Project 2: Feature Detection and Matching - Report

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1 Harris Feature Detection

Harris Feature Detection results for Yosemite1 and Yosemite2 images can be observed below in **Figures 1 and 2**. It can be observed that the features detected lie on the edges of the mountains. It also detects certain features between the mountains and the forests as well as the mountain and the sky.

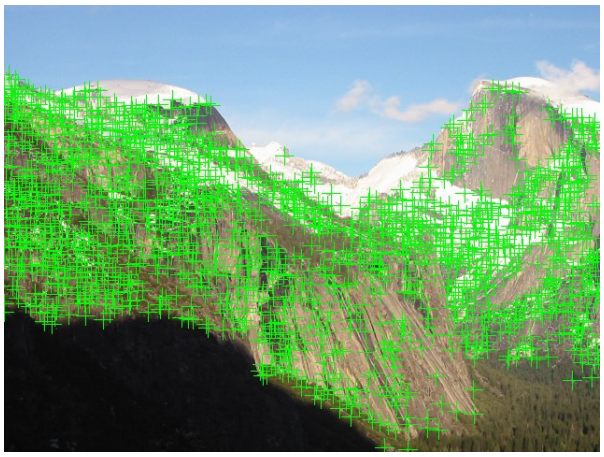

Figure 1: Yosemite1 - Harris Feature Detection

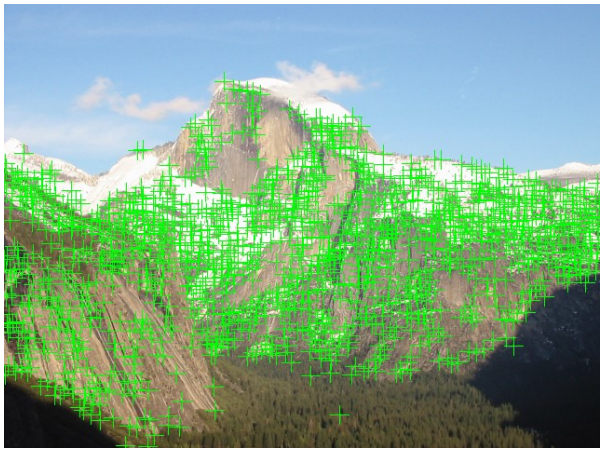

Figure 2: Yosemite2 - Harris Feature Detection

2 Feature Matching

Feature Matching for Yosemite1 and Yosemite2 images using different techniques are shown below in **Figures 3 and 4**.

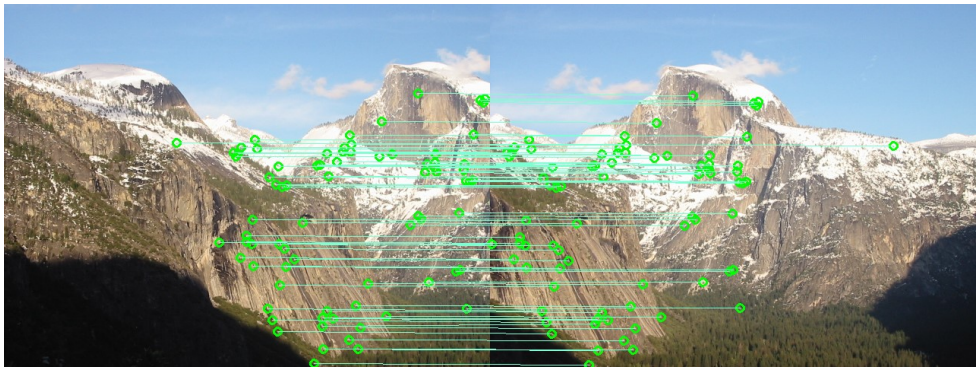

Figure 3: Yosemite - Feature matching using Simple feature descriptor SSD

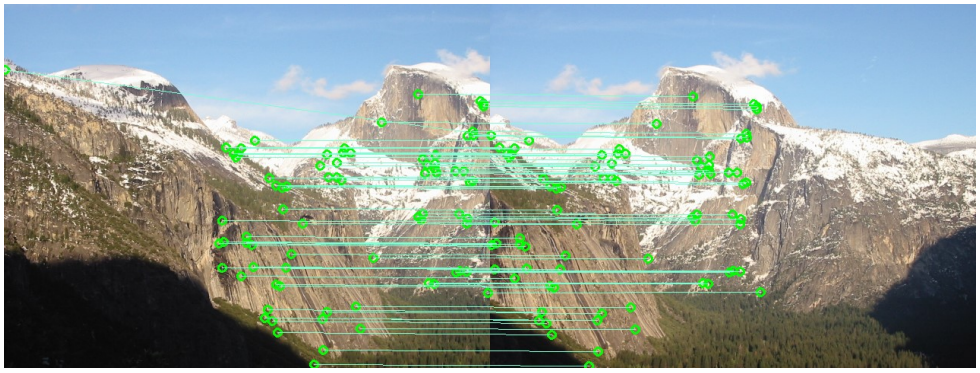

Figure 4: Yosemite - Feature matching using Simple feature descriptor Ratio

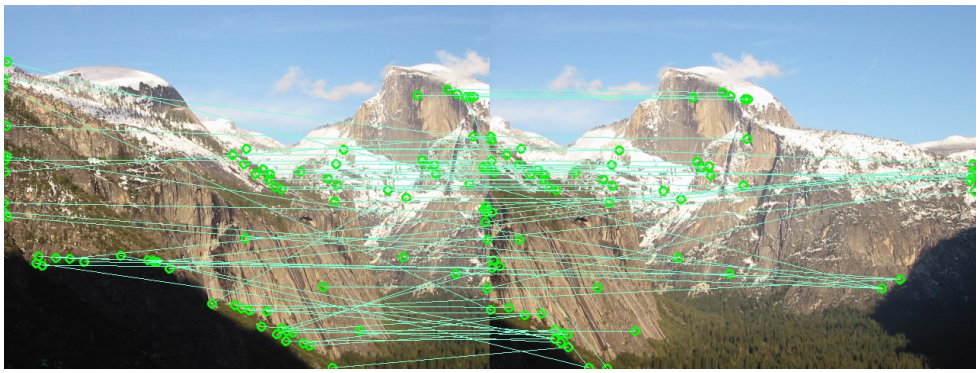

Figure 5: Yosemite - Feature matching using MOPS descriptor SSD

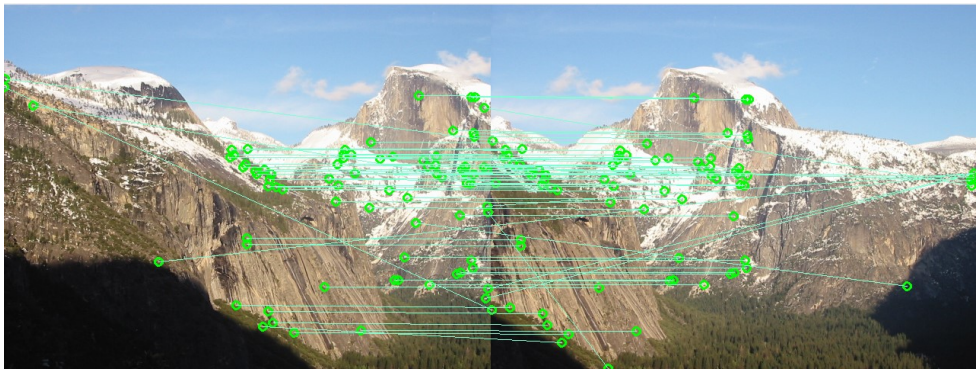

Figure 6: Yosemite - Feature matching using MOPS descriptor Ratio

2.1 Performance Results

The MOPS descriptor with Ratio matching technique produced the best results, with an average AUC of 0.9039, followed by the Simple descriptor and Ratio method, which produced an AUC of 0.9007. Both the SSD matching techniques using the MOPS descriptor and Simple Descriptor yielded worse results, having an AUC of 0.86 and 0.845, respectively. Figures 7 shows the ROC curves for all the descriptors and matching techniques with their respective AUCs.

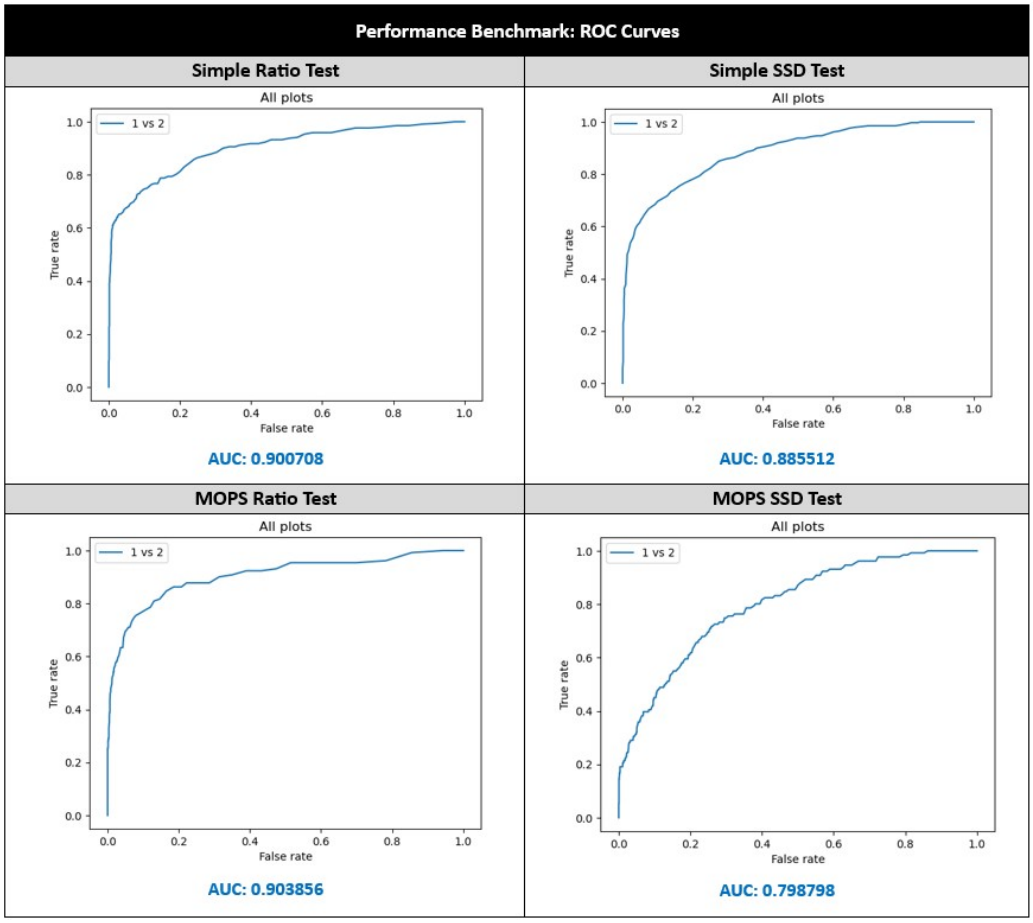

Figure 7: Benchmarks for Simple Feature Descriptor and MOPS feature descriptor using SSD Feature Matching and Ratio Feature Matching

3 Our Image: Feature Matching

We took two images of the Cornell Tech campus and passed them through the same code as for the Yosemite images to get the feature matching performance of MOPS descriptor with Ratio distance. **Figure 8** below shows the resulting visual of the feature matching using MOPS descriptor with Ratio matching for our Cornell Tech images.

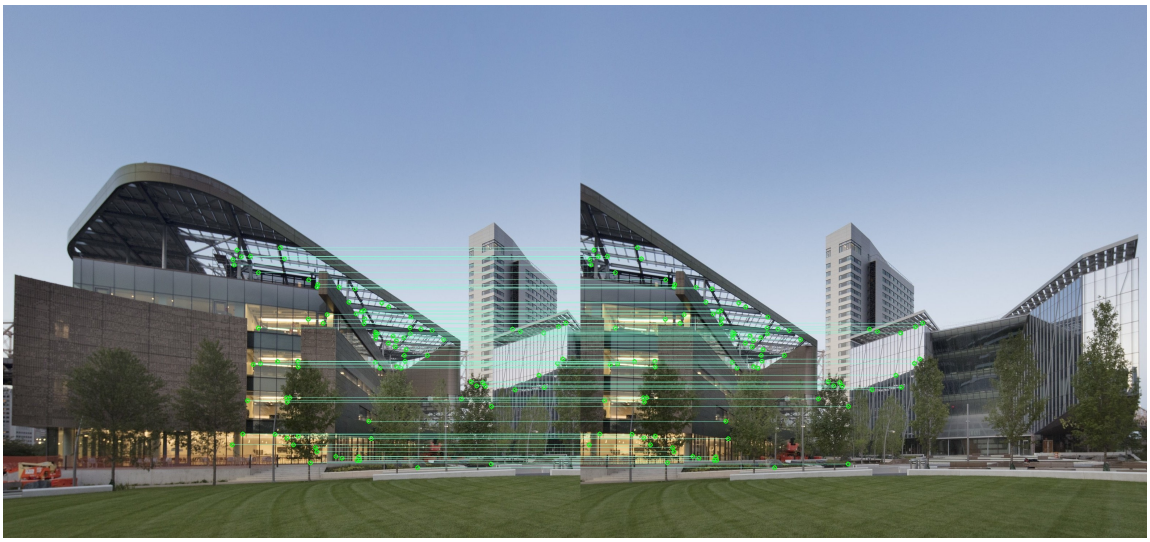

Figure 8: Cornell Tech Campus - Feature matching using MOPS feature descriptor with Ratio matching

4 Extra Credit

We made use of the SIFT feature descriptor in extracedit.py and features_scale_invariant.py which achieved an average AUC of **98.58%** and **98.41%** on the Yosemite images. This was a significant improvement over the MOPS feature descriptor which provided an average AUC of **90.39%** and **79.87%** using the Ratio feature matcher and SSD feature matcher, respectively. Additionally, using SIFT reduces the average distance between the true and actual matches to **238.5** compared to the average distance of **337.34** for MOPS and the average distance of **269.31** achieved by the Simple Feature Descriptor. The SIFT feature descriptor can be run by selecting the **'SIFT'** option under **'Descriptor Type'** on the UI provided. The SIFT implementation takes a 16x16 square window around the detected feature, in that 16x16 window the edge orientation of each feature is calculated and stored in an angle histogram (an array in the implementation). The angle histogram is taken as a 16x8 array in the implementation dividing each bin of the histogram by 45 degrees. Edge orientations found to be less than 0 degrees are incremented by 360 degrees. After which the angle histogram is normalised and used as a feature descriptor. The ROC Benchmark curves for the SIFT feature descriptor can be seen in **Figure 11 and Figure 12** while the feature matching results using the SIFT feature descriptor can be seen in **Figures 9 and 10**. One of the reasons for the superior performance of SIFT over MOPS is its ability to detect features at multiple scales unlike MOPS which relies on a fixed-scale detection approach due to which important features present at a different scale can be missed.

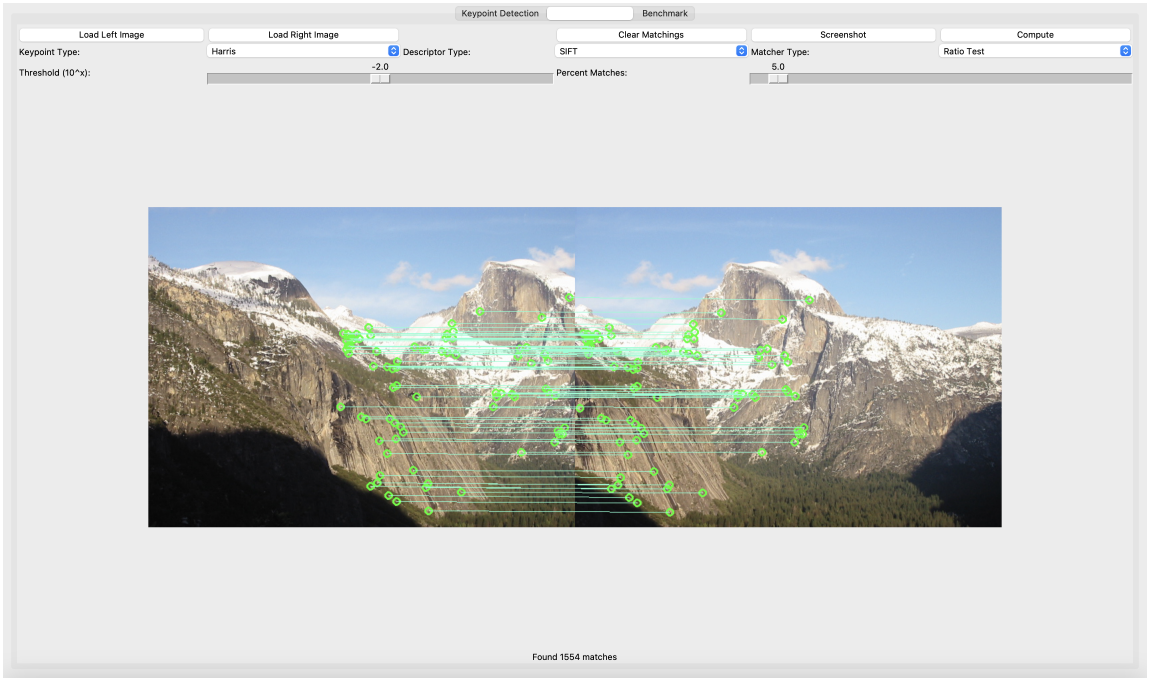

Figure 9: Yosemite - Feature Matching using SIFT Ratio

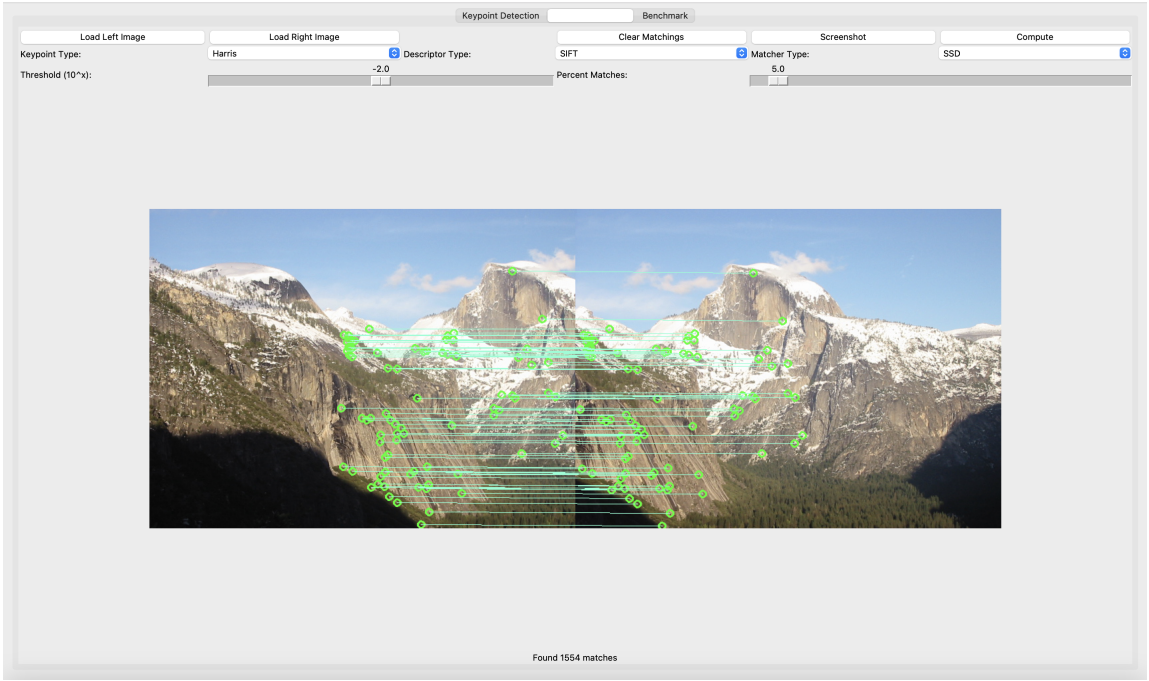

Figure 10: Yosemite - Feature Matching using SIFT SSD

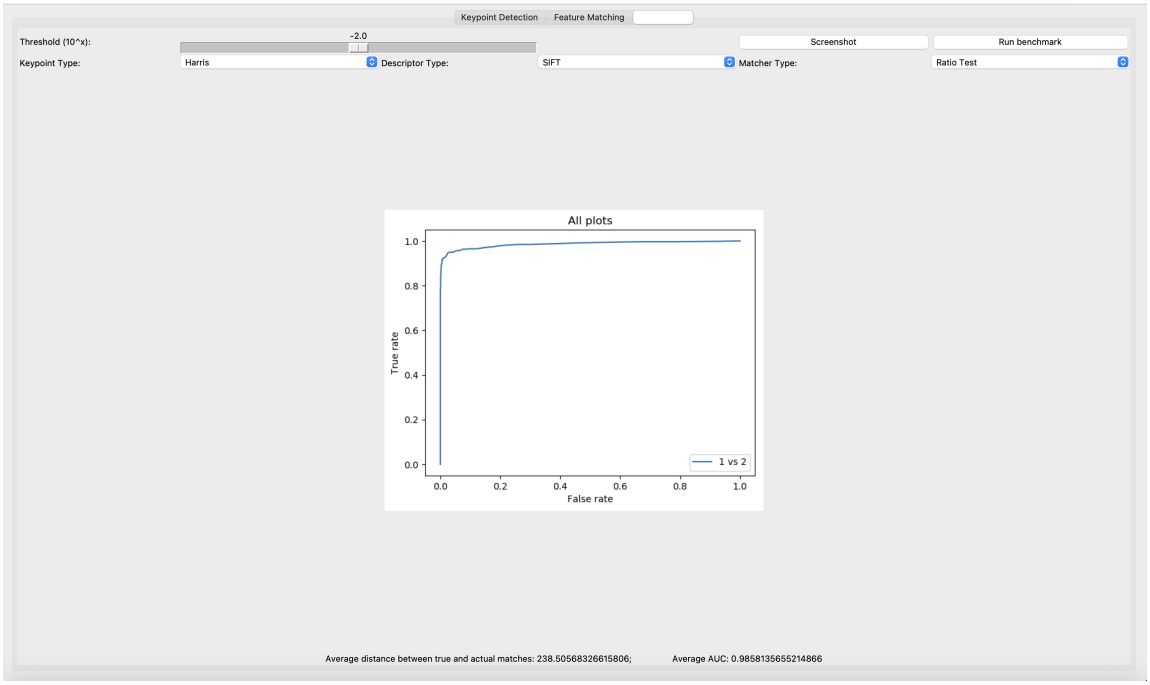

Figure 11: Benchmark for SIFT Feature Detector on Yosemite images using the Ratio Feature Matching

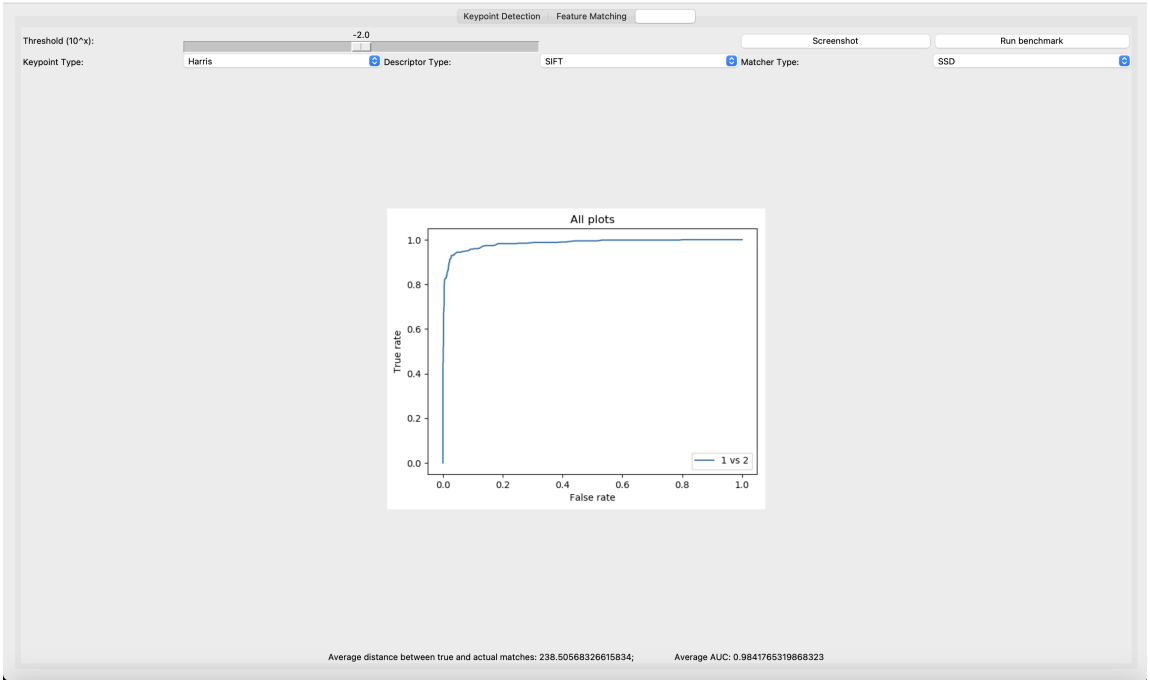

Figure 12: Benchmark for SIFT Feature Detector on Yosemite images using the SSD Feature Matching