CS 4476 Project 3

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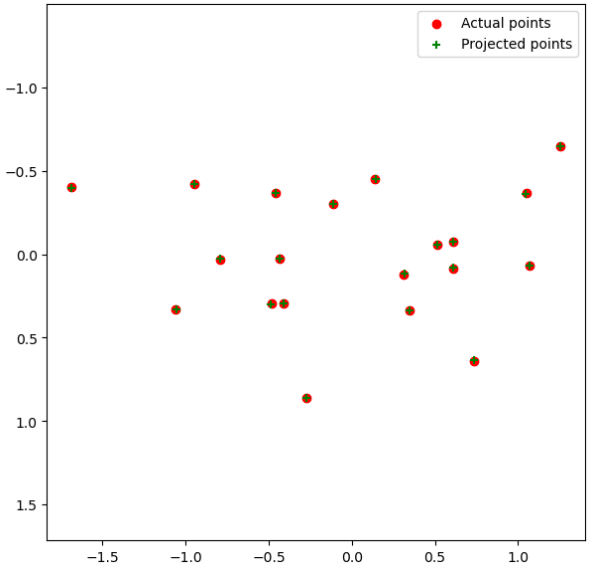
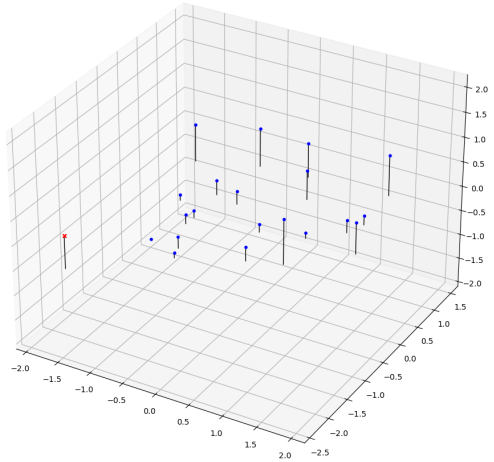
Part 1: Projection matrix

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

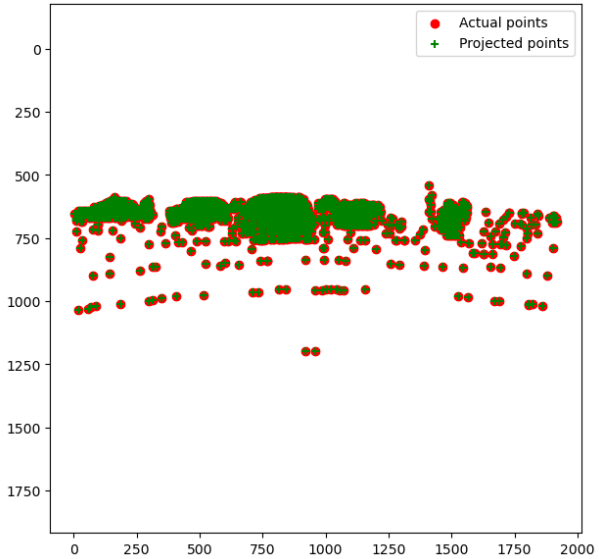


[insert visualization of camera center for the CCB image here]

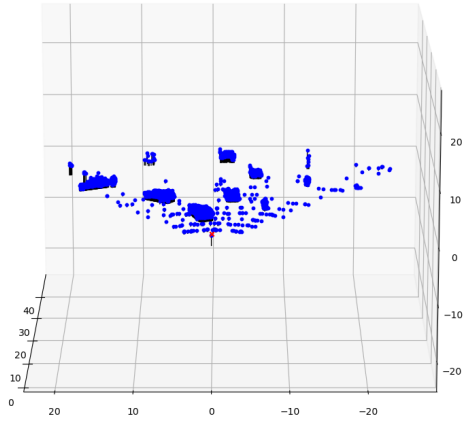


Part 1: Projection matrix

[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 a point in camera coordinates to a point in the world coordinates

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

The camera matrix can be decomposed into intrinsic and extrinsic properties, K and RT.

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

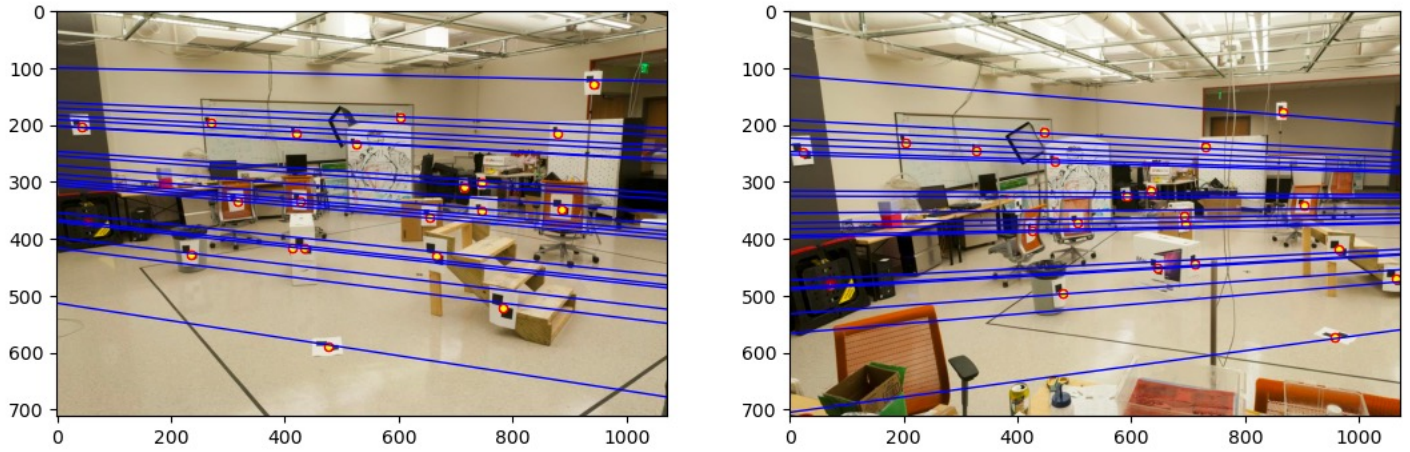
Optical Center

Unit Aspect Ratio

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?]

Because we are going from 3D to 2D we are losing information, so therefore it's possible the point could lie somewhere on the epipolar line rather than specifically on another point on the other image.

[What happens to the epipoles and epipolar lines when you take two images where the camera centers are within the images? Why?]

The lines will intersect at the all at the camera centers, because the camera center is where all epipolar lines are projected from.

Part 2: Fundamental matrix

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

It means that the camera is in the same place, with the same height, aspect ratio and skew, etc.

[Why is the fundamental matrix defined up to a scale?

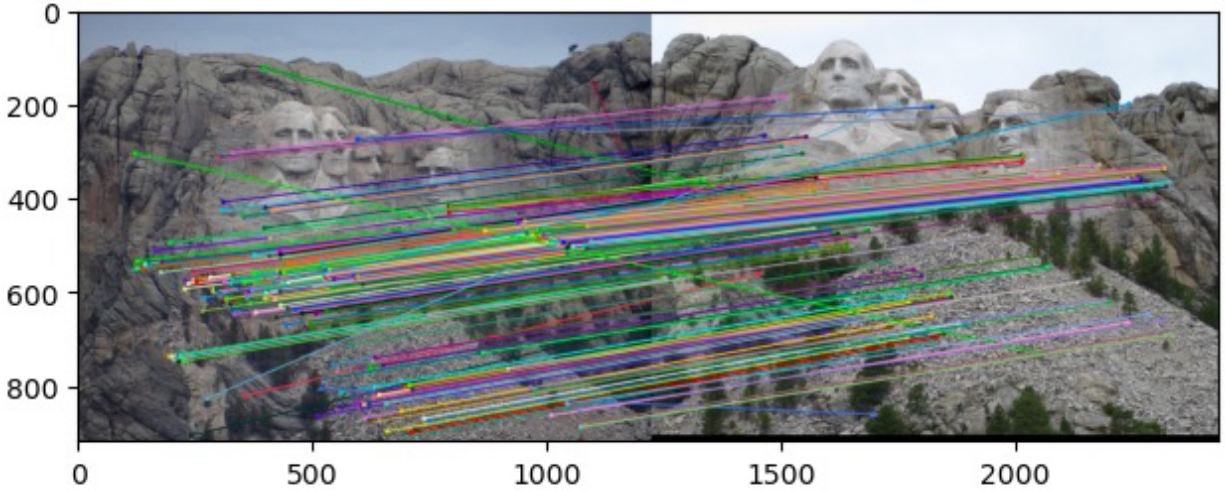
Because it defines the relationship between two points regardless of scale. Scale can’t be determined unless the distance between two points or camera centers is known.

[Why is the fundamental matrix rank 2?]

The fundamental matrix must have rank 2 because it maps a point to a line, and necessarily has a null space, which means it cannot have rank 3.

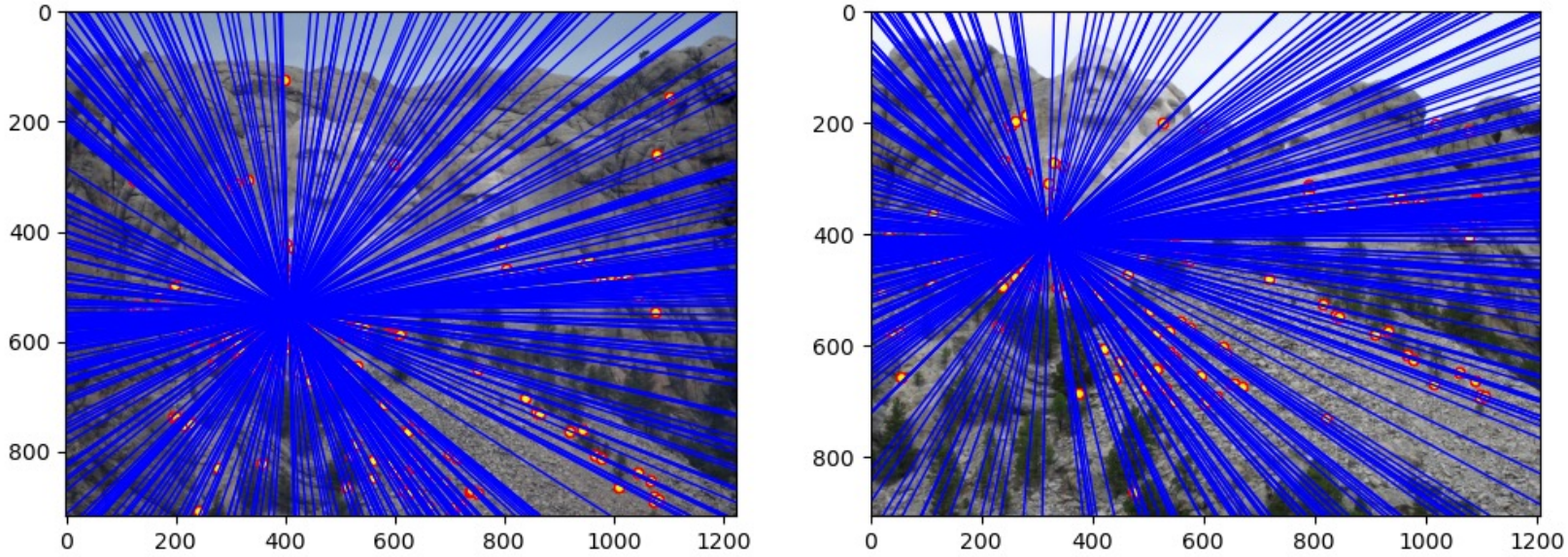
Part 3: RANSAC

[insert visualization of correspondences on Notre Dame after RANSAC]



Part 3: RANSAC

[insert visualization of epipolar lines on the Notre Dame image pair]



Part 3: RANSAC

[How many RANSAC iterations would we need to find the fundamental matrix with 99.9% certainty from your Mt. Rushmore and Notre Dame SIFT results assuming that they had a 90% point correspondence accuracy if there are 9 points?]

14 iterations

[One might imagine that if we had more than 9 point correspondences, it would be better to use more of them to solve for the fundamental matrix. Investigate this by finding the # of RANSAC iterations you would need to run with 18 points.]

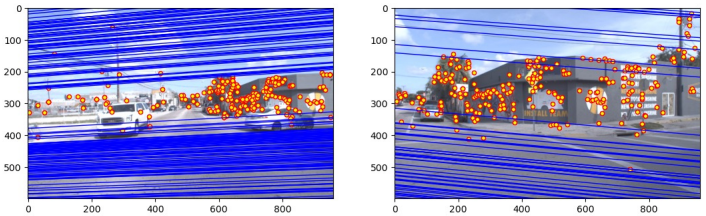
40 iterations

[If our dataset had a lower point correspondence accuracy, say 70%, what is the minimum # of iterations needed to find the fundamental matrix with 99.9% certainty?]

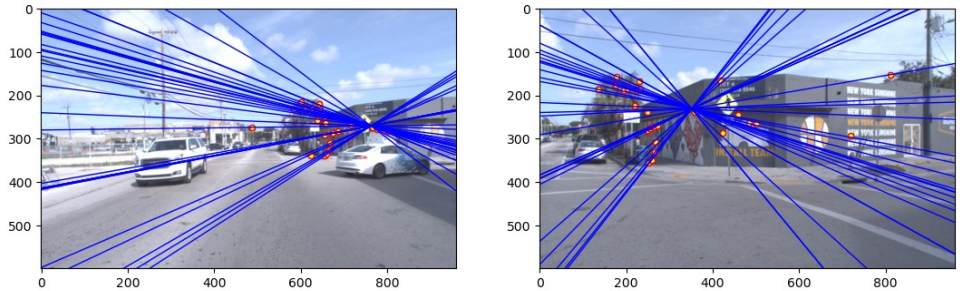
169 iterations

Part 4: Performance comparison

[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 4: Performance comparison

[Describe the different performance of the two methods.]

Ransac performed much better than just the linear estimator, although my linear estimator may not be working correctly.

[Why do these differences appear?]

Ransac method allows us to ignore outliers in the data to give a better solution

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

Ransac should be more robust in real applications because it allows us to essentially filter out outliers in our fundamental matrix calculations, and in real applications data is messy with outliers.

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)?]

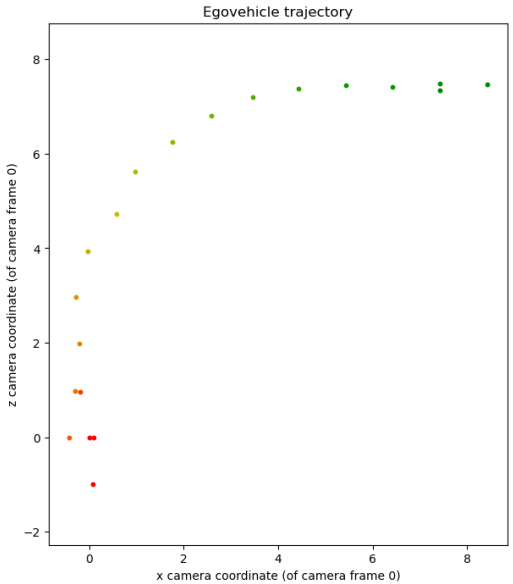
We can estimate the fundamental matrix with RANSAC and use it to try and figure out the relative rotation and translation between the camera at different points.

[In addition to the fundamental matrix, what additional camera information is required to recover the ego-motion?]

We need to also know the calibration matrix so we can estimate the essential matrix.

Part 5: Visual odometry

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



Part 6: Panorama Stitching

[Please add a README style documentation here for your implementation of panorama stitching with: description of what you implemented, instructions on how to replicate the results in clear steps that can be followed by course staff. Failure to replicate results by following this documentation will result in point penalties on this question of the assignment.]

Part 6: Panorama Stitching

[Insert visualizations of your stitched panorama here along with the 2 images you used to stitch this panorama (**there should be 3 images in this slide**)].

Conclusion

[What are the potential real-world applications and implications of accurately estimating the fundamental matrix with the most inliers using RANSAC in computer vision tasks, particularly in scenarios where camera calibration information may be unavailable or unreliable?].

Extra Credits

[Insert visualizations of Epipolar line plot after image rectification. Also answer how does uncalibrated epipolar rectification enhance the efficiency and accuracy of stereo vision algorithms in scenarios where camera calibration information is unavailable or unreliable? Discuss the potential benefits and challenges associated with implementing this technique in real-world computer vision applications. (you can extend the answer to this part to the next slide if needed)].

Extra Credits