# Visual Comparison for Satellite Multi-Spectral Images


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## Abstract

The analysis of images helps people to gain insights by extracting geographic features and showing variances between them. However, it is hard to analyze the underlying events further without users' participation and initiative. To solve this challenge, we proposes a visual analytic system based on collaborative tagging techniques to allow users to identify features and events from multi-spectral images. We evaluate our system with Mini Challenge 3 of VAST Challenge 2017. The results show that our system can solve the tasks of this challenge effectively.


## 1 Introduction

Despite there are lots of image processing algorithms for images, it is hard to efficiently make comparisons for different images and analyze their differences [2]. In the VAST Challenge 2017 Mini Challenge 3 [1], the task is to identify features in the preserve area and detect the features that change over time. The dataset provided are multi-spectral satellite images. Analysis of them requires much human knowledge, so how to combine the computation capabilities and human experience together is quite significant and challenging.

Information visualization is often motivated as a way to leverage the innate human visual processing capacity for the analysis of data and provide users with the insights [3]. To identify features and detect changes from multi-spectral images, we propose a visual analysis pipeline(as shown in Figure 1). In Features Identification step, features in the images are identified in the Image Tagged View and recorded in Image Matrix View. In Change Identification step, changes based on the detected features are identified in the Image Comparison View and also stored in Image Matrix View. Based on this, we develop the visual analytic system(as shown in Figure 2) to support these desirable functionalities. This system is based on collaborative tagging techniques.

This work makes the following contributions:

- An analysis pipeline to help people to analyze the features, changes and the underlying events efficiently.
- A visualization system for image exploration based on the collaborative tagging method.

## 2 Background

In VAST Challenge Mini Challenge 3, the dataset contains 12 multi-spectral images of a preserve on different dates. Our tasks are to identify features in the preserve area captured in the images and detect the features that change over time. The data files are from a multispectral sensor with six different bands (B1 B6).

Each of bands can be useful in assessing different land covers. B1, B2 and B3 represent portions of the visible spectrum. B4, B5 and B6 represent longer wavelengths that are beyond human perception. Different channel combinations could help users to detect specific features, such as the combination of channels B4, B3, B2 could be useful in showing changes in plant health.

In our system, we display 10 channels and channel combinations in total for each multi-spectral image to detect different features. Considering the dates and channel combinations, there are 120 different images totally.


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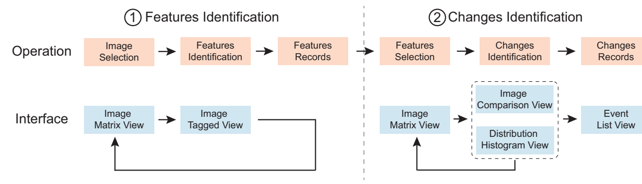


Figure 1: Analysis Pipeline.

## 3 Visual Analytic System

Our visual analytic system contains two major components: Features Identification Component and Changes Identification Component. These two components constitute the entire process of the image analysis. The second step(Changes Identification) is based on the detected features from the first step(Features Identification).

### 3.1 Features Identification Component

Features Identification Component has two views, Image Matrix View for selecting interested images and recording the detected features, Image Tagged View for identifying features from the images and adding tags on the images. Once added tags, the detected features will be shown in the image matrix view.

In Image Matrix View(as shown in Figure 2(1)), images are arranged horizontally according to the time sequence and each row is images derived by different channels combinations, which constitute a image matrix. For each image in the matrix, the detected features are placed adjacent to it.

Image Tagged View allows users to lasso the interested area and add descriptions to the selection. The interface is shown in Figure 2(2). If the detected feature is submitted, the feature is added into the Image Matrix View.

### 3.2 Changes Identification Component

To select and compare the features to obtain the changes, Image Comparison View mainly exploits four views: Image Matrix View, Image Comparison View, Distribution Histogram View and Event List View.

Similar as the Features Identification Component, Image Matrix View also supports the image selection and detection results records. In the Changes Identification Component, if users select two images, the images with tags will be displayed in the Image Comparison View(as shown in Figure 2(3)). At the same time, the selected features are highlighted with black border in the Image Matrix View.

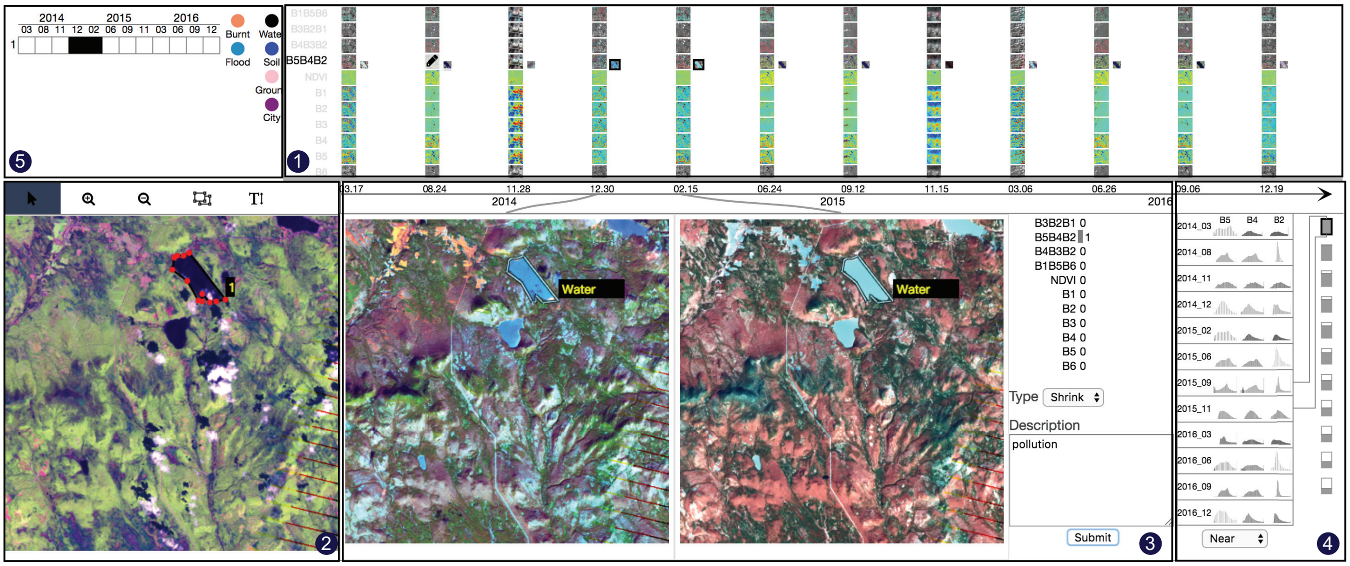


Figure 2: Collaborative Tagged System. 1. Image Matrix View. It provides users with the overview of the whole images 2. Image tagged view. It enables users to add tags to the satellite images. 3 Image comparison view. It allows users to compare the detected features to get the events. 4. Distribution comparison histogram. It computes the color distribution histogram through the selected regions. 5. Event list view. It is the overview of the detected events.

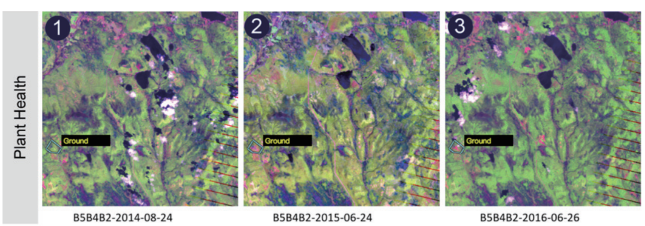


Figure 3: Fire Event. The fire occurred in the marked region and images are generated under the channel B5B4B2. The area in red is the newly burned ground.

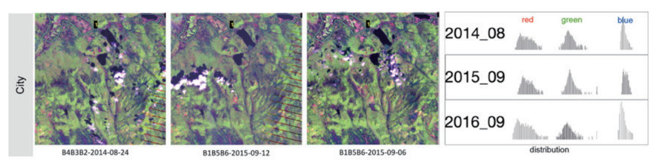


Figure 4: Urbanization. The marked area shows the city regions. The distribution in the right shows the values distributions in different channel of the selected region.

Both Image Comparison View and Distribution Histogram View(as shown in Figure 2(4)) are designed to compare images from the image and statistics perspectives. The Distribution Histogram View shows the pixel values distribution of the selected area and the height of black bar shows how much diffrence of the linked two histogram. By clicking the difference bar, Image Comparison View will display the two linked images. Once finding an event, user can describe this event with text and submit to the system.

Image Matrix View and Event List View(as shown in Figure 2(5)) can record the detected changes. In the Image Matrix View, the detected changes are noted in the number adjacent to the features, and in the Event List View, each row of rectangles respresents an event and the color of higlighted rectangels encodes the event category.

## 4 Results

We pesent two envents in the given images with our systems.

In Figure 3, the tree images are derived by channel B5B4B2, in which newly burned ground appears red. In the selected area, it's obvious that on Aug. 24th, 2014, this area was covered with green while there was newly burned ground on Jun. 24th, 2015. In the next year 2016, this area recovered a little with more green land.

Another event is about urbanization. Purple areas are often considered cities or towns under channel B1B5B6. From Figure 4, we could learn that the city is becoming larger and darker along the time. The distribution histograms also support users exploration. From the histograms in Figure 4, we could see that the red channel and blue channel, which could be combined to get purple, are becoming denser and having more large values with the evolution of time, so we speculated that during the three years, there is a trend of urbanization.

## 5 Conclusion

To meet the challenge of detecting features and changes from the images, we focused on collaborative tagged method and developed a visual analytics system with an analysis pipeline. We use VAST Challenge 2017 dataset for case study to demonstrate the effectiveness of the system, which enables users to analyze images efficiently.

## Acknowledgments


The authors wish to thank IEEE VAST Challenge committee and reviewers. This work is supported by PKU-Qihoo Joint Data Visual Analytics Research Center.


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