DATA.ML.300 Computer Vision Exercise 7

Ng Zi Yi

25 Feb 2024

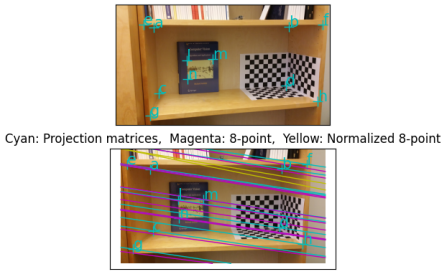
1 Task 1

Structure from motion (SFM) aims to reconstruct a 3D model from multiple 2D images taken from different viewpoints by using projective transformation. This transformation maps the 3D coordinates to 2D image coordinates but it does not preserve lengths, angles or ratios and it maintains only the collinearity. This is why some reconstructed models could be distorted, although its geometrically correct. The issue of ambiguity arises because multiple combinations of 3D structure and camera poses can lead to the same 2D projection. For illustration:

$$x = PX = (\frac{1}{k})P(kX) \tag{1}$$

if we scale the factor of image by k and camera by 1/k, the effect of scaling cancels out and will result in the same 2D projection regardless the value of k.

2 Task 2



3 Task 3

(a) The cameras are calibrated with Direct Linear Transform (DLT). This function takes 3D world coordinates and their corresponding 2D image coordinates and returns the calibrated camera matrix (P1t and P2t)

(b) The model looks distorted in the projective reconstruction because the projective transformation used to convert 3D points to 2D points does not preserve angles and ratios of lengths. However, the model is still correct because the projected points still maintain their collinearity relationships. The relative positioning of points and lines is accurate, and the projection captures the essential geometric structure of the scene.

(d) To upgrade to similar reconstruction, information such as parallel lines could be help. We could Identify lines in the scene that should be parallel in reality and measure their lengths in the image to find a scaling factor. Then, we adjust the reconstruction accordingly. We could also use known angle to correct distortion by adjusting the angle in 3D model to match the known angle in real life.