Multitemporal Analysis for Disaster Management and Response using Evolutionary Computation

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Goals

To develop an innovative tool to extract specific feature types from remotely sensed imagery to improve disaster response and recovery efforts.

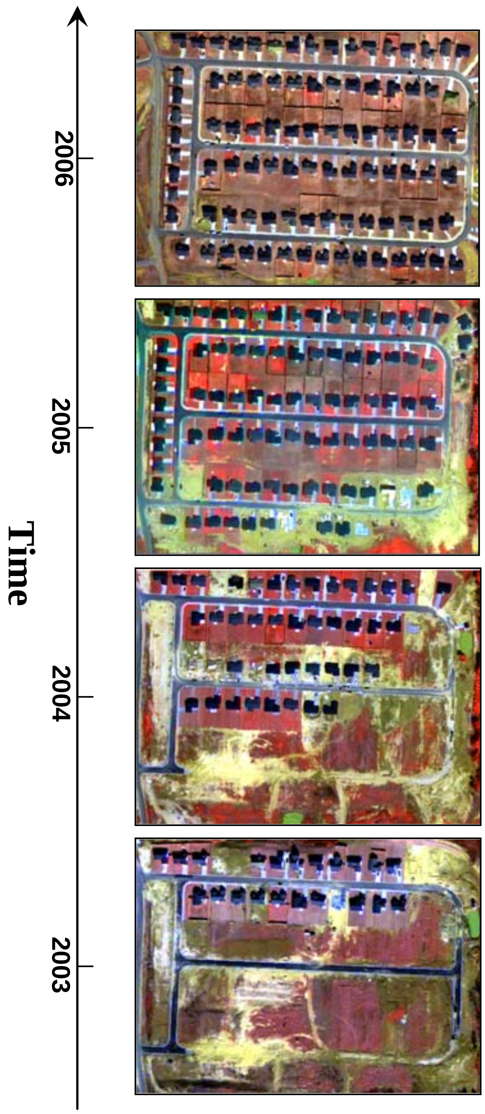

Figure 1. Multitemporal satellite images showing land use change over time. Solutions developed using the 2003 scene and then successfully applied to the remaining scenes showing multitemporal capability of the method.

Project Overview

Situations such as emergency response and disaster recovery require information to be acquired in timely and cost-effective fashion from a variety of data sets. Remotely sensed data has gained the attention of emergency responders and managers as an important source of information to more efficiently access infrastructure changes in urban areas due to natural disasters and/or terrorist attacks. As a result, research has been conducted to develop multitemporal imagery classification techniques.

During disaster mitigation and recovery operations, important information has to be collected on operational basis by non-image analysts. Remote sensing parameters such as the type of remote sensing data to be employed (spatial, spectral, and temporal resolution considerations), image processing techniques, and the search for appropriate images in archives, constitute an additional level of difficulty to the process. Thus, human investigation over large areas (and therefore large amount of image data sets) can be costly and time consuming.

To address this need, our goal is to develop an innovative methodology to assist disaster response efforts in which image processing personnel can use the methodology to develop robust classifiers from a single and representative image (Figure 1 2003 scene).

These classifiers would then be used by non-image analysts during emergency situations to extract information from a set of multitemporal images (Figure 1, 2004 to 2006). The classifiers are designed to make use of non-linear spectral relationship between the features of interest. Classifiers are developed using a framework based on genetic programming and standard unsupervised clustering algorithm (Figure 2).

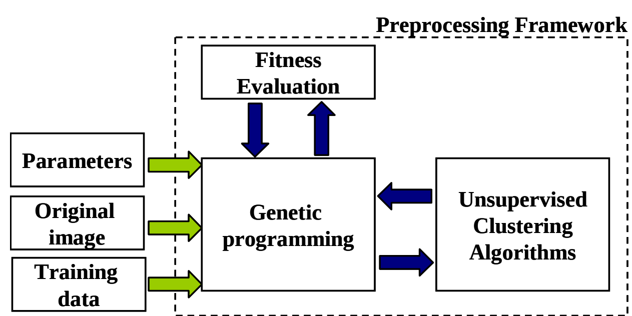

Figure 2. Conceptual diagram illustrating the main components of the evolutionary framework.

CONCLUSIONS

The tools developed with evolutionary computation used the nonlinear relationship between image features (Figure 3) resulting in highly accurate feature extraction when compared to human classification (Figure 4). In addition, results also indicated that the tools developed are able to adapt to changes in environmental variables such as acquisition time, soil moisture, atmospheric composition during acquisition time, and spatial extent of the land use changes.

For these reasons, the developed methods constitute a valuable tool for emergency responders and managers to quickly assess changes in the features of interest to determine the extent of damage from a disaster. The multispectral classification capability offers an opportunity to access temporal changes not only in prior and post event comparisons fashion but also to monitor long term recovery efforts.

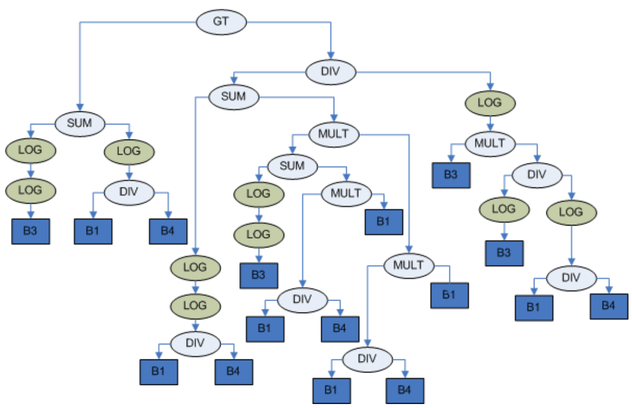

Figure 3. Example of non-linear model developed to spectrally separate asphalt-based materials from the remaining image background for QuickBird images.

IMPACTS

The product of this research is an important tool to assist emergency responders and geospatial intelligence personnel in the extraction of vital information from large quantities of imagery data in a timely and cost-effective way by reducing human interaction.

Figure 4. 2007 rooftop classification results obtained with the models developed using the 2003 image.

<u>Contact Information</u>

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