Visual Analysis for Multi-Spectral Images Comparisons

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Abstract

The analysis for images helps people to gain insights by extracting the inner features and variances between them. However, it is hard to analyze the underlying events further without users participation. We proposes a visual analytic system based on collaborative tagging techniques to allow users to identify features and changes from multi-spectral images. We evaluate our system with mini challenge 3 of VAST Challenge 2017. The exploration results validate the efficiency and effectiveness of our system.

1 Introduction

Despite the abundance of image processing algorithms for images data, it is hard to make comparisons for different images and analyze the differences efficiently [2]. Taking the VAST Challenge 2017 mini challenge3 [1] as an example, the tasks is to identify features, more specifically, sub-area of image and detect changes over time. The dataset provided are multi-spectral images from satellite system, the analysis of which require much human experience, so how to combine the computation capabilities and human experience together is quite significant and challenging.

Information visualization leverages the innate human visual processing capacity [3]. We propose an visual analysis pipeline (as shown in Figure 1). In Features Identification step, features of images are interactively identified in Image Tagged View and recorded in Image Matrix View. In Change Identification step, changes based on the detected features are identified in 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 challenge3, the dataset contains 12 multi-spectral images of a preserve on different dates. Our tasks are to identify features in the preserve area as captured in the imagery and detect the features that change over time. The data files are images from a multispectral sensor with six different bands (B1 - B6).

B1, B2 and B3 represent portions of the visible spectrum. B4, B5 and B6 represent longer wavelengths that are beyond human perception. Single and combinations of multiple bands could help users to detect specific features, for example the combination of channels B4, B3, B2 could be useful in seeing changes in plant health. The computation results could also be useful in some cases.

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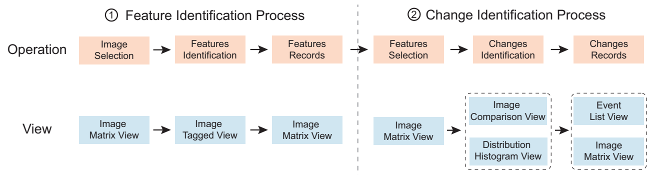

Figure 1: Analysis Pipeline. The operations on the top correspond to the views on the bottom respectively.

3 Visual Analytic System

Our visual analytic system contains two processes: Feature Identification Process and Change Identification Process. These two components constitute the entire process of the image analysis. The second step (Change Identification) is based on the detect features from the first step (Feature Identification).

3.1 Feature Identification Process

Feature Identification Process leverages two views, Image Matrix View for selecting interested images and recording the detected features, Image Tagged View for labelling features from the images and adding tags on them.

In Image Matrix View (as shown in Figure Figure 2(a)), images are arranged horizontally according to the time sequence and each row contains images derived under different band or bands combinations. For each image in the matrix, the detected features are placed adjacently 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(b). After submitting the detected features, the features is added into Image Matrix View.

3.2 Change Identification Process

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

In Change Identification Process, Image Matrix View also supports features selection and recording of comparison results. In Change Identification Process, users select two features and the images with tags will be displayed in the Image Comparison View (as shown in Figure 2(c)). At the same time, the selected features are highlighted using black border in the Image Matrix View.

Image Comparison View enable users compare images and interactively define events, and Distribution Histogram View (as shown in Figure 2(d)) support the comparison from the statistics perspective.

Both Image Comparison View and Distribution Histogram View (as shown in Figure 2(d)) are designed to compare images from the and statistics perspectives. The Distribution Histogram View shows the pixel values distribution of the selected area and the height of

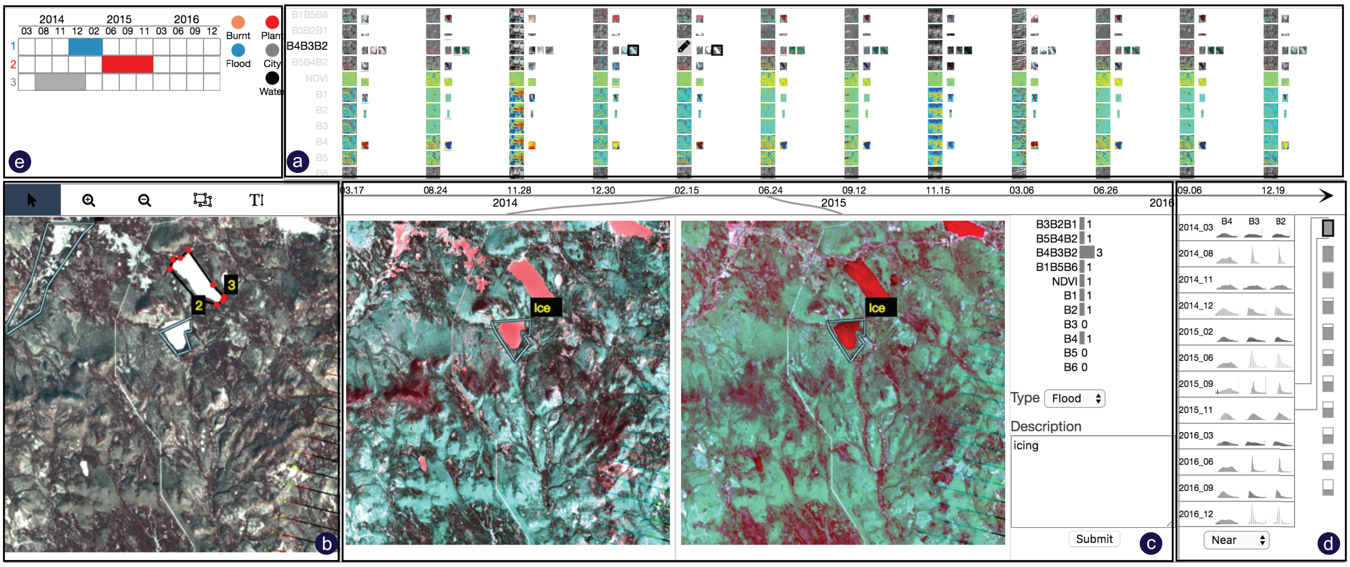

Figure 2: Collaborative Tagged System. a. Image Matrix View. It provides users with the overview of the whole images b. Image Tagged View. It enables users to add tags to the satellite images. c. Image Comparison View. It allows users to compare the detected features to get the events. d. Distribution Comparison Histogram. It computes the color distribution histogram through the selected regions. e. Event List View. It is the overview of the detected events.

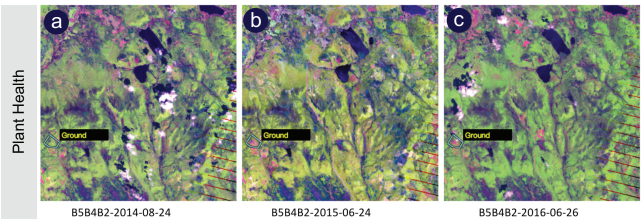

Figure 3: Fire Event. The fire occurred in the marked region and images are generated under the band B5, B4 and B2. The area in red is the newly burned ground.

black bar shows how much difference 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(e)) 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, changes are visualized as the colored rectangle, the color of which encodes the event category.

3.3 Change Identification Process

4 Results

In this section, We present two cases detected with our system.

In Figure 3, these three images are derived by combination of band B5, B4 and B2, in which newly burnt 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 burnt ground on Jun. 24th, 2015. In the next year, this area recovered a little with more green land.

Another event is urbanization. According to the given background information, Purple areas are considered as cities or towns in the image generated from the combinations of band B1, B5 and B6. From Figure 4, we could learn that the city is becoming larger and darker along the time. The distribution histograms also validate users exploration results. From the histograms in Figure 4, we could see that the red channel and blue channel are becoming denser and having larger values, which is consistent with the larger city area, with the evolution of time, so we speculate that there is a trend of urbanization between 2014 and 2015.

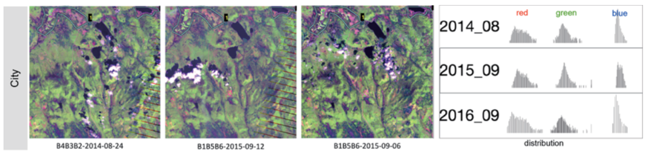

Figure 4: Urbanization. The marked area shows the city regions. The distribution in the right shows the distributions in different channels of the selected regions.

5 Conclusion

To meet the challenge of detecting features and changes from the images, we focus 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 conduct images exploration easily.

Acknowledgments

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References

[1] http://vacommunity.org/vast+challenge+2017+mc3.

[2] J. Schmidt, M. E. Grller, and S. Bruckner. Vaico: visual analysis for image comparison. *IEEE Transactions on Visualization & Computer Graphics*, 19(12):2090–2099, 2013.

[3] C. Ware. *Information Visualization: Perception for Design*. Morgan Kaufmann Publishers Inc., San Francisco, CA, USA, 2004.