Description of python codes:

- Histogram.py is used to calculate the true color histogram for the template Beetles image
- BeetlesTracker.py is used to calculate the correlation map with each pixel corresponding to a correlation value to a Beetles image
  The correlation value is calculated as the multiplication of two values: 1) correlation coefficient between color histogram of query image patch and template Beetles image 2) circular variance of spatial orientation tuning curve for the query image patch which potentially reflect the oriented gradient of Beetles image
- AnalysisTestImage.py is used to calculate the region of interest(ROI) and draw red rectangle. The correlation map is thresholded and regions are considered ROI only when whose maximal correlation values exceed the threshold
  - AnalysisSiftMatch.py and AnalysisFFT.py are not directly used for the real data. They are developed during the testing phases to produce ideas and test ideas. I tested SIFT method to look for keypoints and minimal distances between query image and template image. It turned out that SIFT method is more proper for corner patterns and improper for the striped pattern as in our case. The Sift code was later replaced by the code to test orientation tuning curve. I also tested 2 dimensional Fourier Transform method. It seems the result is interesting. I'll proceed if I have time in the future.

True Color Histogram:

I firstly compared the true color histogram between soil background and Beetles template

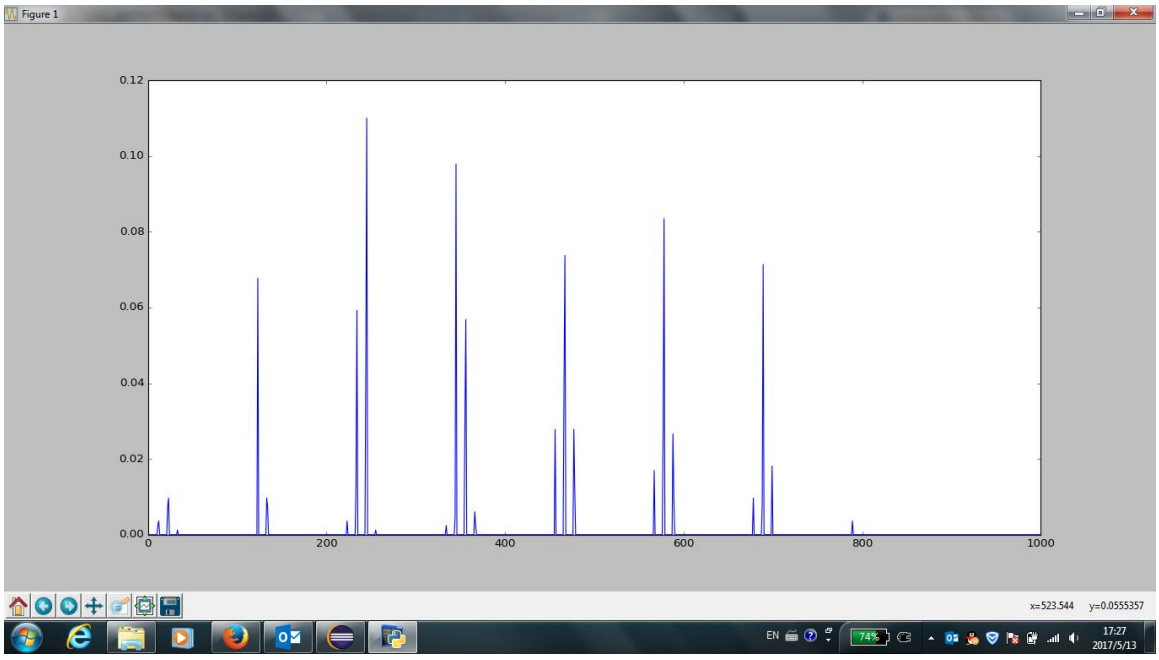

Fig1. Color histogram for Background

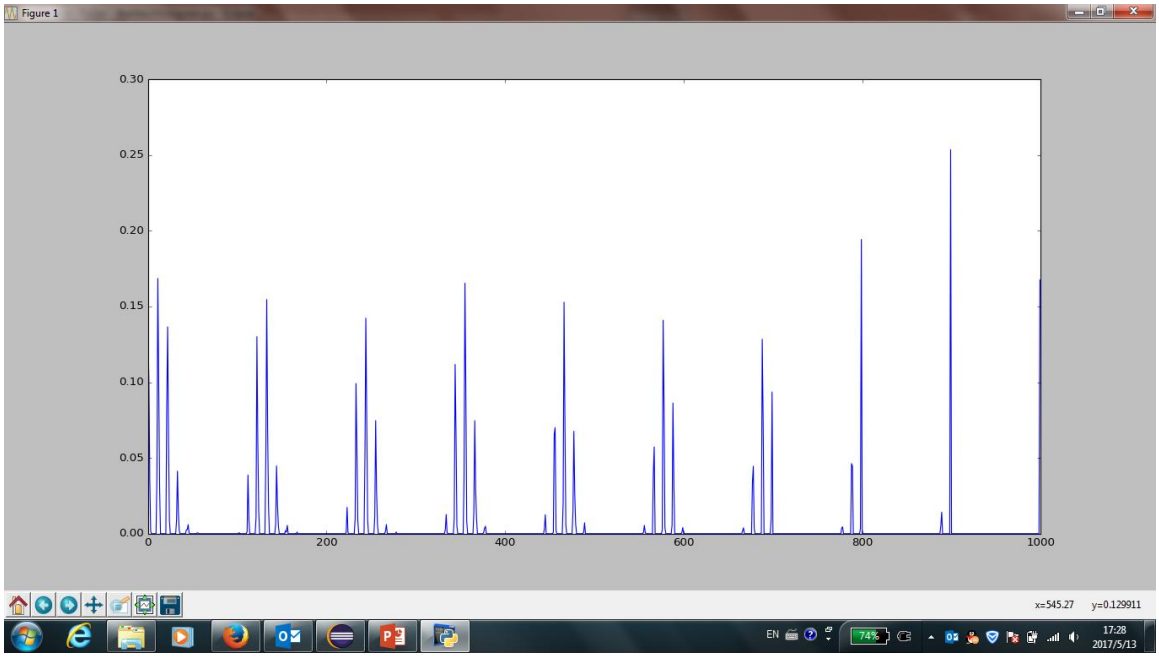

Fig2. Color histogram for Beetles

The conclusion for the comparison is that soil background and Beetles share some common color range, maybe the result of evolution.

Spatial Tuning Curve:

I compared the spatial tuning of template Beetles image and query Beetles image. The characteristics of Beetles image is the oriented strip pattern. I use the spatial tuning curve to describe the oriented spatial gradient. When I compare it with the soil image, the oriented gradient is less obvious so that spatial tuning curve is less peaky than Beetles image. Therefore I chose to use circular variance to reflect the extent of oriented pattern.

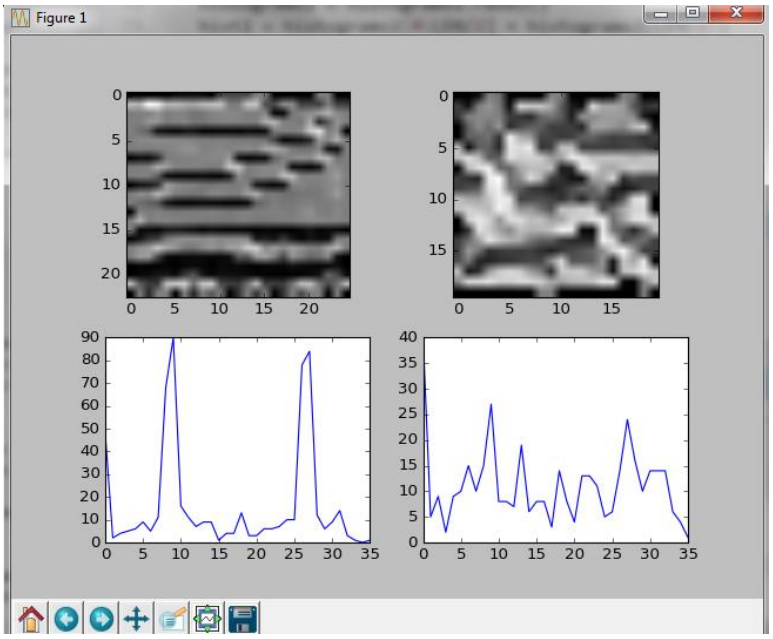

Fig3. Spatial gradient direction and Spatial tuning curve. Left, template Beetles image. Right, Background soil image. Upper, polar map of the gradient of gradient of image (Notice the striped pattern on the left)

Final Results:

80% of beetles were founded with proper thresholding.

There is one beetles missed in Image3.jpg

If I lower down the threshold more, the missed beetles can also be identified. However, in that case, many false positive results would be observed. In my case, I prefer false negative than false positive. Below I posted the correlation map for Image3. Please notice the red arrow on the right which point to the missed Beetles.

For comparison, I also posted a good case of correlation map for Image2. No need to specify, the brightest blob in the map represents the founded Beetles.

In Fig6, I posted the solution for Image2 with the founded Beetles enclosed by a red rectangle in the original image.

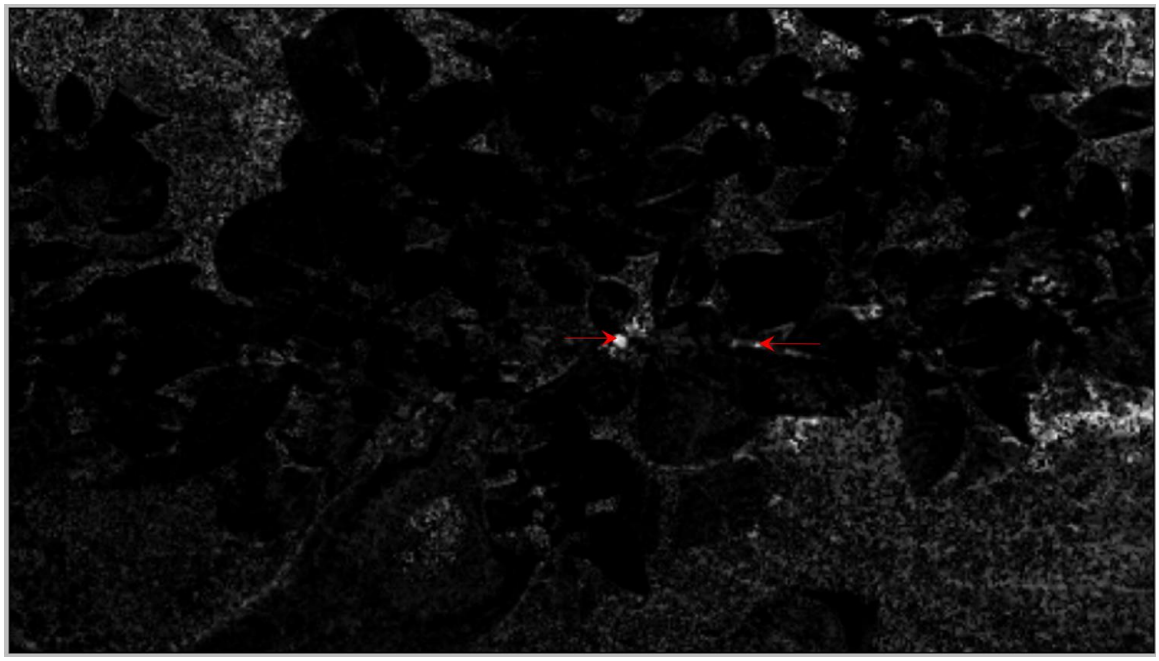

Fig4. The correlation map for Image3. The red arrow on the right point to the missed beetles

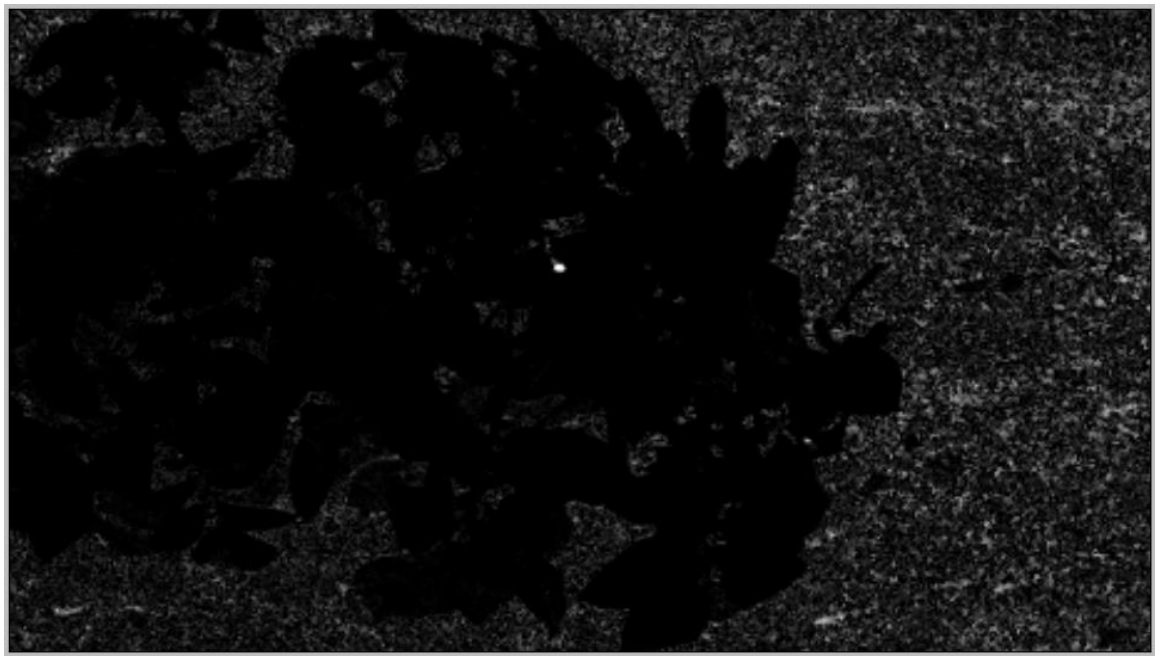

Fig5. The correlation map for Image2. The brightest blob in the map represents the found beetles

Fig6. The final result for Image2. The found beetles is enclosed by a red rentangle.