Simultaneous Sampling and Multi-Structure Fitting with Adaptive Reversible Jump MCMC

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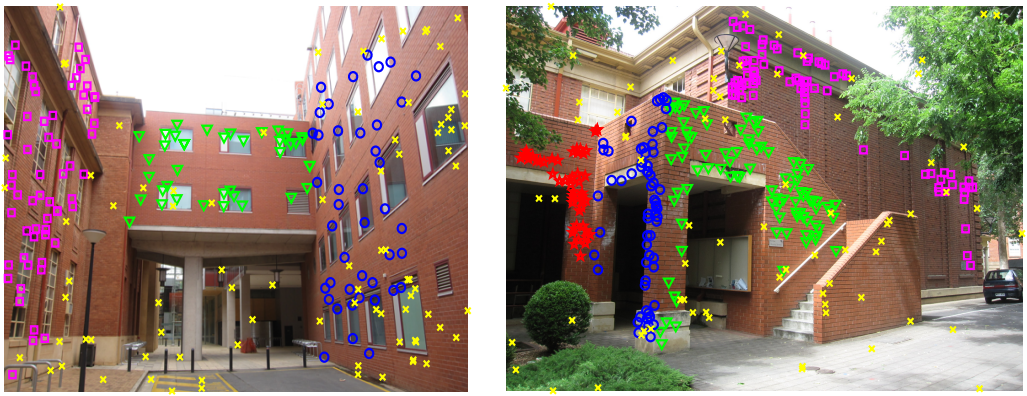
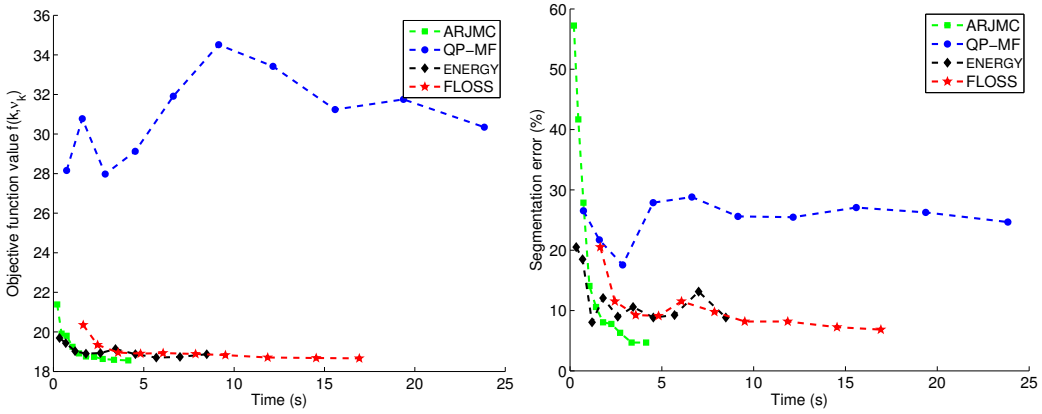
Multiple planar homography detection



(a) *neem* dataset with 3 planar surfaces (42, 28 and 63 inliers, 122 outliers)

(b) *johnsona* dataset with 4 planar surfaces (77, 91, 69, and 58 inliers, 78 outliers)

Figure 1: Examples of 3- and 4-structure datasets (yellow crosses show outliers).



(a) Value of function $f(k, \boldsymbol{\theta}_k)$ (best viewed in colour)

(b) Segmentation error (best viewed in colour)

Figure 2: Performance measures of four methods on the dataset in Fig.1 (a).

We also apply our method to multiple planar homography detection [2]. This problem requires two static images of the same scene. The key points of a plane in the first and second image are related by a homography. Our task is to estimate the number of planar surfaces k and the homography matrices $\mathbf{H} \in \mathbb{R}^{3\times3}$ [1]. The experimental setting is similar to that of two view motion segmentation. We use the publicly available datasets [3] for testing. Fig. 1 shows two example of datasets containing 3 and 4 planar surfaces, respectively. Minimal subsets of size $p = 4$ correspondences in the two images are used to estimate the homography matrix hypotheses using Direct Linear Transformation [1]. The geometric error is computed as the Sampson distance [1]. Again Multi-GS is applied for hypothesis generation. Fig. 2 shows the performance of four methods on the dataset *johnsona*. Similar to the previous experimental results, ARJMC takes less time to converge to a low value of objective function $f(k, \theta_k)$ and segmentation error than other methods. Table 1 summaries the comparison results on more datasets, namely *johnsonb*, *elderhallb*, *neem*, *napierb*.

Dataset # inliers # outliers	*johnsona* (4 structures) 77, 91, 69, and 58 78				*johnsonb* (7 structures) 20, 77, 291, 69, 41, 15 and 58 78				*neem* (3 structures) 64, 43 and 46 88			
M	FLOSS	ENERGY	QP-MF	ARJMC	FLOSS	ENERGY	QP-MF	ARJMC	FLOSS	ENERGY	QP-MF	ARJMC
100	20.51	20.51	26.54	57.24	26.35	45.30	47.61	61.02	27.39	32.78	37.76	51.04
200	11.53	18.50	22.39	41.69	20.80	23.73	30.97	47.77	21.16	31.95	41.91	53.11
300	9.25	8.04	18.50	27.88	22.03	29.89	39.60	39.60	23.24	30.29	41.08	17.01
400	9.12	12.06	28.02	14.08	20.49	23.57	35.13	34.05	22.41	34.02	38.59	8.30
500	11.53	8.98	28.82	10.59	15.25	26.50	39.45	29.28	10.79	30.71	38.59	8.30
600	9.79	10.59	25.60	8.04	17.41	24.50	34.67	29.74	14.11	21.99	36.51	7.47
700	8.18	8.85	25.60	7.77	17.41	23.11	36.52	26.66	11.62	27.80	38.17	**7.05**
800	8.18	9.25	27.08	6.30	18.03	24.19	33.59	17.10	9.54	26.56	36.51	7.05
900	7.24	13.14	26.27	**4.69**	18.03	17.26	24.65	15.41	11.20	25.73	38.17	7.05
1000	6.84	8.85	24.66	4.69	17.72	22.50	32.51	**14.02**	9.54	23.24	38.17	7.05
Time (seconds)	16.93	8.48	23.84	**4.15**	34.27	14.52	38.07	**6.20**	11.41	5.91	16.55	**2.93**

Dataset # inliers # outliers	*elderhallb* (3 structures) 42, 28 and 63 122				*napierb* (3 structures) 49, 36, and 72 102			
M	FLOSS	ENERGY	QP-MF	ARJMC	FLOSS	ENERGY	QP-MF	ARJMC
100	23.53	29.41	46.27	29.80	25.48	23.17	34.36	27.41
200	11.76	27.06	37.65	21.57	24.71	21.24	32.43	19.31
300	11.37	27.06	36.86	15.69	24.71	25.10	31.27	13.90
400	10.20	29.02	30.20	15.69	23.17	22.01	28.57	13.51
500	10.20	29.80	36.47	15.69	24.32	26.64	28.96	13.51
600	9.80	30.59	38.43	11.76	24.32	26.64	28.96	**12.36**
700	9.80	30.20	34.12	11.76	26.25	26.25	30.50	12.36
800	10.20	23.92	34.51	**5.49**	26.64	25.10	27.80	12.36
900	13.33	30.98	33.73	5.49	26.64	26.25	30.12	12.36
1000	9.41	26.67	34.12	5.49	26.64	25.87	31.66	12.36
Time (seconds)	11.64	6.20	17.65	**3.24**	12.56	6.25	16.79	**3.29**

Table 1: Median segmentation error (%) at different number of hypotheses M. Time elapsed at M = 1000 is shown at the bottom. The lowest error and time achieved on each dataset is boldfaced.

References

[1] R. Hartley and A. Zisserman. *Multiple View Geometry*. Cambridge University Press, 2004.

[2] E. Vincent and R. Laganière. Detecting planar homographies in an image pair. In *International Symposium on Image and Signal Processing and Analysis*, 2001.

[3] H. S. Wong, T.-J. Chin, J. Yu, and D. Suter. Dynamic and hierarchical multi-structure geometric model fitting. In *International Conference on Computer Vision (ICCV)*, 2011.