Multi-Spectral Satellite Image Analysis for Feature Identification and Change Detection

VAST Challenge 2017: Honorable Mention for Good Facilitation of Single Image Analysis

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ABSTRACT

Satellite images are helpful in remote sensing of land features. However, such multi-spectral images cannot be displayed using readily available imaging tools. We developed a tool in Processing that is able to read in multi-spectral images and display each band as a grayscale image. This tool also allows for mapping of any of the bands to red, green or blue channel of the displayed image. In this paper, we describe how such tool can be used in identifying land features as well as assist in finding changes over time. We used our tool to successfully solve the VAST challenge 2017 mini-challenge 3.

Index Terms: H.5.2 [Information Interfaces and Presentation]: User Interfaces—Graphical User Interfaces (GUI); H.1.2 [Models and Principles]: User/Machine Systems—Visual Analytics

1 PROBLEM STATEMENT

The population of Rose-Crested Blue Pipit, a popular bird, is decreasing in Lekagul preserve and we are tasked with using visual analytics to find out the cause on this decline. In mini challenge 3, we are provided with twelve multi-spectral images of the preserve over the course of about three years. These images have sensor reading values from six different bands, blue, green, red, near infrared, short-wave infrared 1, and short-wave infrared 2. Each band has its own usefulness in terms of mapping. For example, the green band can be used to differentiate different plants while the short-wave infrared band 2 is insensitive to vegetation color. Our challenge is to find the scale and orientation of these images, identify different features in these images, and find changes over time that might have caused the population of the bird to plummet.

2 INTERACTIVE TOOL

We built an interactive tool using Processing[1] to read in the provided CSV image data and display/save it as a JPEG image. In the grayscale mode, our program has two widgets, one to select the image and another to select a band out of the six bands in the multi-spectral image data. The selected image and band is displayed as a grayscale image. We also have a zoomed version of the image which can be panned or zoomed in/out. This is shown in Figure 1. Furthermore, our tool allows us to slide show all the images which is helpful in determining changes between them.

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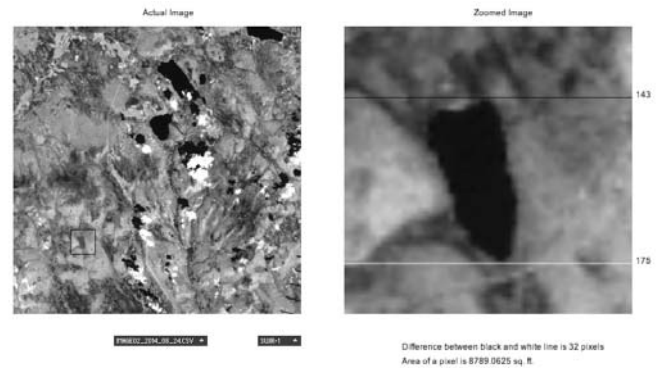
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[1]https://processing.org/

Figure 1: Our tool displaying image 2 in SWIR 1 band (left) and its zoomed version (right).

In the color mode, our tool has the flexibility of mapping individual bands to the red, green, and blue channel of the displayed image. This allows us to view false color images that is beneficial for viewing details that are not visible in a true color image. For example, mapping near infrared to red, red to green, and green to blue channel, gives a false color image in which vegetation appear in different shades of red. This is useful in monitoring plant health.

3 MULTI-SPECTRAL IMAGE ANALYSIS

In this section, we describe how our tool can be used to answer the question of this mini challenge.

3.1 Scale and Orientation

Using a provided guide image of a lake, we were asked to find out the orientation and scale of the given satellite images. Perfect overlapping between images proved that the orientation of the supplied satellite images is north-south, same as the lake image provided. To find the scale of the images, we marked two lines, black and white, in the zoomed version of the image as seen in Figure 1. This enables us to calculate the length of the lake as well as the area covered by a pixel. Averaging this measurement over all possible images, we found the area of a single pixel to be 8982.86 sq. ft. with the 95% confidence interval for the mean being [8856.98 sq. ft., 9108.74 sq. ft.]. Since the image was 651 pixels by 651 pixels in size, the scale of the supplied satellite image is about 11.67 miles by 11.67 miles with a resolution of 94.6 feet.

3.2 Features Identification

Mapping red band to red channel, green to green, and blue to blue, creates a true color image, one that we see in everyday life. Observing true color image, we could identify features like lakes, roads, settlements, clouds, etc. in the images. Due to space limitation, we
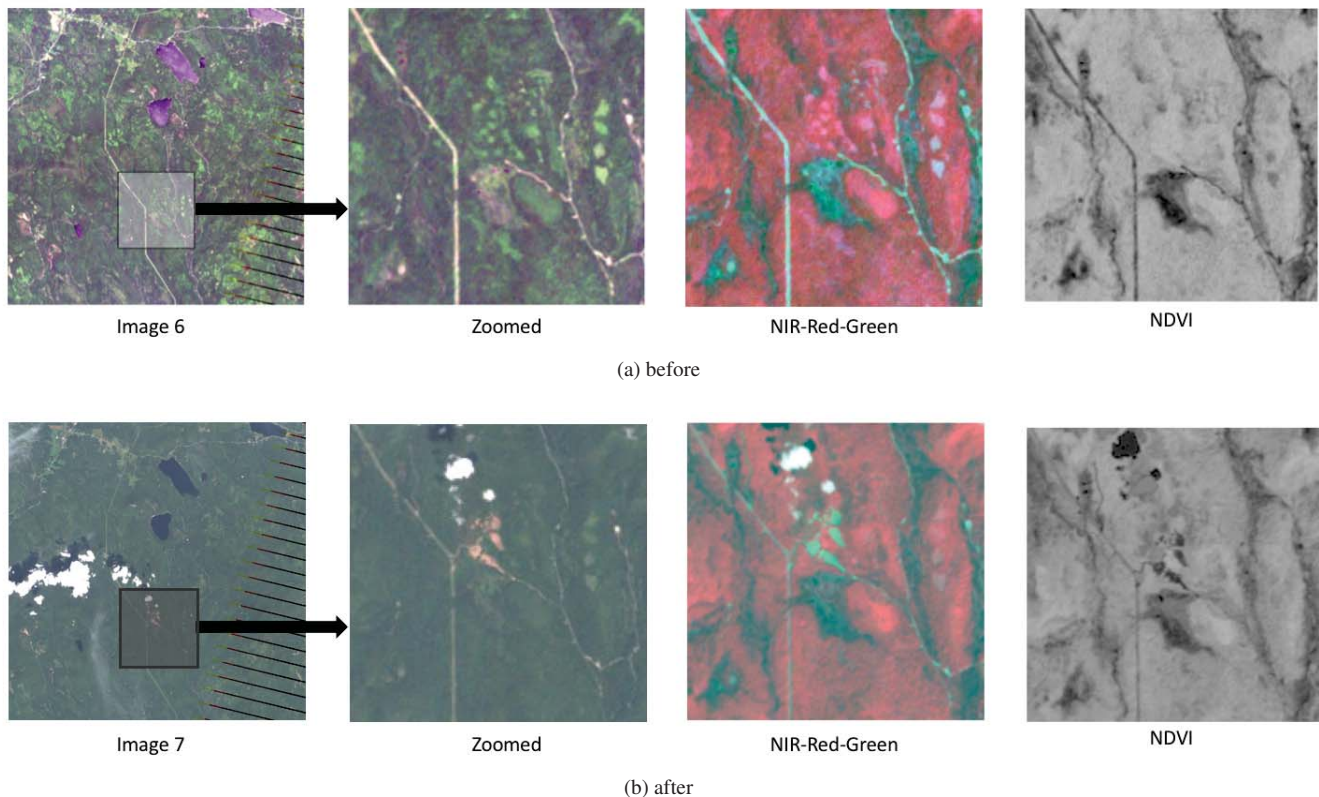
(a) before

(b) after

Figure 2: Actual image, its zoomed version, NIR-Red-Green and Normalized Difference Vegetation Index (NDVI) of (a) image 6 taken on June 2015 and (b) image 7 taken three months later.

are not able to show all the figures. For this, we refer our readers to our submitted answer sheet[2] as well as our video[3] available online.

Looking at individual bands as grayscale image was also helpful. We could identify a river in short-wave infrared 1 band that was not visible in the true color image version. Furthermore, different false color images revealed various features like seasonal crop, snow, and cloud. For example, false color combination of blue to red, short-wave infrared 1 to green, and short-wave infrared 2 to blue shows snow/ice in orange or bright red color whereas clouds in white. This false color combination is useful in distinguishing between snow and cloud, both of which appear white in true color [1].

3.3 Temporal Analysis

We looked at images over time and tried to contrast between them. We found many barren lands and a new road being formed. New barren lands might be new camping areas constructed inside the preserve. For example, in Figure 2, we have the same area before and after three months. We also have near infrared-red-green (NIR-Red-Green) false color image in which vegetation appear red. Additionally, we calculate Normalized Difference Vegetation Index (NDVI) and plot it as a grayscale image, to differentiate healthy vegetation from barren land. NDVI is an index to measure vegetation health [2]. These two extra plots, NIR-Red-Green and NDVI, are useful in monitoring vegetation in the zoomed area. In the bottom image, we can see that a new interconnecting road that goes east to west is constructed with additional barren lands. The grayscale NDVI image also shows the area black in color.

This new road connects the main road (with probably more traffic) to the smaller road (with probably less traffic). This new road might have caused many people using the main road to take the more scenic route alongside the river, increasing traffic in that area. Increased car traffic and the noise pollution they bring with them might have drove the Pipit bird away. Moreover, deforestation and construction of new camping areas might have destroyed the Pipit bird habitat.

4 CONCLUSION

In conclusion, we developed a tool that can read in multi-spectral satellite image data and assist visual exploration. Using our tool, we could visually analyze the given data to find features as well as detect changes over time. In this way, we could successfully answer all three questions in the VAST mini challenge 3.

REFERENCES

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[2] Compton J Tucker, Daniel A Slayback, Jorge E Pinzon, Sietse O Los, Ranga B Myneni, and Malinda G Taylor. Higher northern latitude normalized difference vegetation index and growing season trends from 1982 to 1999. *International journal of biometeorology*, 45(4):184–190, 2001.

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[2] http://eng.usf.edu/~sulavmalla/sulav_malla_files/vast2017/index.htm

[3] https://youtu.be/FAaAGAvN2ek