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: Separating 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.

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.

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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.

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

<table>
<thead>
<tr>
<th>Image</th>
<th>SIFT</th>
<th>SURF</th>
<th>BRISK</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>4765</td>
<td>4064</td>
<td>7056</td>
</tr>
<tr>
<td>101</td>
<td>5401</td>
<td>4620</td>
<td>4352</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Image</th>
<th>SIFT</th>
<th>SURF</th>
<th>BRISK</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>6.44×10^{-6}</td>
<td>6.44×10^{-6}</td>
<td>3.16×10^{-6}</td>
</tr>
<tr>
<td>101</td>
<td>6.27×10^{-6}</td>
<td>6.27×10^{-6}</td>
<td>3.14×10^{-6}</td>
</tr>
</tbody>
</table>

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
Figure 4: Image 98
Figure 5: Image 100
Figure 6: Image 101
Figure 7: Stitched image composed of images 98, 100, and 101

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.

References

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