# Computer Vision Assignment 7: Structure from Motion

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## 1. Feature extraction and initialization with epipolar geometry

We begin by taking the first and last image of the given sequence. Using the VLFeat toolbox, we match features from the two images. Then, we use the 8-point RANSAC algorithm in order to differentiate inliers from outliers. The result is shown below:

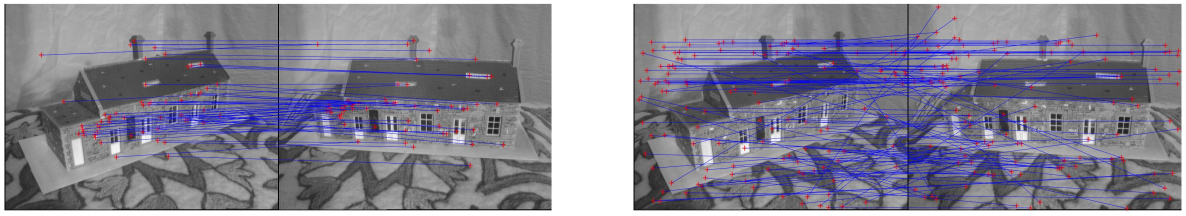

**Figure 1:** Inliers and outliers resulting from the 8-point RANSAC

Follows the epipolar geometry:

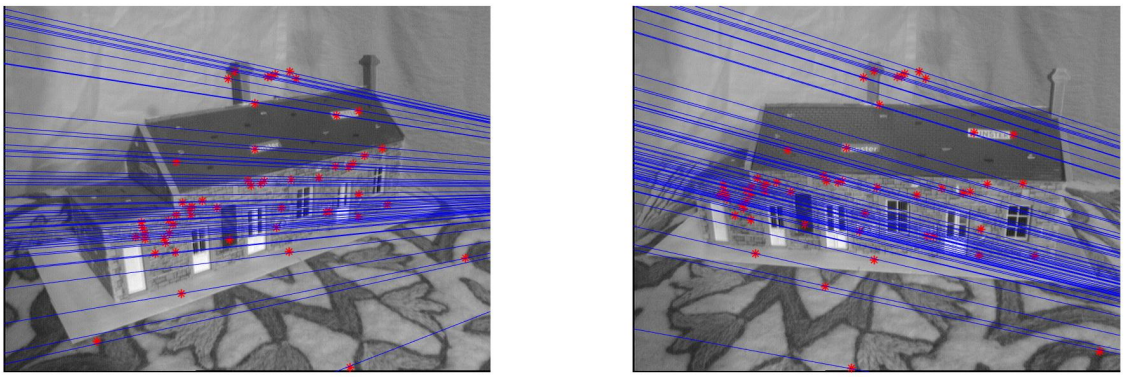

**Figure 2:** Epipolar geometry

Assuming the projection matrix of the first image is $\begin{bmatrix} I \mid 0 \end{bmatrix}$, we can compute the projection matrix of the second image using the essential matrix and the calibrated inlier matches of both images:

$$E = K' \, F \, K$$
$$x_{inlier,img1,calibrated} = K^{-1} \, x_{inlier,img1}$$
$$x_{inlier,img2,calibrated} = K^{-1} \, x_{inlier,img2}$$

And we can finally triangulate the inlier matches using the two projection matrices and the calibrated inlier matches.

## 2. Triangulation and adding new views

When adding a new view, we begin by matching its 2D features with the 2D features of the 3D-3D correspondence of the first view. After calibrating the obtained matches, we run the 6-point RANSAC algorithm. After checking that the $R$ matrix has a positive determinant, we calibrate the points and triangulate using the computed projection matrix.

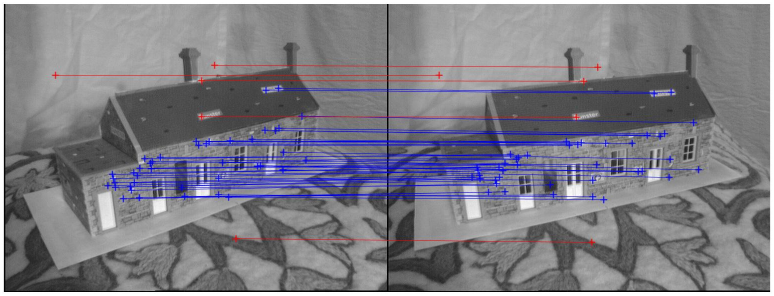

**Figure 3:** Inliers (blue) and outliers (red) after 6-point RANSAC between images 0 and 1

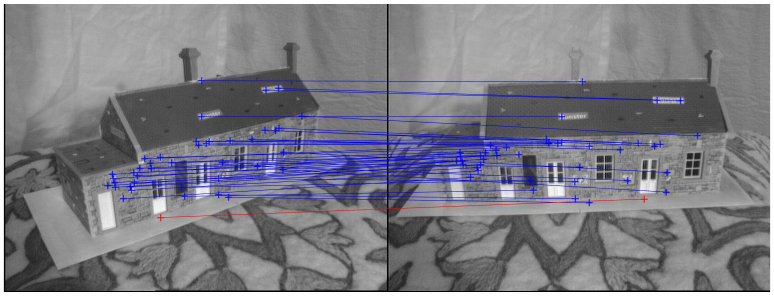

**Figure 4:** Inliers (blue) and outliers (red) after 6-point RANSAC between images 0 and 2

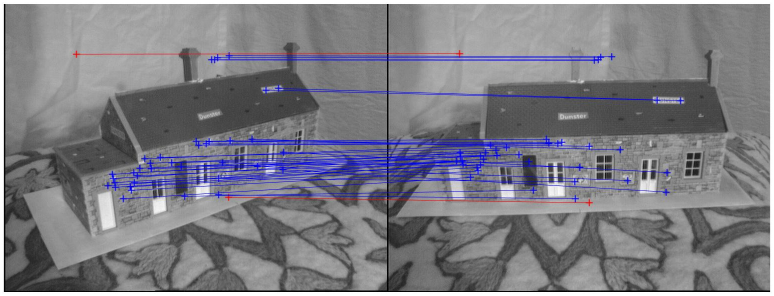

**Figure 5:** Inliers (blue) and outliers (red) after 6-point RANSAC between images 0 and 3

## 3. Plotting

We plot the triangulated 3D inlier points from the previous tasks together with the inliers from the first task. We also plot the camera poses, yielding the following result:

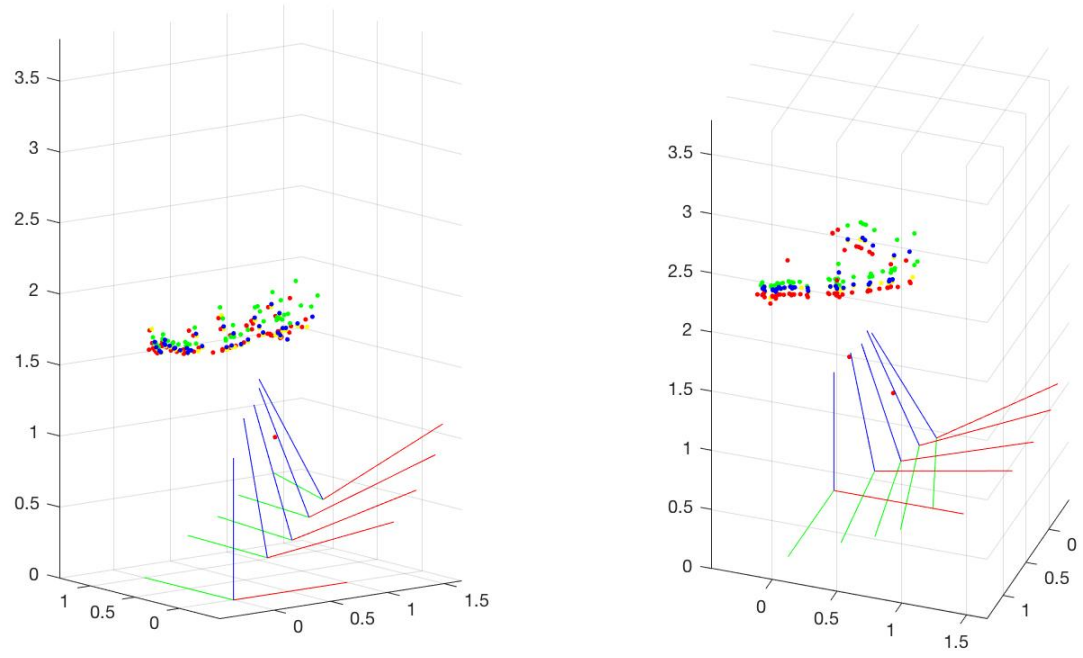


**Figure 6:** Triangulated points and camera poses plotted in 3D

Red dots are the triangulated points from the initialization, green dots are the triangulated points from the first additional image, blue dots are from the second additional image, and yellow dots are from the third additional image.

As expected, we see that the initial camera pose is at the origin. The following ones go up while rotating slightly counter-clockwise, which is representative of what happened in real life when the pictures were taken.