Image Stitching

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Abstract

This report presents an advanced implementation of image stitching using SIFT (Scale-Invariant Feature Transform) for keypoint detection and description, followed by feature matching and homography estimation using RANSAC. A key enhancement in this project is the inclusion of a smoothing mask to apply multi-band blending for seamless transition across the overlapping regions of images. The result is a more coherent and natural panoramic image.

1 Introduction

Image stitching is a key task in computer vision that involves combining two or more images to create a panorama. Traditional stitching pipelines face issues like visible seams and lighting mismatches. To mitigate these, this project uses:

- **SIFT** for scale- and rotation-invariant feature detection.
- **Ratio test** for filtering reliable matches.
- **RANSAC** for robust homography estimation.
- **Multi-band blending masks** for smooth merging of overlapping areas.

2 Methodology

2.1 Feature Detection and Matching

Features are detected using SIFT, and matches are filtered using Lowe's ratio test to retain reliable correspondences.

```
self.sift = cv2.SIFT_create()
kp1, des1 = self.sift.detectAndCompute(img1, None)
kp2, des2 = self.sift.detectAndCompute(img2, None)
```

The best matches are drawn and saved using OpenCV for visualization. An example is shown in Figure 7.

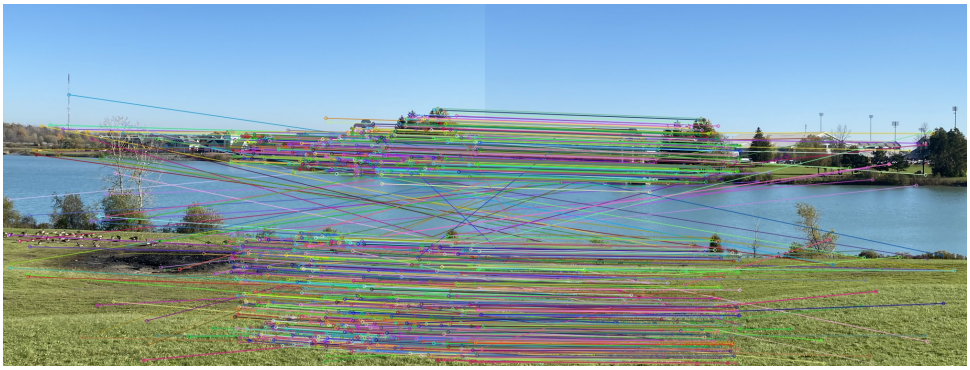

Figure 1: Feature Matches between Images

2.2 Homography Estimation

Using the good matches, a homography matrix is calculated using the RANSAC algorithm, which helps to reject outliers and accurately align the images.

```
H, status = cv2.findHomography(image2_kp, image1_kp, cv2.RANSAC, 5.0)
```

2.3 Blending with Smoothing Masks

To blend images seamlessly, two masks are created:

- A left-image mask that gradually decreases from left to right.
- A right-image mask that increases from left to right.

These masks allow overlapping regions to be combined smoothly without harsh transitions.

Figure 2: Final Stitched Panorama (First Pair)

2.4 Warping and Cropping

The second image is warped using the homography matrix and then added to the base canvas with the left image. Post-blending, the image is cropped to remove any black borders.

```
rows, cols = np.where(result[:, :, 0] != 0)
final_result = result[min_row:max_row, min_col:max_col, :]
```

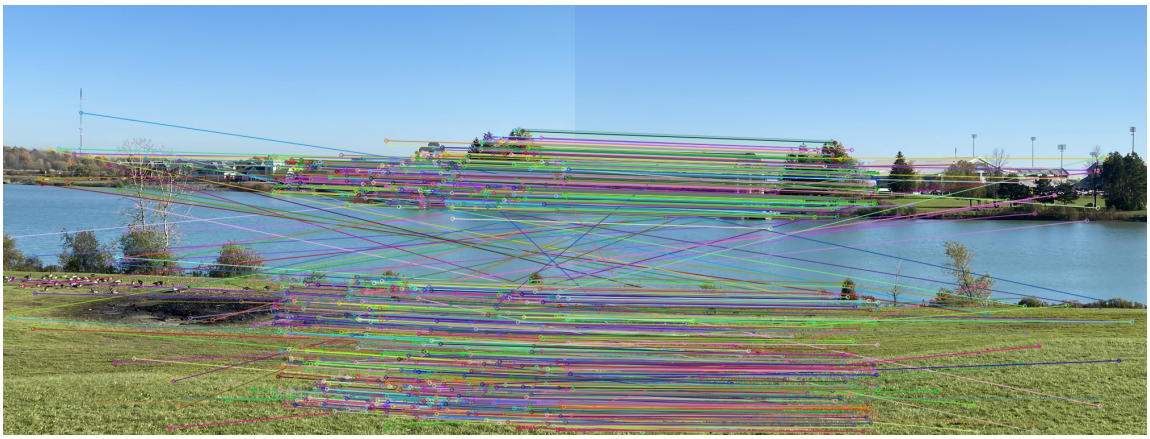

Figure 3: Final Stitched Panorama (Second Pair)

3 Results

I have used my images to implement this practically.

Figure 4: left image

Figure 5: right image

Figure 6: Image Stiching

Figure 7: Feature Matches between Images

The results demonstrate improved stitching quality due to:

- Enhanced feature detection from SIFT.
- Robustness through RANSAC.
- Smoothing at boundaries via custom blending masks.

Both image pairs (‘left.jpg‘ + ‘right.jpg‘ and ‘left2.jpg‘ + ‘right2.jpg‘) were stitched successfully.

4 Conclusion

This project presents a reliable and visually appealing image stitching pipeline using SIFT-based matching and blending masks. The smoothing window helps reduce seams, producing better results than naive image joining techniques.

5 Future Improvements

- Integrate exposure compensation for better brightness consistency.
- Use multi-resolution pyramids for true multi-band blending.
- Extend to support 360° panoramic views with cylindrical projection.