# RepMatch

Robust Feature Matching and Pose for Reconstructing Modern Cities

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Pose Estimation Problem

- Urban scenes often contain large quantities of repetitive structures. This impacts SfM's stability.
- Detecting and explicitly modeling repetitions is difficult
- **Our Goal**: A feature matcher with intrinsic robustness to repetitive structures

(a) Visual SfM

(b) Visual SfM with our matches
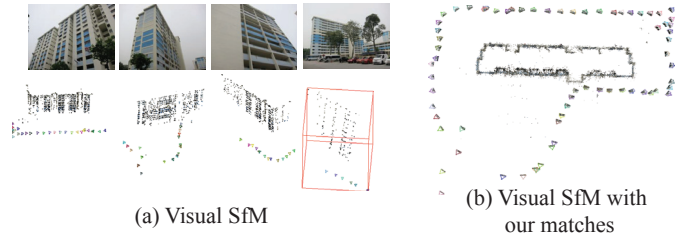
Match Consistency on Repetitive Structures

Match consistency

- Measures two basic attributes: <u>density</u> and <u>spatial extent</u>
- It is possible to separate true and false matches using match consistency [1,2]
- Repetitive structures introduce consistent but wrong matches
- However, consistency score of correct matches tends to be much higher as there are usually many alternative false positions
- By taking the most consistent matches, we can achieve a stable core set of matches which is then expanded

Consistent matches   Inconsistent matches
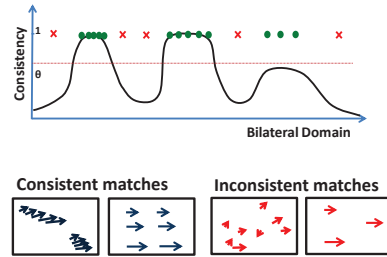
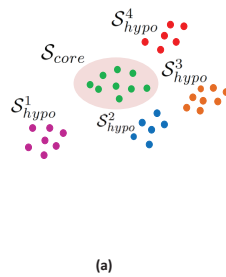$$\arg\min_{\mathbf{w}} \sum_{i=1}^{N} C(1 - f(\mathbf{m}_i)) + \lambda \mathbf{w}^T G \mathbf{w}$$

where f(.) takes the form derived in [1,2]:

$$f(\mathbf{m}) = \sum_{i=1}^{N} \mathbf{w}(i) \exp^{-\frac{\|\mathbf{m}-\mathbf{m}_i\|^2}{\sigma}}$$
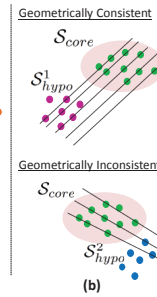
Separating into true and false sets:

$$\mathbf{m_j} \in \begin{cases} \mathcal{T}, & \text{if } f(\mathbf{m_j}) > \theta \\ \mathcal{F}, & \text{otherwise} \end{cases}$$
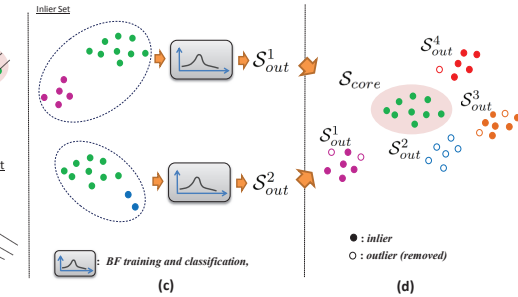
RepMatch system flow-chart

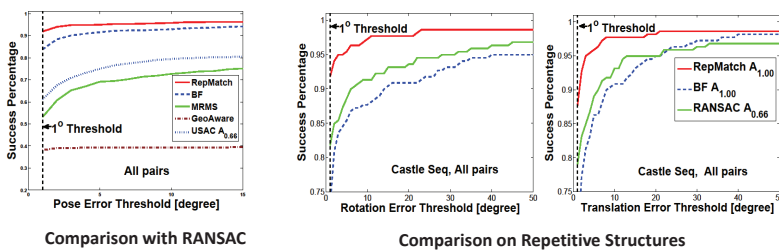Core-set and Local hypothesis   Local match consistency   Final Matches

(a)   (b)   (c)   (d)

Match Illustration

All matches   *Epipolor*   *BF*   RepMatch
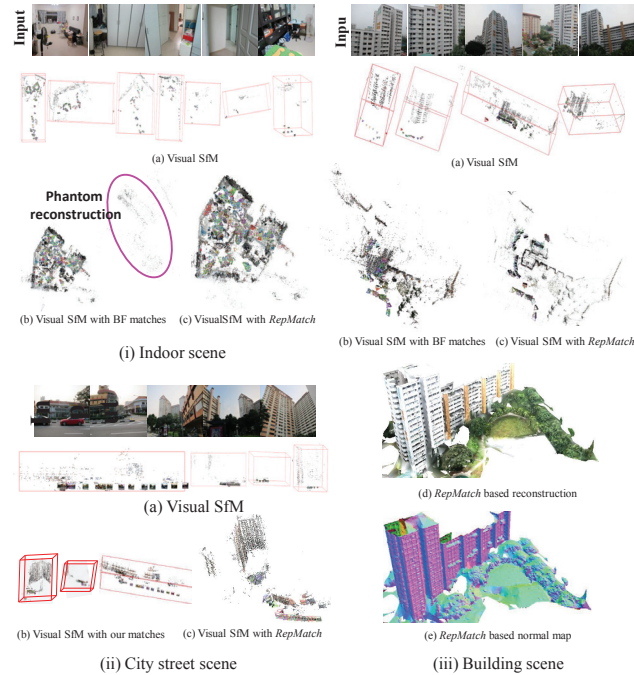
Illustration on real images. Black dots indicate wrong matches.

Note: Common central towers belong to physically different parts of the building.

Reconstruction

(a) Visual SfM

Phantom reconstruction

(b) Visual SfM with BF matches   (c) VisualSfM with *RepMatch*

(i) Indoor scene

(a) Visual SfM

(b) Visual SfM with BF matches   (c) Visual SfM with *RepMatch*

(a) Visual SfM

(b) Visual SfM with our matches   (c) Visual SfM with *RepMatch*

(ii) City street scene

(d) *RepMatch* based reconstruction

(e) *RepMatch* based normal map

(iii) Building scene

Compared with naïve matching, RANSAC pose estimation is significantly more accurate

Evaluation

Comparison with RANSAC   Comparison on Repetitive Structures

Conclusion

Pose estimation is potentially useful in many computer vision tasks. However, it has often been considered too unstable. This paper illustrates that stable, moderate baseline pose may be practical goal. Perhaps the problem is deserving of another look. Code can be obtained at *www.kind-of-works.com*

[1] Wen-Yan Lin, Ming-Ming Cheng, Jiangbo Lu, Hong Sheng, ,Minh N. Do, Philip Torr, "Bilateral Functions for Global Motion Modeling", ECCV14.
[2] Wen-Yan Lin, Ming-Ming Cheng, Shuai Zheng, Jiangbo Lu, Nigel Crook, "Robust Non-parametric Data Fitting for Correspondence Modeling", ICCV13.