INITIAL DISPARITY ESTIMATION USING SPARSE MATCHING FOR WIDE-BASELINE DENSE STEREO

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Abstract

We propose a triangulation based initialization method for dense disparity estimation from uncalibrated wide-baseline image pairs using sparse correspondences. The method includes: (a) sparse correspondence retrieval, (b) Delaunay triangulation and homography estimation, and (c) obtaining a dense initial disparity map to initialize dense stereo algorithms. Comparison with existing methods demonstrates improvement in results with lower computational complexity.

1 Introduction

3D reconstruction from images requires dense stereo matching to estimate the scene depth. A comparative study of stereo matching for narrow-baseline views is presented in [1]. Existing stereo algorithms commonly fail in the case of wide-baseline views due to the large disparity range. In this paper, we propose a triangulation based initialization method by estimating coarse disparity map using sparse feature matching. Dense stereo is then performed using established off the shelf narrow-baseline correspondence algorithm [2].

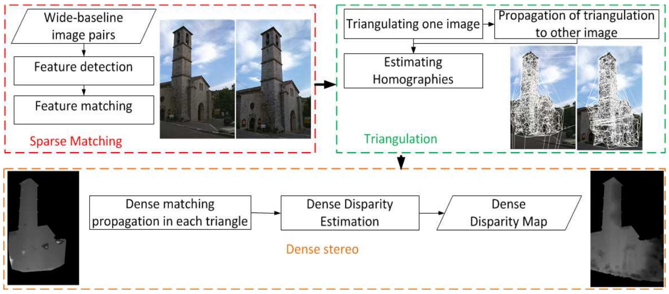

Figure 1: Dense disparity estimation using triangulation.

2 Dense disparity estimation

In this section we describe our three step approach for disparity estimation shown in Figure 1. The main motivation is to obtain a reliable disparity estimate for wide-baseline uncalibrated image pairs using the sparse correspondences.

2.1 Sparse matching

Feature detection is performed on each pair of images followed by feature matching using a SIFT descriptor. Ratio and left-right symmetry tests are performed to eliminate ambiguous matches and get reliable correspondences. RANSAC is used to estimate the relative calibration and the inliers are chosen as the set of 'good' matches. Bundle adjustment is then performed to obtain accurate structure.

2.2 Triangulation

Delaunay triangulation is performed on the inliers for one image and is propagated to the second image using the sparse correspondences. For each corresponding triangle pair direct linear transform is used to estimate the affine homography.

2.2 Dense stereo

Displacement at each pixel within the triangle is estimated by interpolation to get the initial dense disparity map for the image pair. Dense stereo is then performed using a narrow-baseline correspondence algorithm to refine the estimate.

3 Results

Evaluation is performed on various wide-baseline image sets and Valbonne dataset is compared against Block matching (BM) and Semi-global BM as initial estimate. The same dense optical flow algorithm of [2] is used for disparity refinement. Since the main focus lies on the structure of the scene, sky region is removed manually. The proposed approach is faster and gives a better disparity map compared to the existing methods as illustrated in Table 1 and Figure 2 respectively. Similar results were recorded for other datasets.

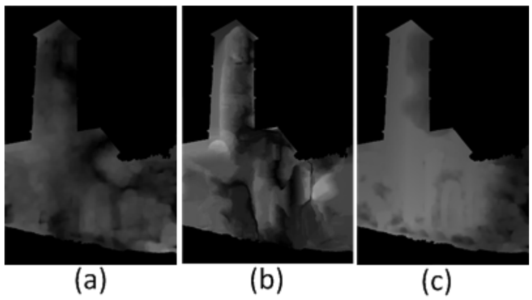

Figure 2: Dense disparity map for Valbonne: (a) BM with [2], (b) SGBM with [2] and (c) Proposed approach with [2]

Algorithm	**BM**	**SGBM**	**Proposed**
Time (ms)	329.106	415.031	197.086

Table 1: Computational complexity for Valbonne

4 Conclusion

An approach is to obtain a dense disparity initialisation from uncalibrated wide-baseline views. The approach has been evaluated on wide-baseline uncalibrated image pairs of various indoor and outdoor scenes achieving improved dense disparity maps relative to other stereo initialisation approaches. Future work will quantitatively evaluate the approach on other methods for refining the dense stereo.

Acknowledgements

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References

[1] G. Farnebäck. "Two-frame motion estimation based on polynomial expansion," 13th Scandinavian conference on Image analysis, 363-370, 2003.
[2] D. Scharstein, R. Szeliski. "A taxonomy and evaluation of dense two-frame stereo correspondence algorithms," IJCV 47, 7–42, 2002.