not be familiar with machine learning. The adaptive interface hides the complexity of the extraction process, making the software fun and easy to use.

PRODUCT POSITIONING

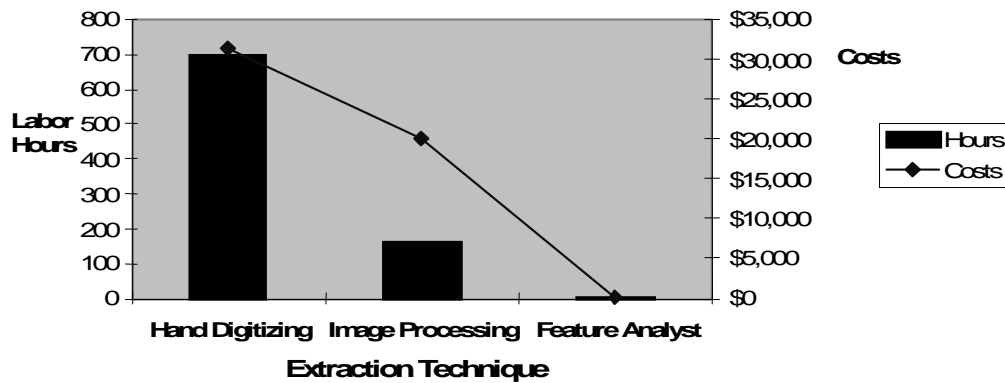
Feature Analyst complements existing ArcView GIS 3.x and ArcGIS 8.x extensions such as the ArcView Spatial Analyst. Feature Analyst is tightly integrated with the extensions shown in the diagram below.



- The Feature Analyst improves the efficiency of extracting geographic feature data from high-resolution satellite and aerial imagery.

- The shelf life or temporal currency of geographic features varies as a function of ground sample distance (GSD) commonly referred to as image resolution.
- Organizations that rely on GIS analyses must now address the labor and cost issues of maintaining GIS databases using high-resolution imagery. The Feature Analyst extension for ArcView, ArcGIS, and IMAG-INE provides a solution for this business problem.
- Cost-benefit analysis of a feature extraction project using 0.5 meter multi-spectral imagery collected over the Presidio area of San Francisco indicates that the Feature Analyst can improve the feature extraction process by a factor of 100 to 200 times compared to hand digitizing methods.

Cost-Benefit Analysis for Feature Extraction Techniques for the 1999 Multi-Modality Image Fusion Project

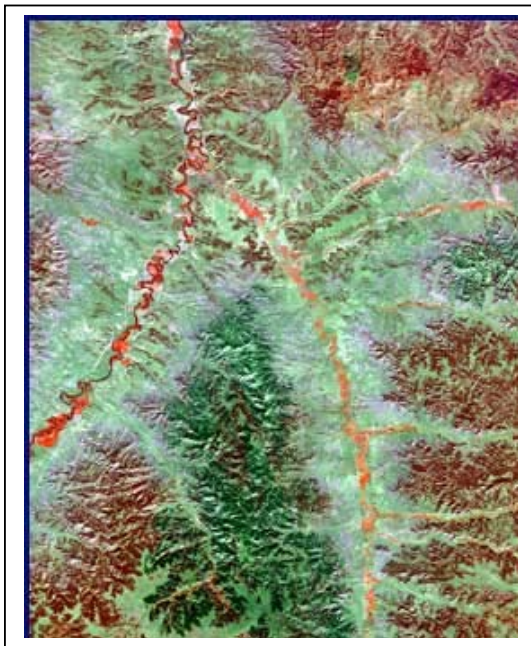


FUNCTIONAL DESCRIPTION

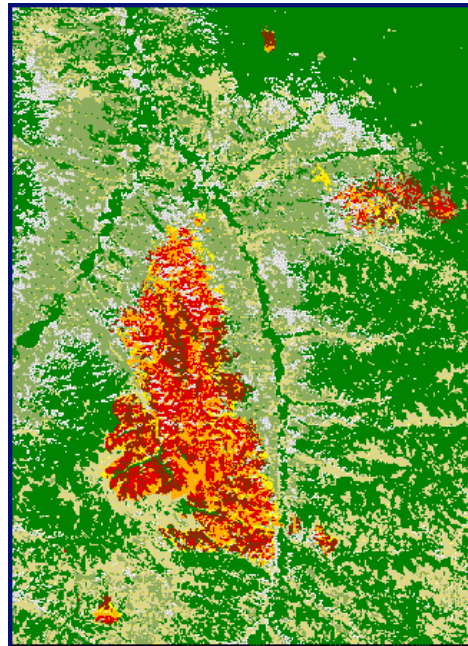
The Feature Analyst extension for ArcView GIS and ArcGIS provides you with a powerful and sophisticated suite of machine learning algorithms and techniques. Feature extraction technology is tightly integrated into the ArcView GIS capabilities, tools, and commands.

Feature Analyst includes:

- Access to industry standard image data types and formats in the ArcView, ArcGIS, and IMAGINE environment.
- Learning Wizard for object-specific feature extraction using state-of-the-art machine learning algorithms.
- Hierarchical Learning for clutter mitigation to extract objects in complex and cluttered scenes.
- Software Agent technology for adaptive learning.
- Spatial Representation for inclusion of spatial context in the object-specific feature extraction process.
- Image Fusion for enhanced target recognition and feature extraction.
- Learning Library for importing and exporting learning recipes for user-specified geographic feature classes and published data models such as roads, hydrology, and buildings.



Raw Landsat 7 image of wildland fire



Feature Analyst Classification

DES APPLICATIONS

The Feature Analyst technology represents a paradigm shift in GIS database maintenance by integrating machine learning into the geographic feature extraction workflow process. Hence, any type of DES application that uses GIS will benefit if high-resolution imagery represents the fresh source of geographic information for the geospatial database.

Examples of DES applications that use digital imagery include:

- Flood delineation
- Wild-land fire tracking
- Hurricane and typhoon damage assessments
- Infrastructure analysis for managing first-responder teams
- Land cover and land-use mapping using IKONOS, IRS, or Landsat satellite multi-spectral imagery
- Change detection for user-defined objects such as structures, vegetation, bridges, and road networks

These features are encompassed in a user-friendly interface designed for the GIS analyst who may not have a background in image processing or remote sensing.