Computer Vision
and Geometry Lab

Computer Vision

Exercise Session 8 – Structure from Motion

Structure from Motion

- Arc3D **www.arc3d.be**
  - http://www.youtube.com/watch?v=0tzW8dm71ec
- Acute3D (123D Catch **www.123dapp.com/catch**)
  - http://www.youtube.com/watch?v=UwBd1RbKljk
- 2D3 boujou
  - http://www.youtube.com/watch?v=qrszsSbStoQ
- etc...

Exercise 8

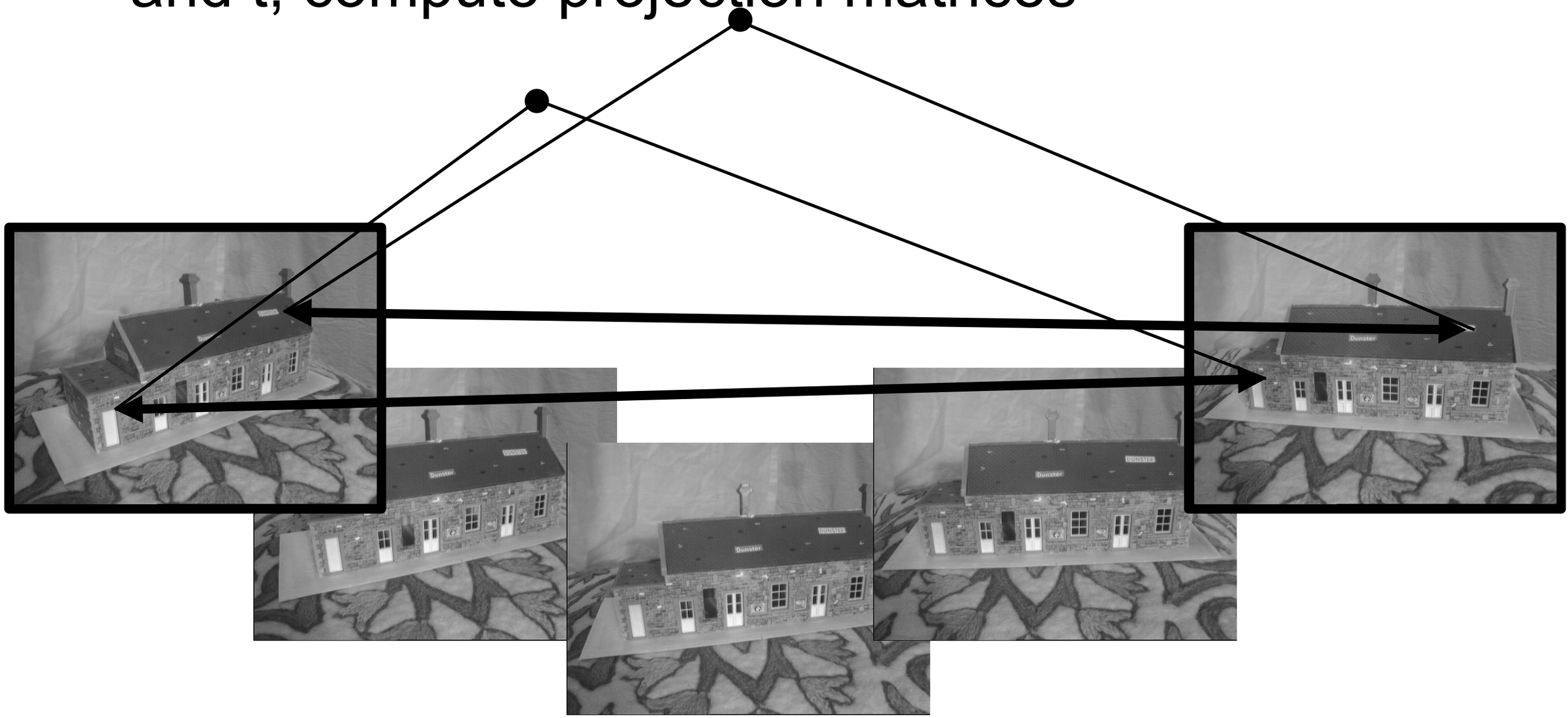
- 5 Images of a house on a turn table
- Background is static = at infinity

Exercise 8

- 4 Tasks:
  - Initialization with epipolar geometry
    - Do 8-point RANSAC and triangulate
  - Add more views
    - Do 6-point RANSAC and triangulate
  - Plot everything
  - Dense Reconstruction
    - Stereo matching and depth map plot

Task I: Initialization

- Compute essential matrix, decompose into R and t, compute projection matrices



Estimation of Fundamental Matrix

- Code is provided to extract and (mis-)match features using VLFeat routines
- Initialize VLFeat !
- Estimate F using a set of randomly sampled 8 point correspondences (➔ RANSAC)
- Involves least squares solution for f in a set of linear equations of the form Af = 0 minimizing ||Af|| per SVD of A subject to condition ||f||=1

Estimation of Fundamental Matrix

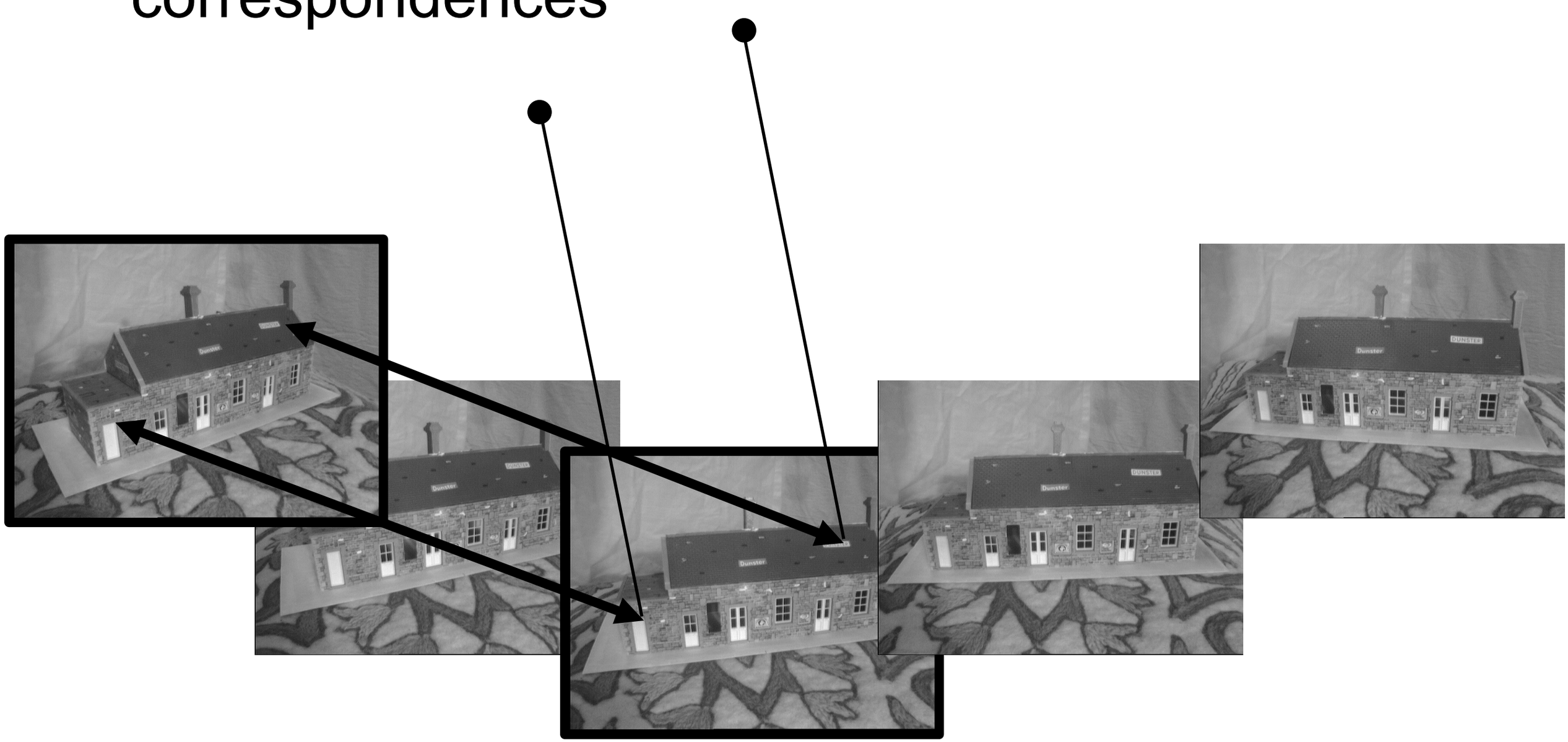
- Estimated F will probably have rank 3
- In reality F is singular, thus having rank 2
- Since the code is already provided, check it and try to understand how the singularity of F is imposed after first estimation (how is F replaced by F' minimizing the Frobenius norm $\|F-F'\|$ subject to the condition $\det F'=0$?)
- Can you realize the shortcomings of 8-point estimation of F?

Estimation of Essential Matrix

- Intrinsic camera parameters are provided
- Compute E from estimated F
- Think about the calibration of inlier matches
- Decompose E in to R and t
- Create the projection matrix for the second view assuming that the first one is identity
- Triangulate

Task II: Adding more views

- Feature matches define 3D-2D point correspondences



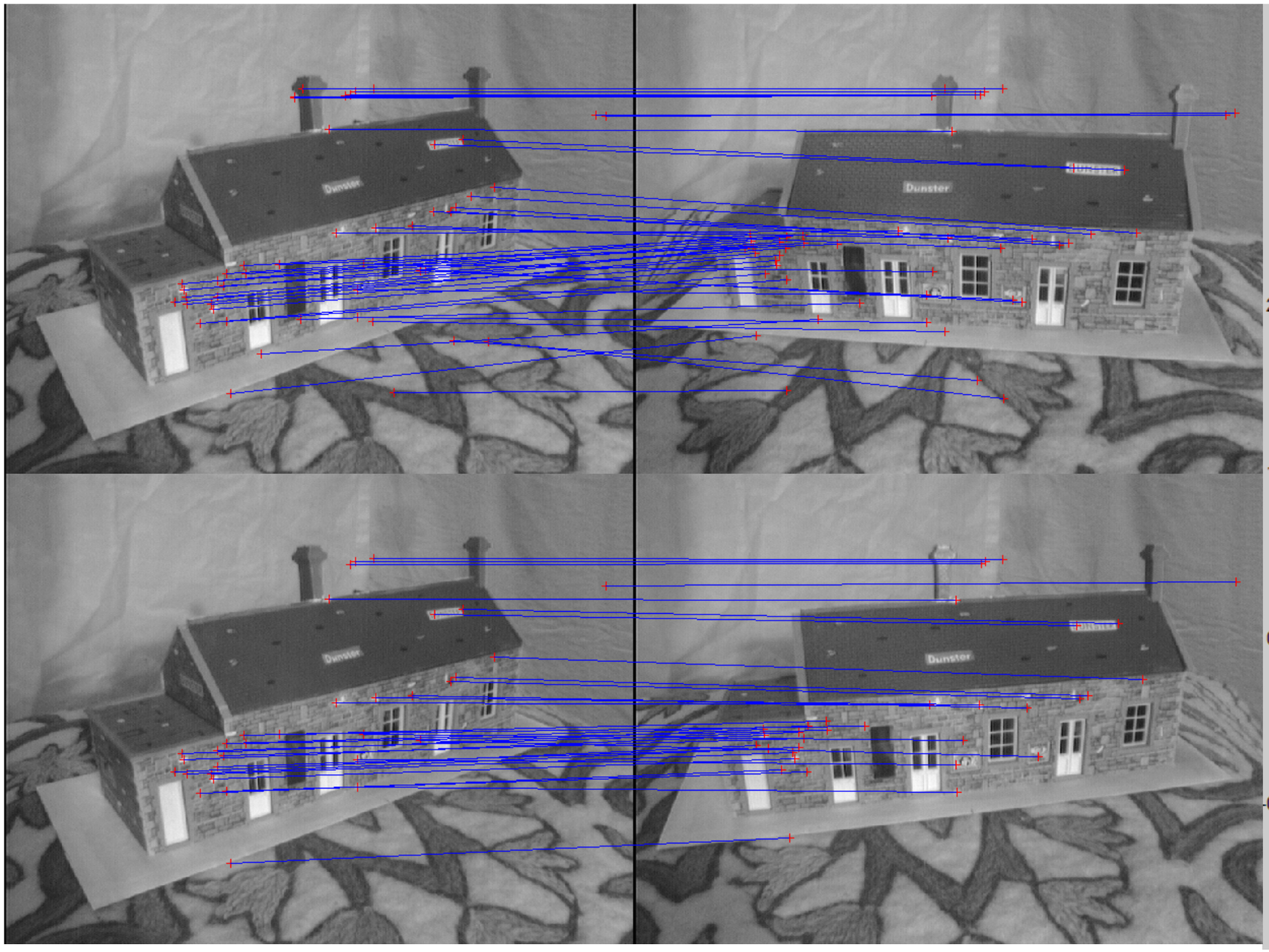
6-Point Algorithm

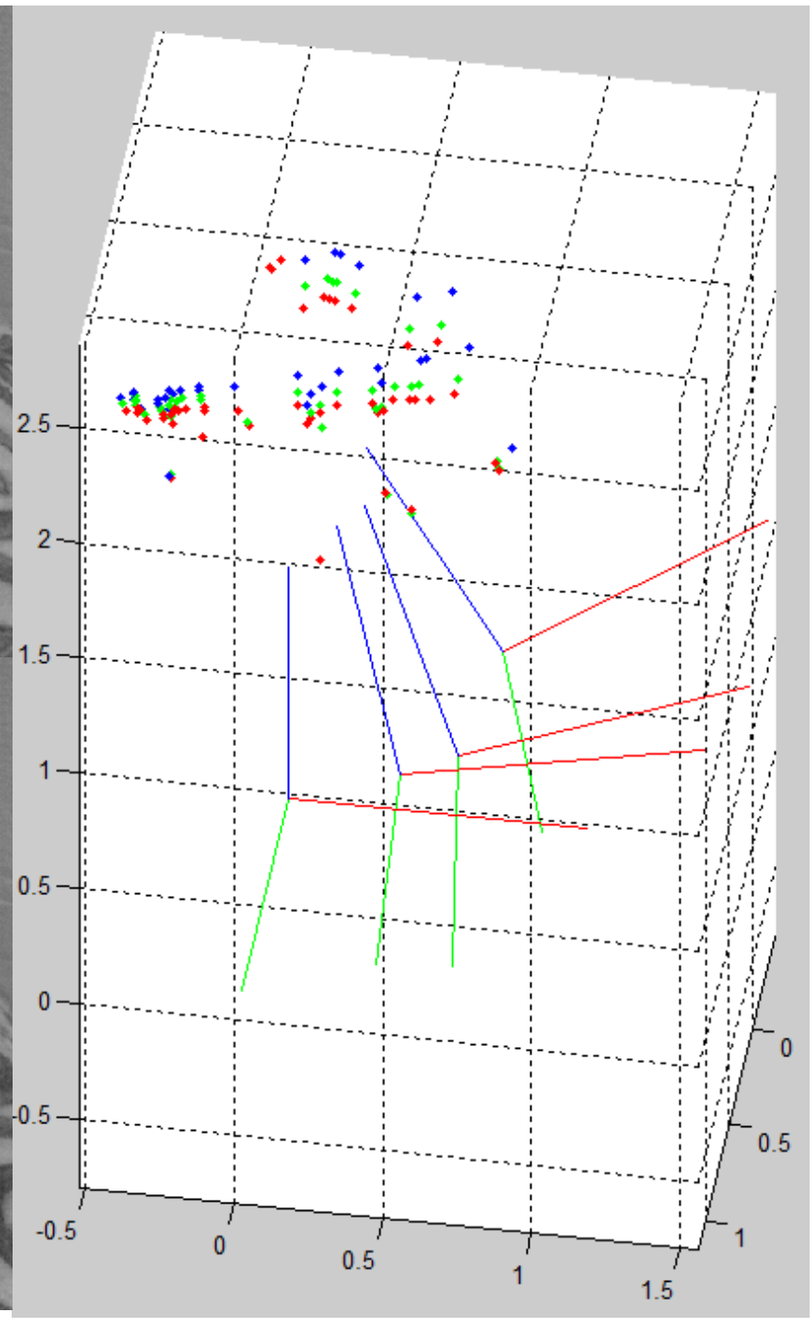
- The 6-point algorithm that was used for the camera calibration can be used to compute the projection matrix relative to the scene

- Do RANSAC to filter out wrong matches

- It does not work well on planar scenes – make sure you have 3D points distributed all around

Plotting

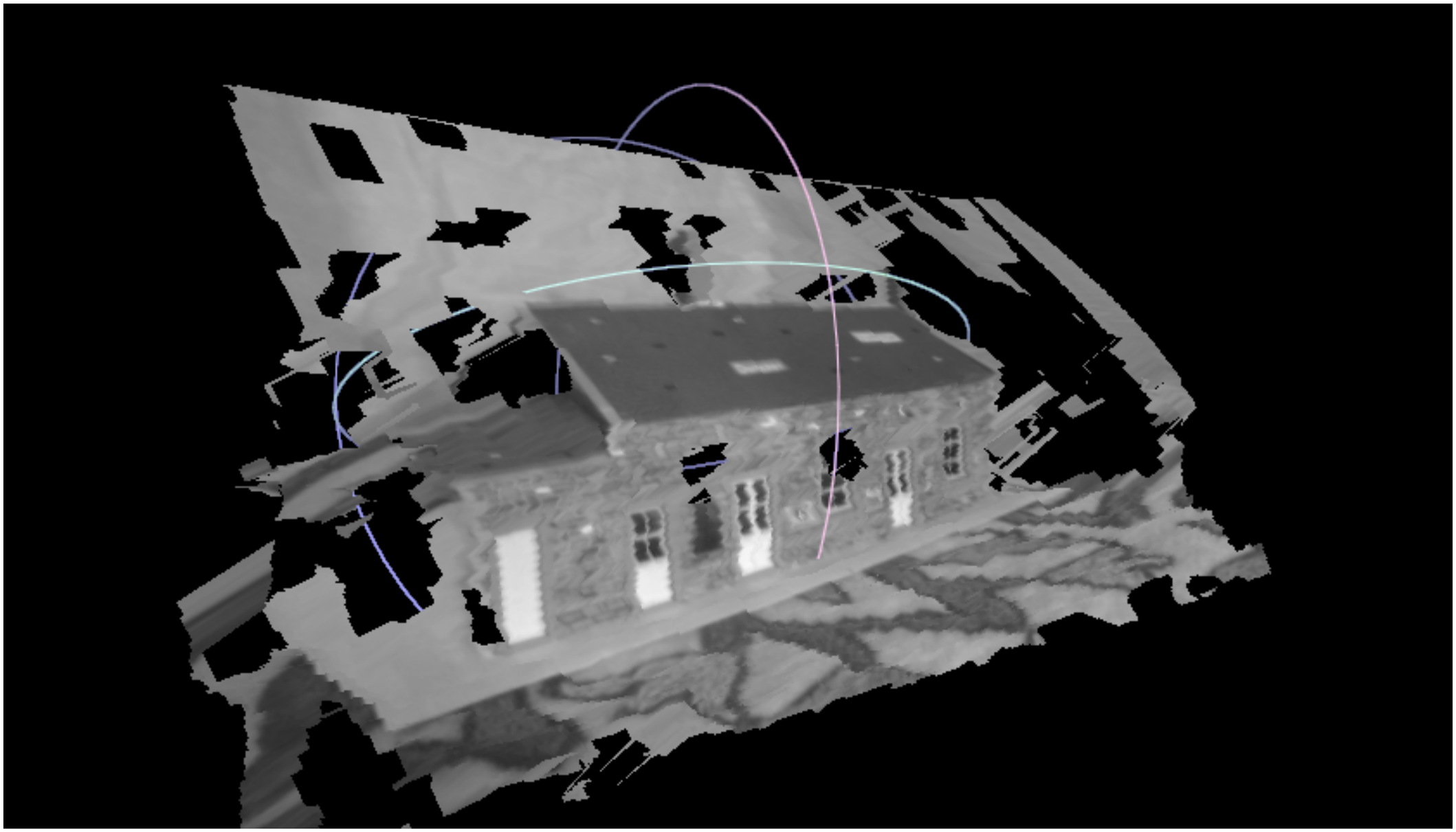

Dunster
Dunster
Dunster
Dunster


2.5
2
1.5
1
0.5
0
-0.5
-0.5
0
0.5
1
1.5
0
0.5
1

Hand-in

- Report should include:
  - Images with visualized inlier and outlier matches
  - Epipolar geometry of the initialization images
  - Sparse reconstruction with inlier 3D-points and cameras
- Source code

Bonus: Dense Reconstruction



Hand-in

By **1pm** on **Thursday 28th November 2013**

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