Detection and Matching of Keypoints in Road Scene Images

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Background & Objectives

- Background:

1. Road scene images are taken in different views
2. Road scene images contain moving objects
3. Road scene images contain repeating objects

- Objectives:

1. Keypoints are detected automatically from road scene.
2. Automatic keypoints matching applied to any pair of images with different viewpoints but of the same scene.
3. As robust as possible

Method

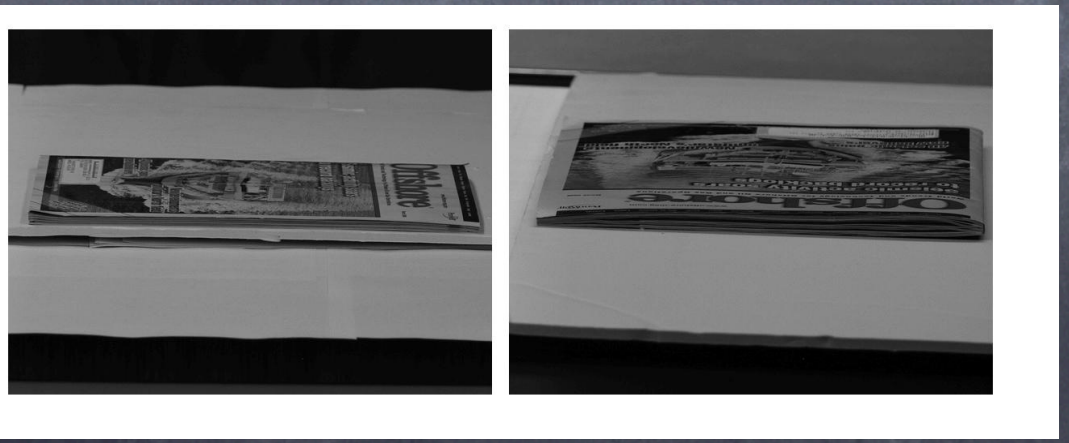
- Trials

1- global context SIFT + Hungarian
2- SIFT + Hungarian
3- global context SIFT + Flann
4- SIFT + Flann
5- SURF + Hungarian
6- SURF + Flann

- Current
- Detection & Matching Key points: Affine-SIFT
- Elimination of bad matches: Moisan-Stival Procedure + RANSAC

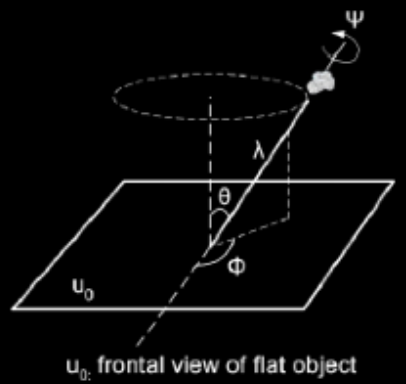
Affine-SIFT

- In addition to SIFT, Affine-SIFT handles large transition tilt
- Affine-SIFT is proven to be fully affine-invariant



Affine-SIFT

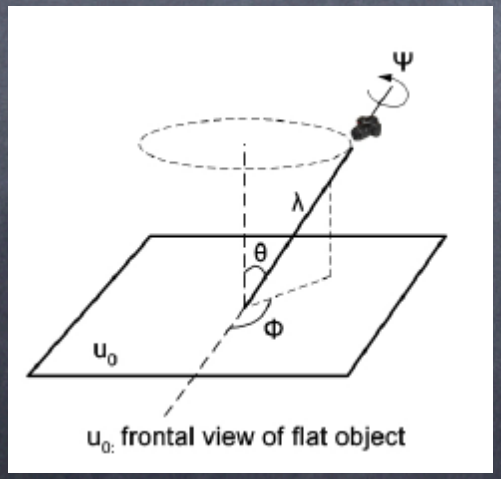
- SIFT is invariant only for 4 parameters: zoom, rotation and translation(x and y)
- Affine-SIFT can also handle angles defining camera axis orientation

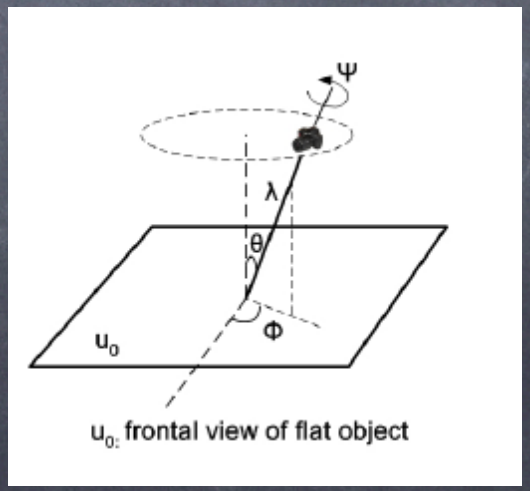


- ϕ: *longitude* angle between optical axis and a fixed vertical plane.
- $\theta = \arccos(1/t)$: *latitude* angle between optical axis and the normal to the image plane. Tilt $t > 1 \leftrightarrow \theta \in [0°, 90°]$.
- ψ: rotation angle of camera around optical axis.
- λ: *zoom* parameter.
- $\mathcal{T} = (e, f)^T$: translation, not presented here.

Affine-SIFT

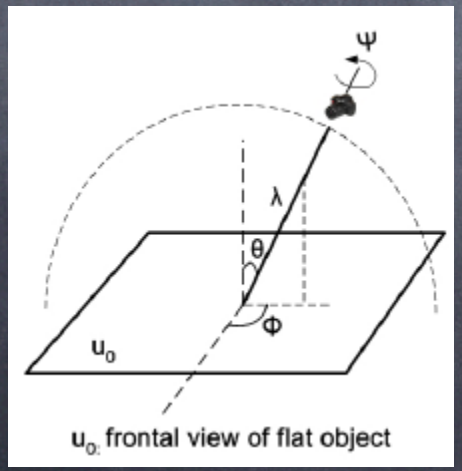
- Φ is the longitude angle between optical axis and a fixed vertical plane

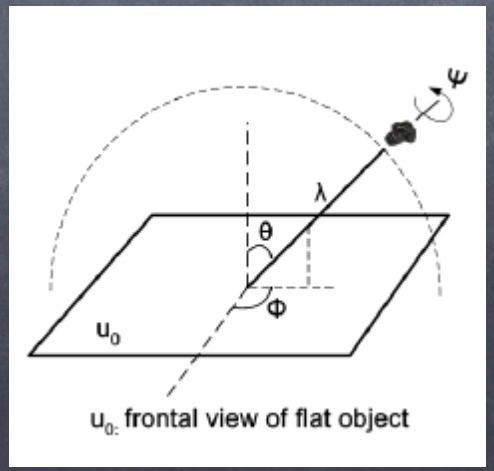




Affine-SIFT

- Θ is the latitude angle between optical axis and the normal to the image plane





Affine-SIFT algorithm

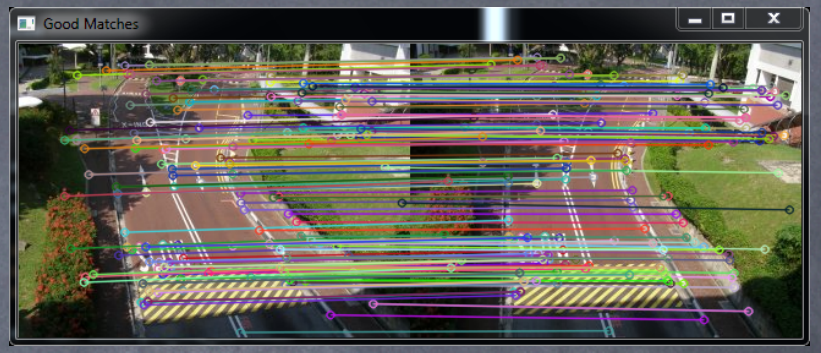
- 1. Apply rotation to both images
- 2. Apply simulated tilts to all rotated images
- 3. Perform SIFT of all pairs of resulting images

Affine-SIFT vs SIFT and SURF

- Affine-SIFT produces more good key points
- Affine-SIFT produces more matches

Affine-SIFT vs SIFT

- SIFT

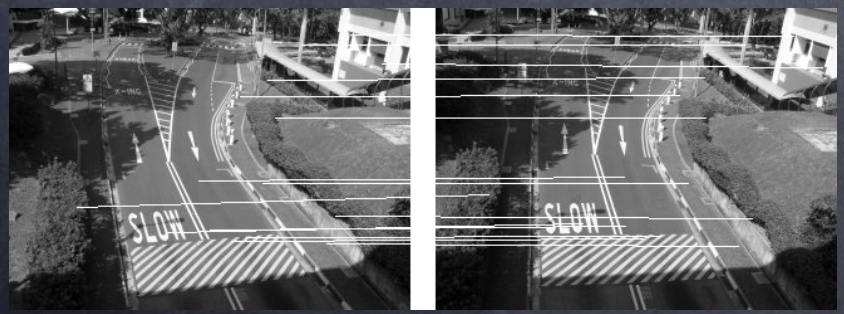


Number of keypoints
Image 1: 747
Image 2: 704
Number of matches: 200
Number of correct matches after filtering bad matches: 171

- Affine SIFT

Number of keypoints
Image 1: 4010
Image 2: 3909
Number of matches: 687
Number of correct matches after filtering bad matches: 687

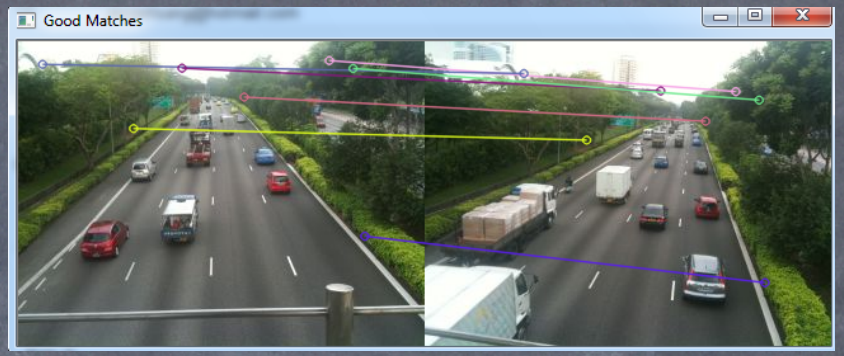
Affine-SIFT vs SIFT



Affine-SIFT vs SURF

- SURF

Number of keypoints:
Image 1: 727
Image 2: 716
Number of matches: 27
Number of correct matches: 7



- Affine SIFT:

Keypoints
Image 1: 2480
Image 2: 2692
Number of matches: 23
Number of good matches: 20

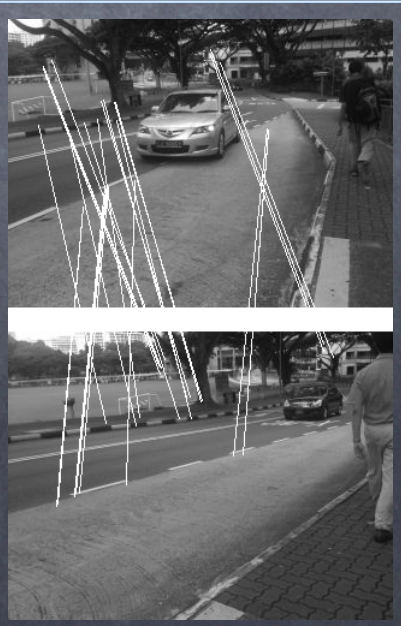
Affine-SIFT vs SIFT

- SIFT

Number of keypoints:
Image 1: 377
Image 2: 315
Number of matches: 24
Number of correct matches: 16

- Affine SIFT:

Keypoints
Image 1: 2428
Image 2: 1662
Number of matches: 26
Number of good matches: 24



Moisan-Stival Procedure

- Eliminate matches that are incoherent with epipolar geometry
- Moissan-Stival procedure can detect rigidity and provide a good estimate of the fundamental matrix when the initial set of point matches contains up to 90% of outliers. RANSAC typically breaks down around 50% of outliers.

Moisan-Stival Procedure vs RANSAC

- Relies on rigidity constraint - change of point view to apply a 3D rotation & translation to scene
- Check points whether correlated by rigid motion
- Define rigidity as the least epipolar distance for all geometric from 7 sub-pairs
- Define meaningfulness as the expected number of similar sets in random (ask the question whether this set of points is epipolar by chance or not)
- Requires no assumption on camera motion

Moisan-Stival + RANSAC

- Moisan-Stival

- Moisan-Stival + RANSAC

remove 2 more bad matches

Future work

- Key point matches with multi view points
- Fully illumination invariant (possible)
- Global context with ASIFT to introduce more good matches when the image has many repetitive features

References

- http://www.insa.ac.in/insa_pdf/20005b8c_49.pdf
- http://www.ams.jhu.edu/~castello/362/Handouts/hungarian.pdf
- http://people.cs.ubc.ca/~mariusm/uploads/FLANN/flann_visapp09.pdf
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- thanks