Photometric Based 3D Registration

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[1]http://recherche.ign.fr/labos/matis/ [2]http://mis.u-picardie.fr/

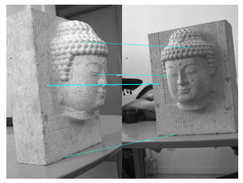
Problem

Computation of homologous points from corresponding images is one of the most studied problems in computer vision and photogrammetry. Due to the geometric transformation, the number of point matches is decreased when the angles between the images are increased.

SIFT algorithm

Short baseline

Wide baseline



Motivation

To develop a software program that is efficient computing the homologous points from a pair of images with associated depth information.

Acquisition: Image + 3D

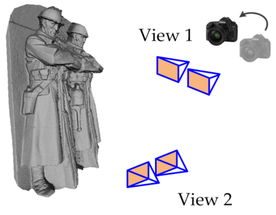
Kinect

Lytro

Stereo camera

Laser scanner

Multi-stereoscopic



References

[1] D. Lowe: Distinctive Image Features from Scale Invariant Keypoints. In *IJCV '04*

[2] B. Lévy et al.: Least Squares Conformal Maps for Automatic Texture Atlas Generation. In *ACM Transactions on Graphics '02*

[3] MICMAC: http://www.micmac.ign.fr/

General Strategy

1. Compute images that are locally ortho-rectified, and memorize the mapping from initial into ortho-rectified image.
2. Obtain point matches on the ortho-rectified.
3. Import the point matches into the initial geometry, using the inverse mapping.

1 Rectified image → 2 Matching → 3 Initial geometry

- Affine
- Perspective

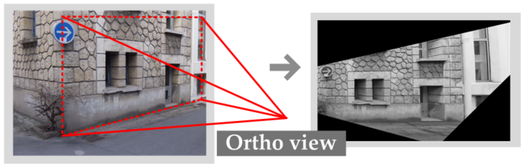
- Scale
- Rotation
- Translation

- Import points to initial image

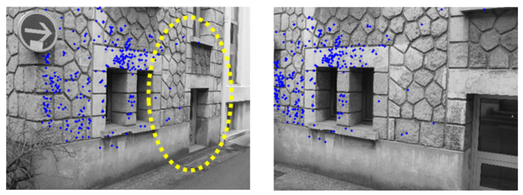
Planar Surface Scene

Image with associated 3D points.

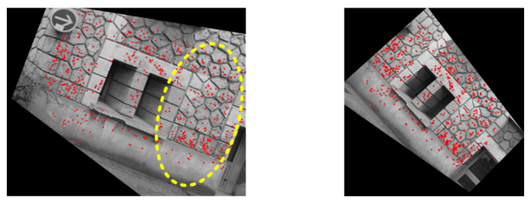
Compute ortho-rectified for each region.



SIFT on initial images (view 1 and view 2)

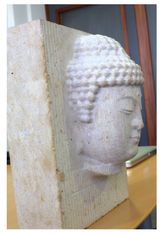


SIFT on ortho-rectified (view 1 and view 2)



Smooth Surface Scene

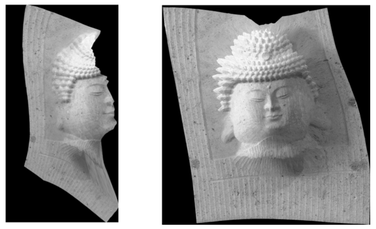
Images (view 1 and view 2)



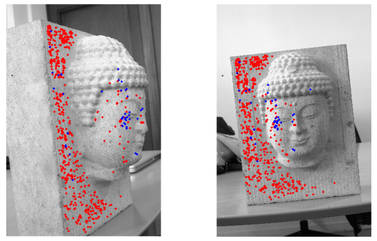
vertices = 3,427
faces = 6,572

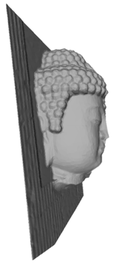
vertices = 3,393
faces = 6,605

Conformal images

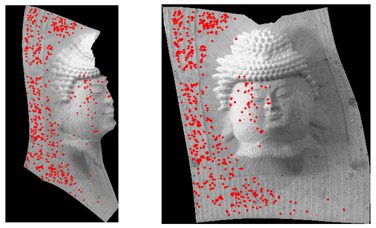


SIFT (blue) vs Our approach (red)





SIFT matching on conformal images



Comparison # of point matches between SIFT and our approach

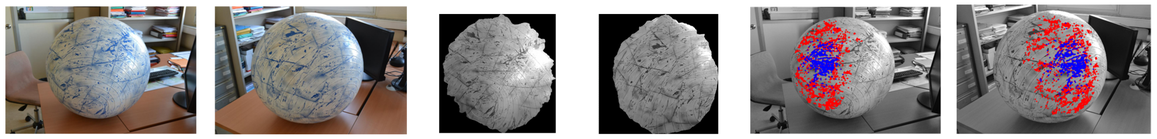
Method	SIFT	Our approach
# 1	208,943	43,499
# 2	261,045	83,186
Matches	48	615

where
1 : number of keypoints (view 1)
2 : number of keypoints (view 2)
Matches : number of matches

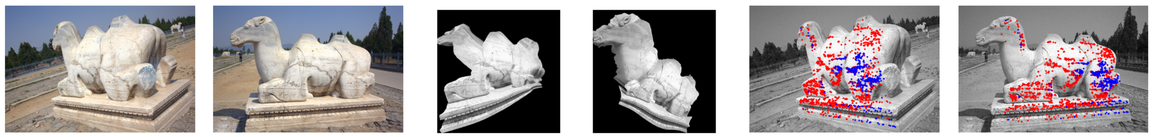
Other Results

Wide baseline images | Conformal images | SIFT (blue) vs Our approach (red)

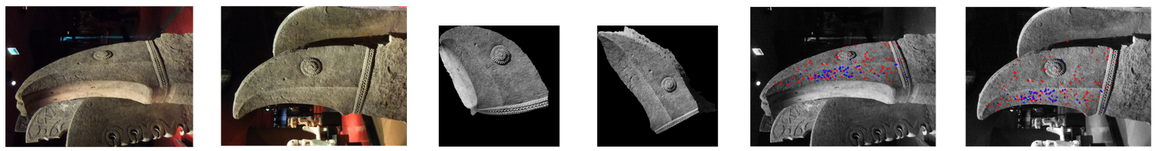
Sphere



Camel



Stone



Future Works

- Perform automatically segmentation of 3D point clouds between plane region, smooth region and "noisy" region (e.g. trees), this is necessary to obtain an automatic system.
- Use more sophisticated development than least square conformal mapping, for example non linear isometric constraint to limit possible degeneracy with unsmooth surface.