Parallax-tolerant Image Stitching

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1 Introduction

Parallax handling is a challenging task for image stitching. Our implementation makes use of a local stitching method to handle parallax based on the observation that input images do not need to be perfectly aligned over the whole overlapping region for stitching. Instead, they only need to be aligned in a way that there exists a local region where they can be seamlessly blended together. We adopt a hybrid alignment model that combines homography and content-preserving warping to provide flexibility for handling parallax and avoiding objectionable local distortion[1]. We then search for a homography using RANSAC [5], which, combined with content-preserving warping, allows for optimal stitching. We predict how well a homography enables plausible stitching by finding a plausible seam and using the seam cost as the quality metric. For this task,we employ a seam finding method[2] that estimates a plausible seam from only roughly aligned images by considering both geometric alignment and image content. We then pre-align input images using the optimal homography and further use content-preserving warping to locally refine the alignment. We finally compose aligned images together using a standard seam-cutting algorithm[2] and a multi-band blending algorithm. Our experiments show that our

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method can effectively stitch images with large parallax that are difficult for existing methods.

Figure 1: Input Images

Figure 2: Expected Output

2 Literature Review

Image stitching is a well-studied topic[3]. Its first step is to align input images. Early methods estimate a 2D transformation, typically a homography, between two images and use it to align them[4]. Since a homography cannot account for parallax, these methods require that the input images should be taken from the same viewpoint or the scene should be roughly planar. Otherwise, no homography exists that

can be used to align these images, resulting in artifacts like ghosting or broken image structures. While advanced image composition techniques, such as seam cutting[2] and blending, can relieve these artifacts, they cannot address significant misalignment.

3 Pipeline

The pipeline of our application is shown in Figure 3.

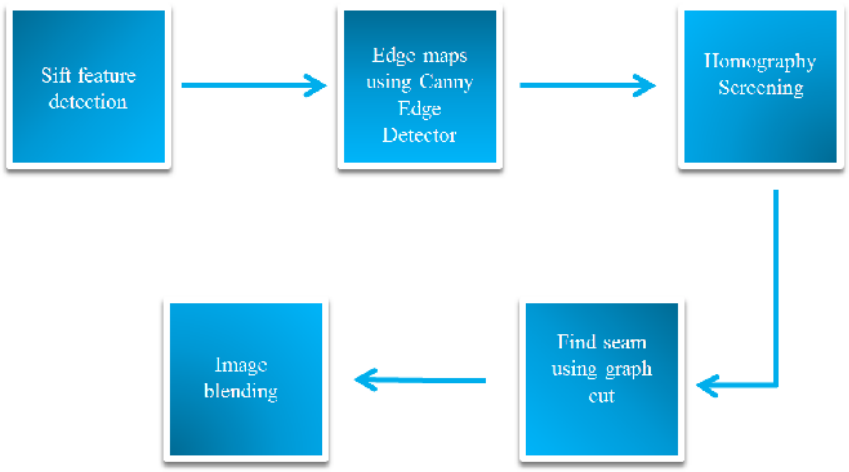


Figure 3: Pipeline for our stitching algorithm

4 Algorithm

The algorithm applied for task of image stitching is as described below:

- Detect and match SIFT features between input images and estimate edge maps for input images.
- Apply homography to the input images using RANSAC to find the optimal alignment.

- Define a cost funtion by

$$e(s,t) = f_c(s)|E_d(s)| + f_c(t)|E_d(t)|$$

where

$$f_c(s) = \frac{1}{\sum_{P_i} g(||P_s - P_i||) + \delta}$$

is the alignment confidence function $f_c(s)$ to weight the edge cost. Here P_i is the position of a SIFT feature point and P_s is the position of pixel s, g is a Gaussian function and is used to propagate the effect of a SIFT feature to its neighbourhood. δ is a small constant with a default value 0.01..E_d is the edge difference map between the edge map of the warped image and the edge map of the reference image. This cost is used for scoring the alignment quality.

- The aligned images are then blended using simple average linear blending.

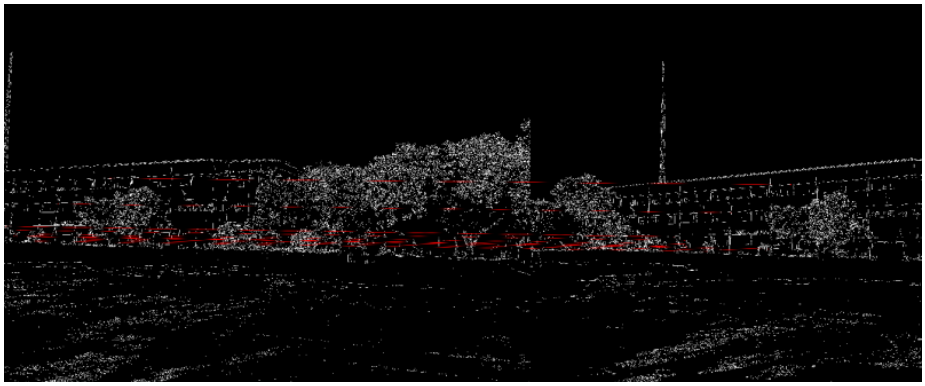
5 Results

5.1 SIFT Feature Matching

Figure 4: Sift features matching in the two parallax induced Images

Figure 5: Sift features matching in the two parallax induced Images

5.2 SIFT Feature Matching on Edge Maps



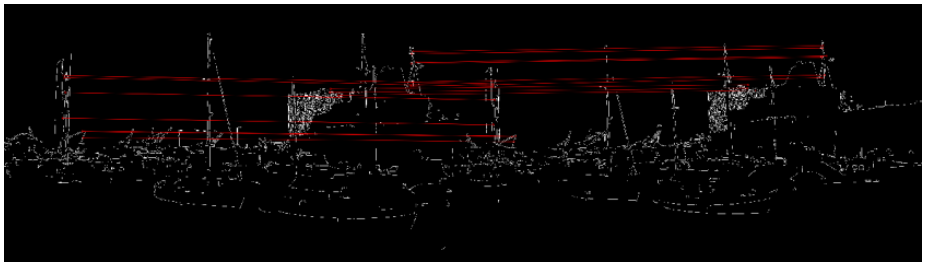


Figure 6: Sift features matching in the edge maps of the two parallax induced Images

5.3 Image Alignment using Homography

Figure 7: Image alignment using homography

5.4 Seam finding using Graph Cut Method

Figure 8: Seams obtained after applying the Graph Cut method

5.5 Image Blending

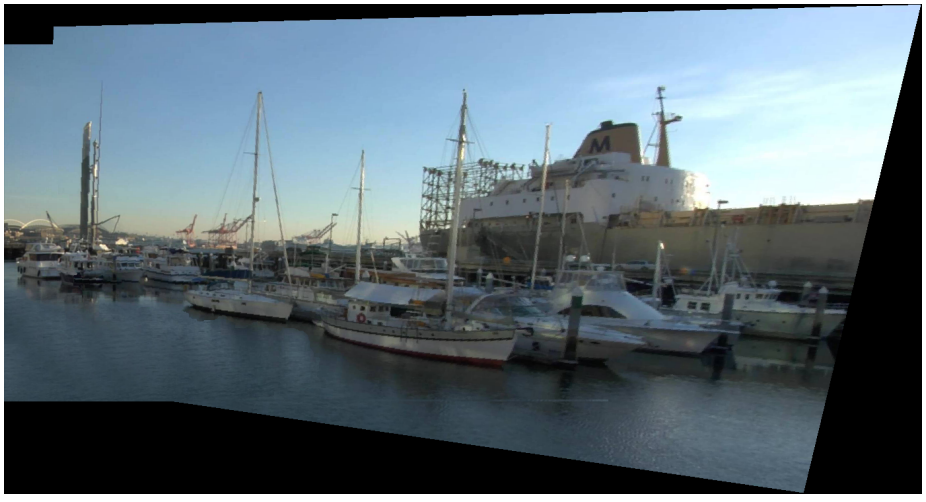


Figure 9: Outputs obtained after blending

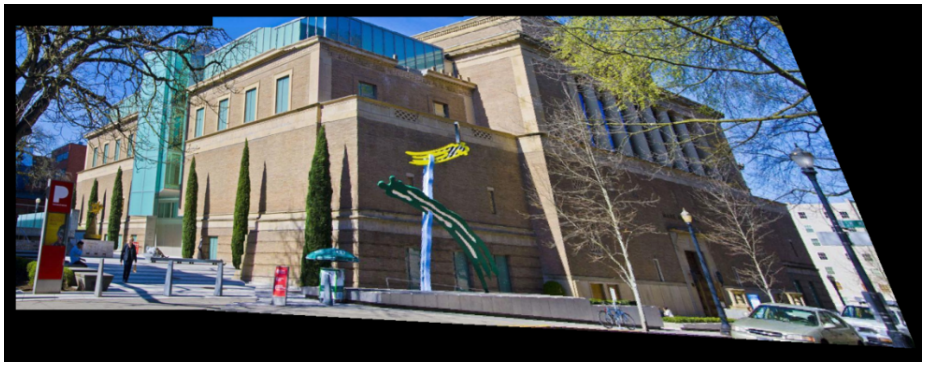
5.6 Unsatisfactory Results

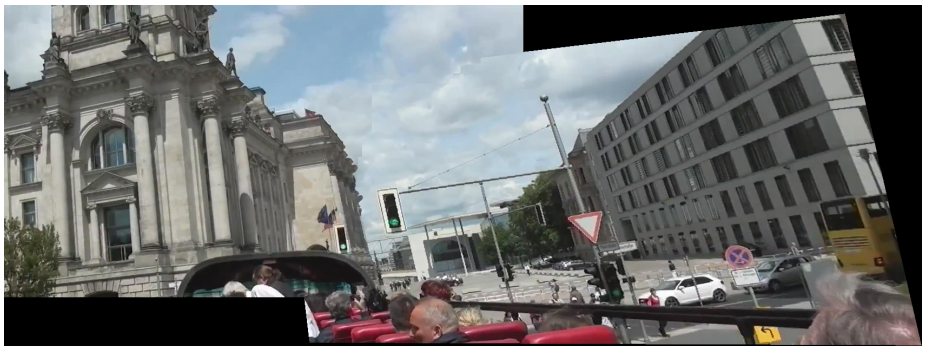
The algorithm described above failed in case of the following images.

Figure 10: Input Images

Figure 11: Result of Stitching

6 Output on other images





7 Conclusion

We were able to achieve our objectives of implementing a method to stitch images containing parallax. The use of SIFT features, Canny edge maps, Graphcut method provided us with image alignment assessment. Also, we were able to blend the images together after obtaining a optimal seam using the cost function defined in the algorithm. However, images with major parallax didn't produce the right blending even though the homography found was marginally correct.

8 Acknowledgement

For the completion of this project, the authors referred to various repositories on Github for guidance. The authors are also grateful to the contributors of APAP which provided useful reference.

9 Work Division

Stage	**Bhavya (%)**	**Shrutimoy (%)**
SIFT	100	0
Homography Screening	100	0
Edge Maps	0	100
Seam Finding	0	100
Blending	70	30
Report	50	50
Presentation	50	50

Table 1: Work Division between Bhavya and Shrutimoy

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