CS x476 Project 5

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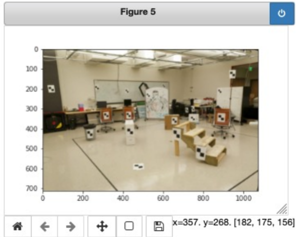
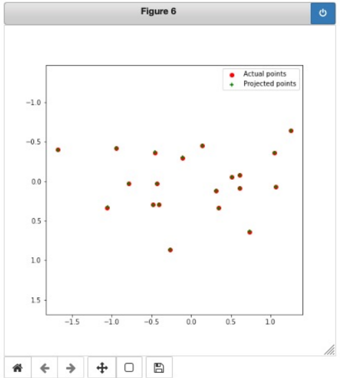
[Section - 4476/6476]

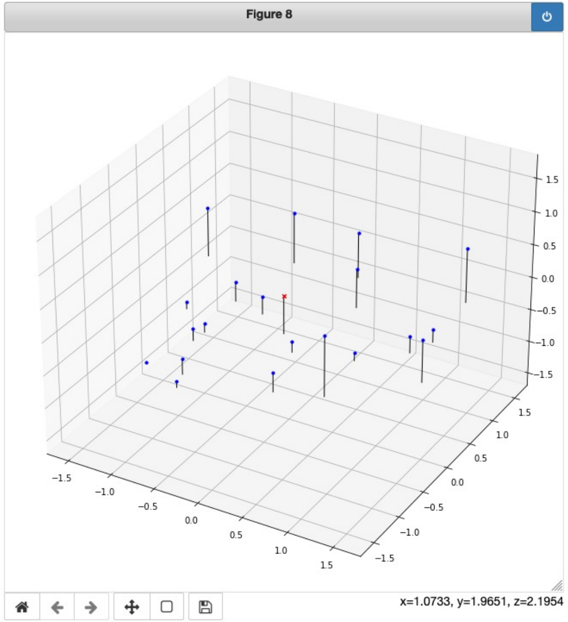
Part 1: Projection matrix

[insert visualization of projected 3D points and actual 2D points for the CCB image we provided here]



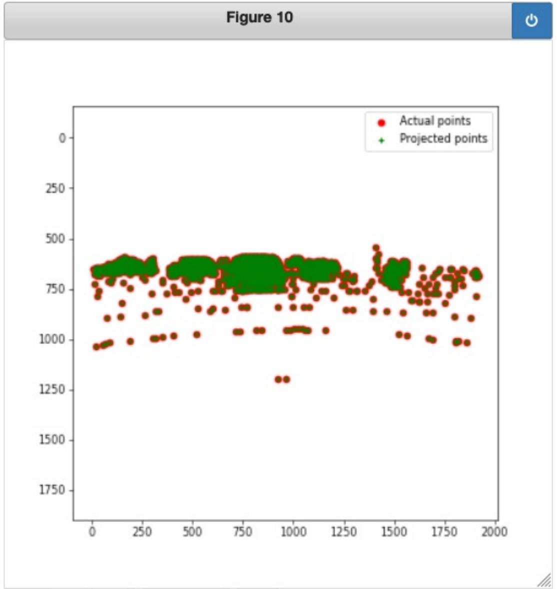


[insert visualization of camera center for the CCB image here]

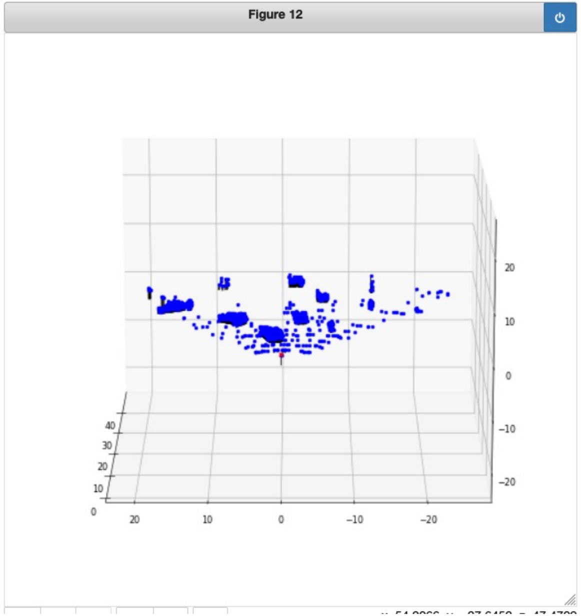


Part 1: Projection matrix

[insert visualization of projected 3D points and actual 2D points for the Argoverse image we provided here]



[insert visualization of camera center for the Argoverse image here]



Part 1: Projection matrix

[What two quantities does the camera matrix relate?]
The camera matrix relates 3D points to 2D image points.

[What quantities can the camera matrix be decomposed into?]

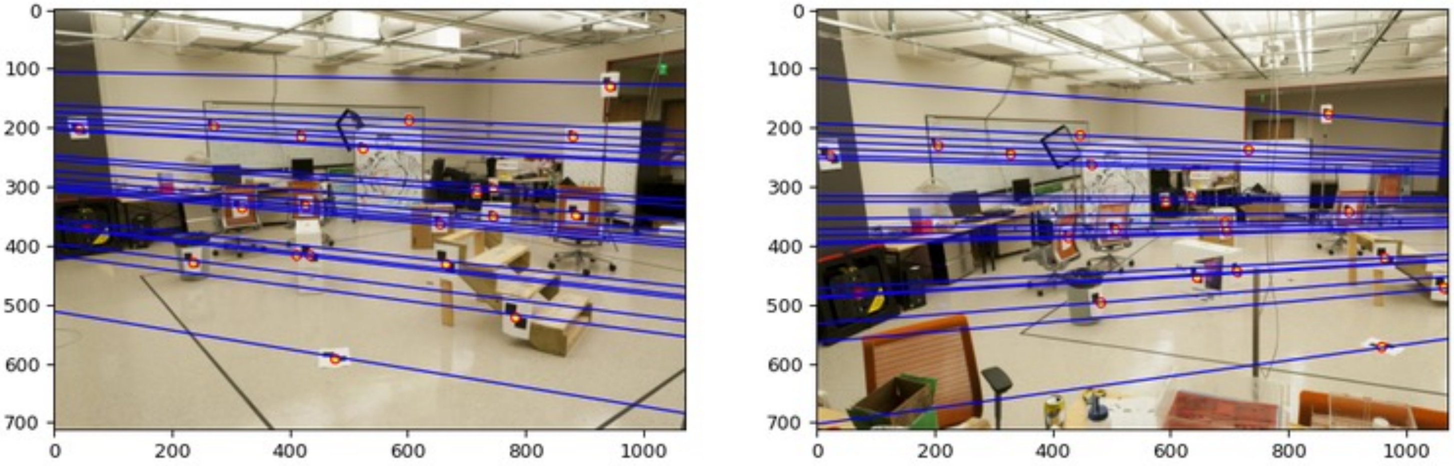
The camera matrix can be decomposed into intrinsic and extrinsic parameters

[List any 3 factors that affect the camera projection matrix.]

Focal legth, principal point offset, and axis skew

Part 2: Fundamental matrix

[insert visualization of epipolar lines on the CCB image pair]



Part 2: Fundamental matrix

[Why is it that points in one image are projected by the fundamental matrix onto epipolar lines in the other image?]

The fundamental matrix F maps a point in image_a to a corresponding epipolar line connecting a point on image_b.

[How many minimum points do we need to estimate the Fundamental matrix. Explain?]

8 points are needed to compute the fundamental matrix. This is because there are 8 different point pair combinations used to solve for the Fundamental matrix.

Part 2: Fundamental matrix

[What does it mean when your epipolar lines are all horizontal across the two images?]

It means that the points in both images that correspond to each other can be found by looking only along a horizontal line.

[Why is the fundamental matrix defined up to a scale?] (Hint: you can reason using the equation for F)

Since the equation that solves for F (x^T * F * x = 0) can be multiplied by any scalar to solve it. So, a scale is fixed to arrive at a single unique solution.

[Why is the fundamental matrix rank 2?]

F represents a mapping from 2-dimensional space to 1-dimensional projective space. Hence, it must should have rank 2.

Part 4a: Visualize Fundamental Matrices

(EC for 4476, required for 6476)

[insert visualization of epipolar lines for Notre Dame]

[insert visualization of epipolar lines for Mount Rushmore]

Part 4a: Visualize Fundamental Matrices
(EC for 4476, required for 6476)

[insert visualization of epipolar lines for Gaudi]

[insert visualization of epipolar lines for Woodruff]

Part 4a: Visualize Fundamental Matrices

(EC for 4476, required for 6476)

[Explain any one difference you noticed in the feature detection/matching for these 4 pair of images]

Part 4b: Performance comparison
(EC for 4476, required for 6476)

[insert visualization of epipolar lines on the Argoverse image pair using the linear method]

[insert visualization of epipolar lines on the Argoverse image pair using RANSAC]

Part 4b: Performance comparison
(EC for 4476, required for 6476)

[Describe the different performance of the two methods.]

[Why do these differences appear?]

[Which one should be more robust in real applications? Why?]

Part 5: Visual odometry

[How can we use our code from part 2 and part 3 to determine the “ego-motion” of a camera attached to a robot (i.e., motion of the robot)?]

From calculating the fundamental matrix, the camera center coordinates can be obtained and charted over time to determine the camera’s coordinates.

[How many outputs (poses) does the get_visual_odometry function return?]

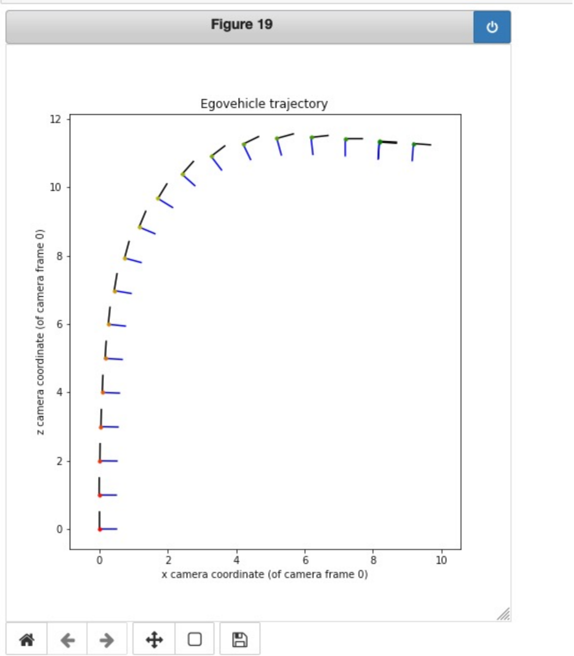
The function returns 20 poses.

[How many outputs (poses) does the compute_absolute_poses function return?]

The function returns 20 poses.

Part 5: Visual odometry

[Attach a plot of the camera's trajectory through time]



Part 6: gtSAM (EC for Grad Students Only, no credit for UG)

[Attach a plot of the camera's trajectory through time as computed using gtSAM w/o skip connections]

Part 6: gtSAM (EC for Grad Students Only, no credit for UG)

[Attach a plot of the camera's trajectory through time as computed using gtSAM with skip connections]

Part 6: gtSAM (EC for Grad Students Only, no credit for UG)

[Explain the differences in the individual factor errors in both the results (optimized_poses1 & optimized_poses2)]

[Of all the factor errors, how many of these correspond to skip connections?]