Comparing Common Approaches to Image Merging

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Motivation and Background

This study proposes KEAS, Keypoint Extraction And Stitching algorithm. KEAS uses three different algorithms, Scale Invariant Feature Transformation(SIFT), Speed up Robust Features(SURF), and Binary Robust Invariant Scalable Keypoints(BRISK). I have compared the results of these algorithms. This poster compares the results of these approaches and proposes a flexible software capable of meeting the needs of many different groups.

Keypoint Extraction and Analysis

Image recognition, analysis, and merging rely on keypoint dictionaries, generated from images. A keypoint is a group of pixels and three values, scale, a descriptor, and an orientation. Scale is the size of the group. A common descriptor is brightness. Comparing if a point of interest is brighter than points surrounding it. Orientation describes where the majority of descriptors are in a POI. Generally there are at least three stages in building a keypoint dictionary.

1.**Feature Detection**: Seperating an image into layers composed of points of interest (POI). Those POI are tested for descriptors. This step assigns magnitude and a descriptor.
2.**Descriptor Assignment**:Defines orientation uses descriptor.
3.**Descriptor Matching**: Builds a library, measuring distance between keypoints.

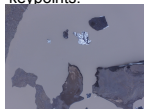


Figure 1: Aerial imagery of basin at Solheimajokull

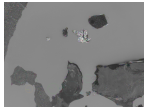


Figure 2: Aerial imagery of basin at Solheimajokull with keypoints drawn using SIFT

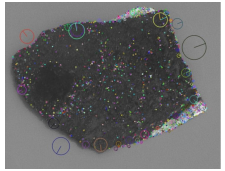


Figure 3: A close up of figure 2

Methods

SIFT: Emphasis on defining accurate keypoints. This results in a lengthy and rigorous process.

SURF:Runs faster than SIFT, and defines more keypoints. This is due to less rigorous testing on those keypoints.

BRISK:Optimized for speed. During feature detection compares fewer points to test POI and creates fewer layers. Finds fewer keypoints in general but very fast.

Image Merging

Following is the algorithm used for merging images using keypoint extraction.

1. Compute keypoint libraries, using SIFT, SURF, or BRISK.
2. Compute distance between keypoints in images. This makes a "mask". Each image's mask is compared.
3. Select the best matches from both images.
4. Randomly sample matches to create homography.
5. Warp images to align. Resize an image using the homography.
6. Stitch warped images. The resized images are aligned according to the homography.

Figure 4: Image 98

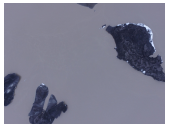


Figure 5: Image 100

Figure 6: Image 101

Figure 7: Stitched image composed of images 98, 100, and 101

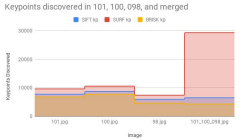
Results

Table 1: Keypoints discovered by SIFT, SURF, and BRISK

image name(.jpg)	SIFT kp	SURF kp	BRISK kp
101	7750	9624	6765
100	8693	10580	7676
098	5891	7411	4620
Merged	6498	29346	4322

Table 2: Run times for SIFT, SURF, and BRISK in seconds

image(.jpg)	SIFT	SURF	BIRSK
101	34.270109	6.44469	3.143501
100	33.027198	6.977087	2.930192
098	34.270109	4.199861	2.318383
Merged	2258.005621	27.269464	15.409138



Conclusion

There are several trends in the data. SURF dramatically outperformed both SIFT and BRISK in the number of keypoints found. However, BRISK ran noticeably faster than both SURF and SIFT. Those results are consistent across image types, and data sets. From data provided the algorithms make different use of the keypoint libraries. SIFT is using the keypoints it founds most effectively of the three. As such KEAS is able to use different approaches to create stitched images.

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References

- Lowe, David G. "Distinctive image features from scale-invariant keypoints." International journal of computer vision 60.2 (2004): 91-110.
- Bay, Herbert, et al. "Speeded-up robust features (SURF)." Computer vision and image understanding 110.3 (2008): 346-359.
- Leutenegger, Stefan, Margarita Chli, and Roland Siegwart. "BRISK: Binary robust invariant scalable keypoints." 2011 IEEE international conference on computer vision (ICCV). Ieee, 2011.
- M. Brown and D. Lowe. Automatic Panoramic Image Stitching using Invariant Features. International Journal of Computer Vision, 74(1), pages 59-73, 2007.