Università della Svizzera italiana

Faculty of Informatics

Computer Vision & Pattern Recognition

Spring 2023

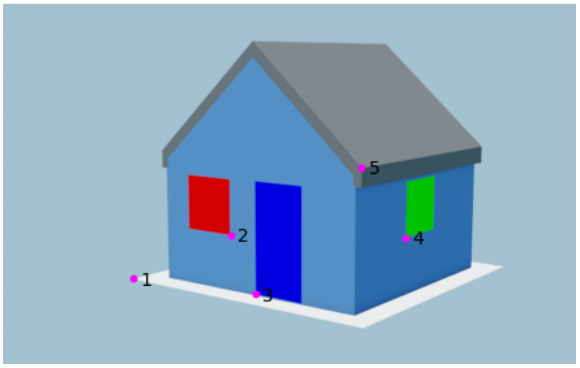
Project, Part 3

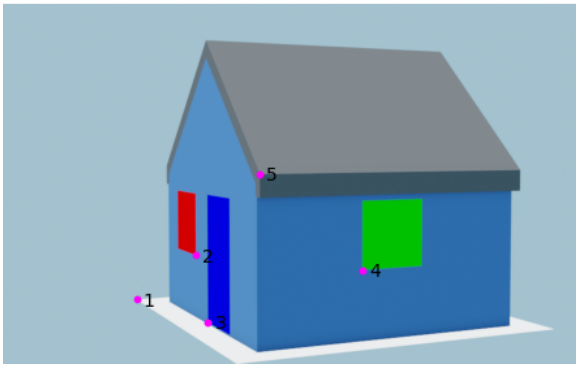
May 29, 2023

Problem 3 [20 points]

Consider the pixel images "`house1.png`" and "`house2.png`" (you can find them on iCorsi) and write a program for recovering the fundamental matrix that relates the two cameras which took these images, as well as the projection matrices for the two cameras. Moreover, you shall reconstruct the world coordinates of the 5 cardinal points of the house marked in the images below. In order to do so, you should attend to the following tasks:

1. Get the image coordinates $\boldsymbol{x}_i$, $i = 1, \ldots, 10$, of the points marked in the image from the second part of the project in "`house1.png`" and the image coordinates $\boldsymbol{x}'_i$, $i = 1, \ldots, 10$, of the same points in "`house2.png`" and use the *8-point algorithm* to reconstruct the *fundamental matrix* F relating the two views.
2. Using the *canonical camera pair* $(\hat{P}, \hat{P}')$, where $\hat{P} = [I \mid \mathbf{0}]$, $\hat{P}' = [[\boldsymbol{e}']_\times F \mid \boldsymbol{e}']$ and *triangulation*, reconstruct the 3D coordinates of the points $\hat{\boldsymbol{X}}_i$, $i = 1, \ldots, 10$, to which the image points $\boldsymbol{x}_i$ and $\boldsymbol{x}'_i$ correspond for this camera pair. To this end, implement the linear triangulation method using the DLT as described in Sec. 12.2 in the book.
3. You will notice that the coordinates $\hat{\boldsymbol{X}}_i$ differ from the world coordinates $\boldsymbol{X}_i$ in the file "`coords.tex`" (you can find it on iCorsi), which is to be expected, since you computed them using the canonical camera pair. By matching the $\hat{\boldsymbol{X}}_i$ with the $\boldsymbol{X}_i$, $i = 1, \ldots, 10$, recover the *3D homography* H that relates the canonical camera pair $(\hat{P}, \hat{P}')$ to the *correct camera pair* (P, P'). Read note (i) in Sec. 4.9.2 of the book to find out how to do this using the DLT.
4. Use the correct camera pair (P, P') and triangulation to find the world coordinates $\boldsymbol{Y}_j$, $j = 1, \ldots, 5$ of the points $\boldsymbol{y}_j$ and $\boldsymbol{y}'_j$ marked in the images below, similar to how you did it in task 2 with the canonical camera pair.





Hand in your code, a short description of your solution, and your estimates of F, $\boldsymbol{X}'_i$ $(i = 1, \ldots, 10)$, $(\hat{P}, \hat{P}')$, (P, P'), and $\boldsymbol{Y}_j$ $(j = 1, \ldots, 5)$.

Solutions (one per team of up to 3 students) must be returned on June 16, 2023 via iCorsi