(Spring 2024) Due: **Friday, May 3**

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0 Fundamental Matrix Estimation From Point Correspondences

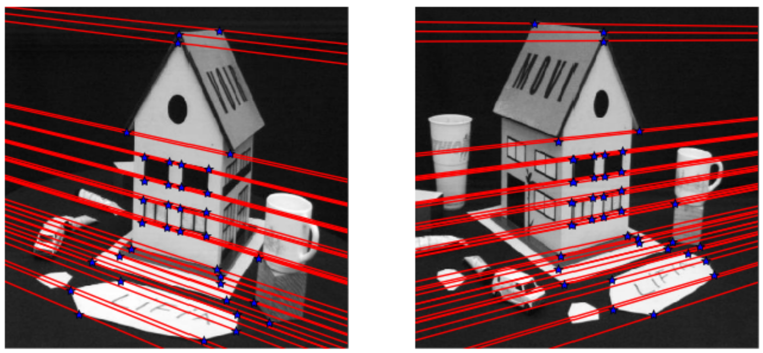


Figure 1: Example illustration, with epipolar lines shown in both images (Images courtesy Forsyth & Ponce)

(a) `Fundamental Matrix from normalized 8-point algorithm`:

```
[[-1.51007608e-07  2.51618737e-06 -1.56134009e-04]
 [ 3.63462620e-06  3.22311660e-07  7.02588719e-03]
 [ 2.36155133e-04 -8.53003408e-03 -2.45880925e-03]]
```

`Implementation procedure:`

```
1. Construct W from uv and uv' (points1 and points2 respectively)
2. Perform SVD to get U', S, V'.T and obtain F' as last row of V'.T
3. Get F by doing SVD with U',S,V' where S = S' (with last element = 0)
```

(b) *[Nothing to report]*

(c) *[Nothing to report]*

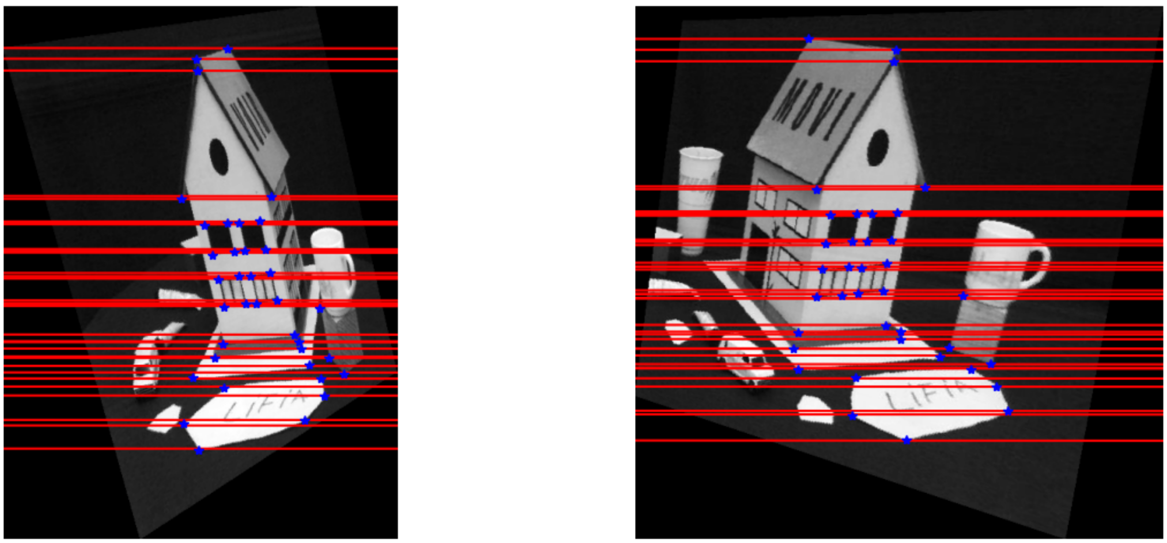
1 Matching Homographies for Image Rectification

(a) *[Nothing to report]*

(b) *[Nothing to report]*

(c) *[Nothing to report]*

(d) For each point p in one image, its corresponding point p' in the other image can be found along a straight epipolar line, because the homography transformation is such that the y coordinate is the same (v=v'). This constraint simplifies the problem from searching in two dimensions (along u,v) to searching in one dimension (along u only).

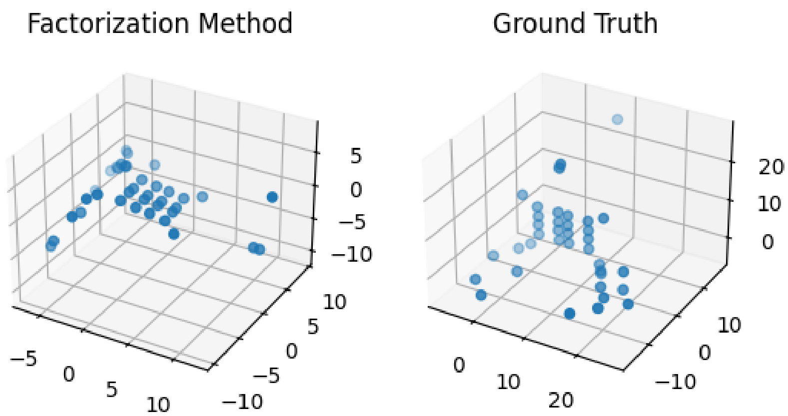


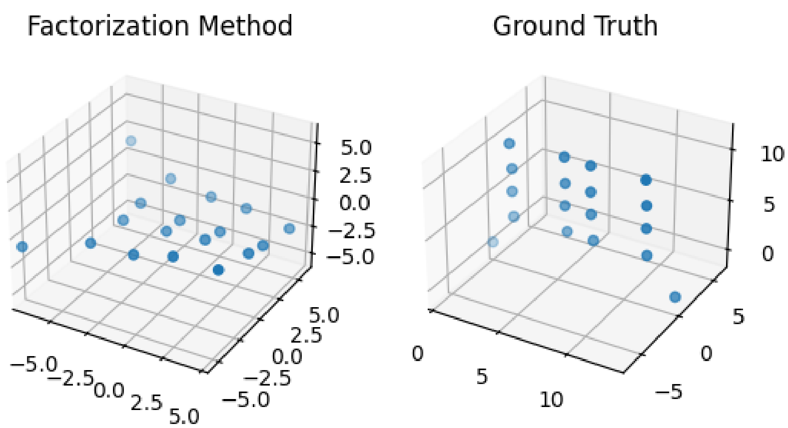
2 The Factorization Method

(a) Implementation procedure:

1. Normalize points by finding mean in each image (in points1, points2)
2. Stack the points such that we obtain D of dimension 2 * num_views x n_points (here, 4x37)
3. Perform SVD to get U, S, Vt
4. Get the 3x3 eqivalents U3 (first three columns), S3 (diagonal matrix of first three singular values), V3t (last three rows)
5. Compute M = U3 . sqrt(S3) and S = sqrt(S3) . V3t

(b) The scaling and rotation issues happen because the factorization method we're using does not consider depth and can only reconstruct the structure and motion up to an arbitrary scale and rotation. A.k.a, it assumes an orthographic camera model which ignores depth, that loses information about true scale and orientation.





(c) *[Nothing to report]*

(d) *[Nothing to report]*

(e) *[Nothing to report]*

3 Triangulation in Structure From Motion

Reconstructing a larger scene might pose problems such as occlusions in cluttered environments. More generally, for larger scenes, feature matching and triangulation can become very complex. Also in larger scenes, to get a decently dense (NOT sparse) reconstruction, we would need multiple views and that may slow down computation by a significant amount. Relative scales and depths may also be a problem with occlusions in scene.