Practice questions - camera calibration, homographies, stereo, etc.

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1. When performing camera calibration, we set up a system of equations $A\mathbf{p} = 0$ in the parameters $\mathbf{p}$ that define the camera projection matrix. We then tried to minimize $\|A\mathbf{p}\|$ subject to $\|\mathbf{p}\| = 1$.

   (a) Why do we constrain $\|\mathbf{p}\| = 1$? Because we are dealing with homogenous coordinates, so P is known only to a scale. Forcing $\|\mathbf{p}\| = 1$ fixes the scale.

   (b) How many entries does $\mathbf{p}$ have? $3 \times 4 = 12$

   (c) What is the minimum number of equations we need? 12 - 1 = 11, since one equation is already provided by $\|\mathbf{p}\| = 1$

   (d) What is the minimum number of 3D-2D correspondences we need? 6: each correspondence provides 2 equations.

2. What do the epipolar lines look like for rectified cameras (cameras with viewing directions parallel to each other that differ only by a translation along X)? They are rows of the image.

3. Can you define a notion of disparity when the cameras with parallel viewing directions differ by a translation not along X, but in an arbitrary direction in the XY plane? What do the epipolar lines look like in this case? A point (X, Y, Z) projects to $(X/Z, Y/Z)$ in one image and $((X + t_X)/Z, (Y + t_Y)/Z) = (X/Z + t_X/Z, Y/Z + t_Y/Z)$ in the other image. Thus the epipolar lines are lines in the direction (t_X, t_Y). We can use either the difference in x coordinates or the difference in y coordinates as disparity.

4. Consider using RANSAC to fit lines to points. What happens when there is more than one good fit (dotted lines in the figure)? How can you change RANSAC so that it can output multiple lines? There will be no single best fit: RANSAC will likely return only one of the two lines. To get both lines, instead of simply returning the model with the most number of inliers, we can return all models for which the number of inliers is above a threshold.