204502926_305498099
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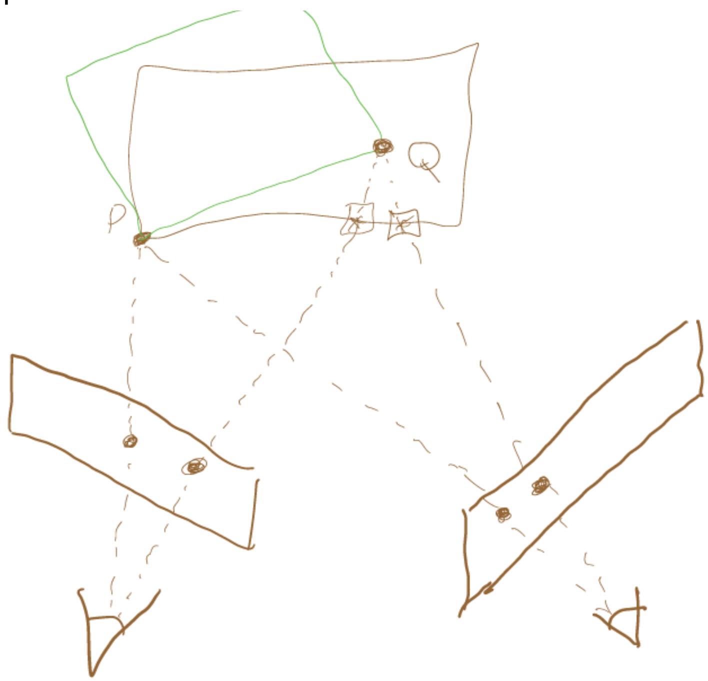
Part A2:

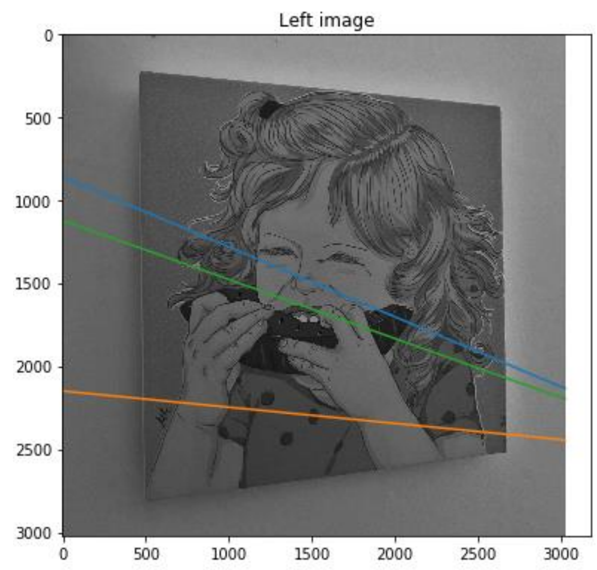
A simple solution to why the blue points pair is not matching is that they are not where they seem to be (on the women's hair). It might be that the blue points are actually located behind her at some depth such that the projection on the left image will make sense.

Basically, it can be some sort of an "illusion", if you will - If we could draw the blue point through her or a transparent object.

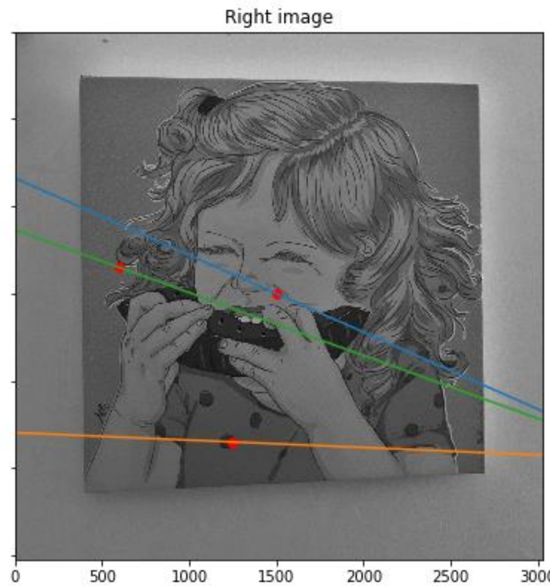
See figure: (the "shift" between the expected location and the actual is the distance between the 2 small squares before Q)



Part C:

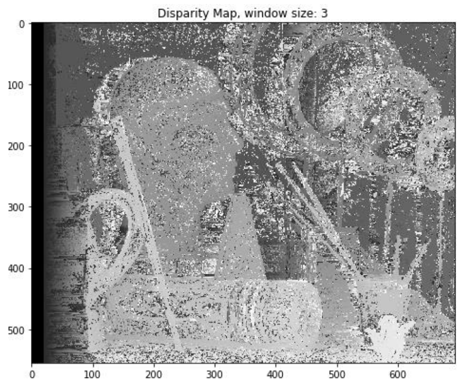


Left image
0
500
1000
1500
2000
2500
3000



Right image
0
500
1000
1500
2000
2500
3000

Part D1:

<table>
<tr><th>Window size</th><th>RMSE average</th><th>Disparity map</th><th>Depth map (Z)</th><th>Reconstructed right image</th><th>3D plot</th></tr>
<tr><td>3X3</td><td>61.06</td>
<td>
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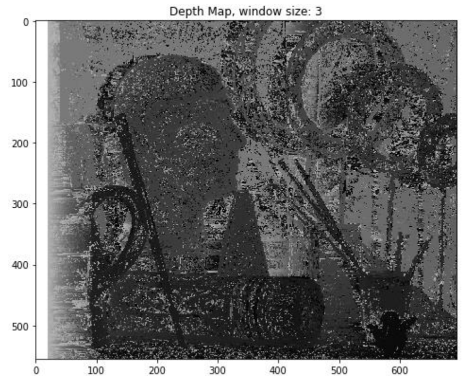
<td>
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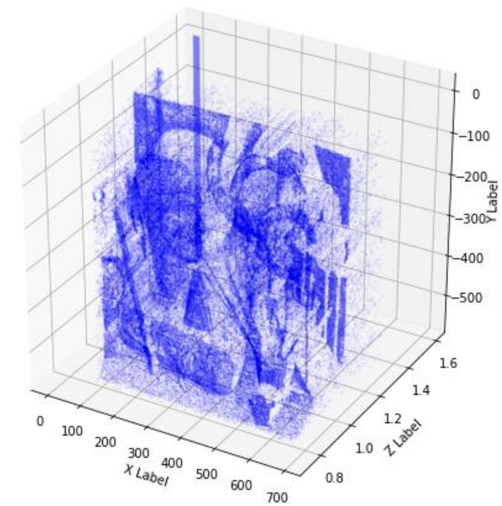
<td>
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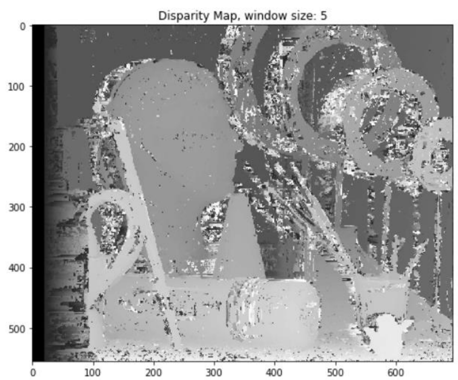
<tr><td>5X5</td><td>59.8</td>
<td>
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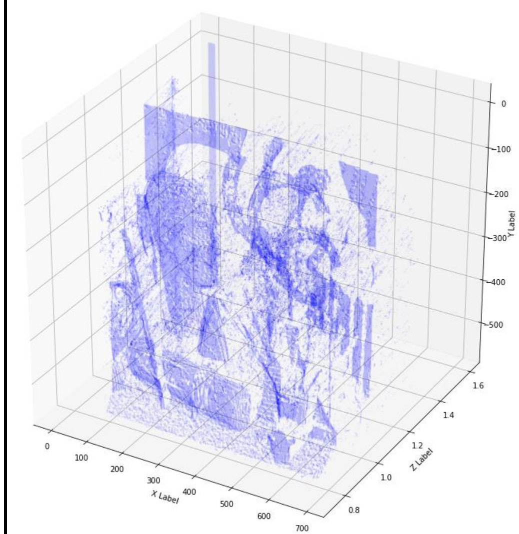
<td>
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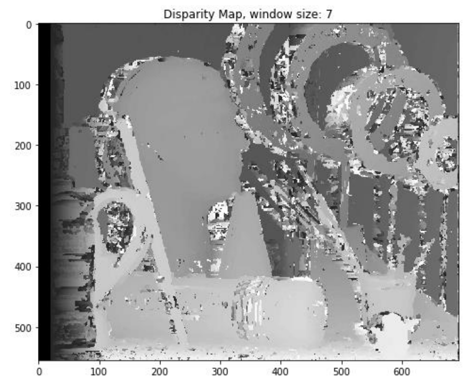
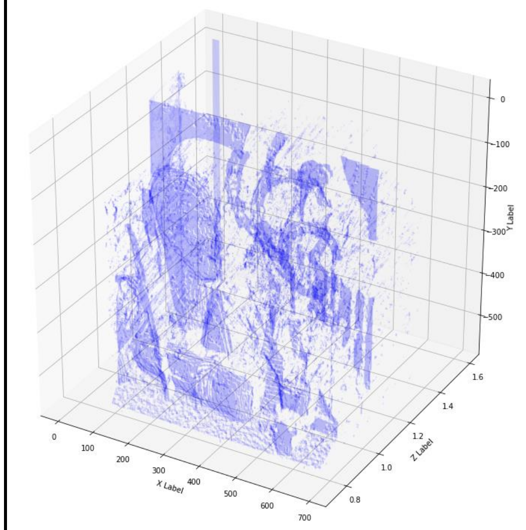
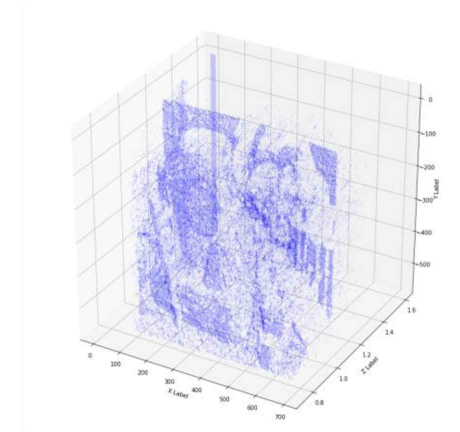
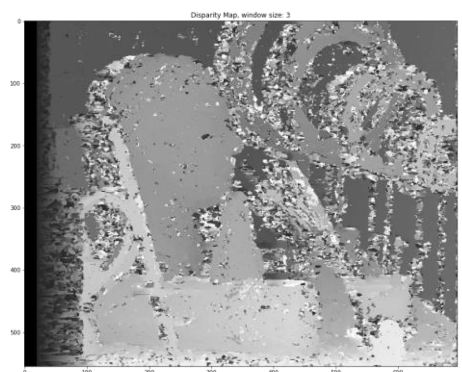
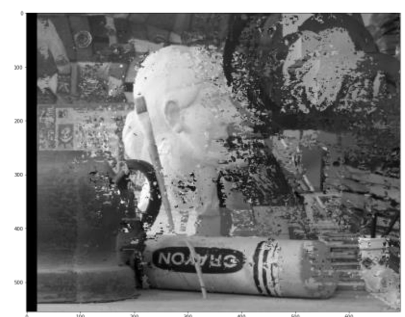
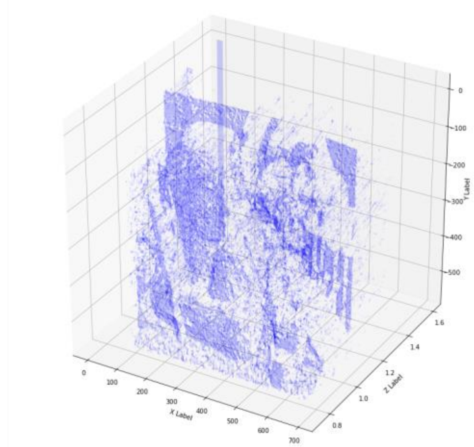
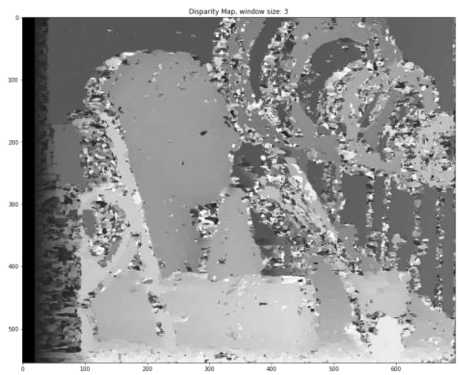
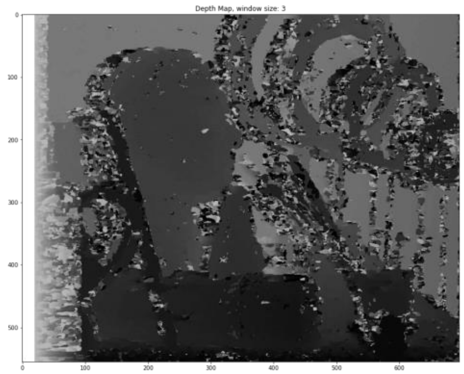
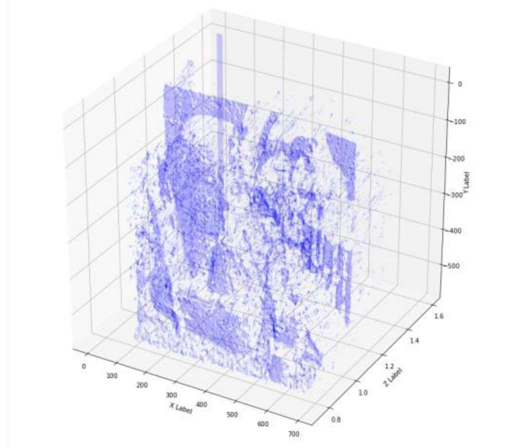
7X7	59.6	Disparity Map, window size: 7	Depth Map, window size: 7	Reconstructed right image, window size: 7	X Label Y Label Z Label

Part D2

(Using the values of the Gradient Magnitude of the images instead of the intensities for computing the descriptors v_1 and v_2)

3x3	60.2				
5x5	59.7				

7x7	59.5				

1. What are the differences in the results of D1 and D2?
   - It seems that D2 results are sharper are a little worse, regarding the Disparity maps and the Depth maps. The reconstruction seems to be a little bit better, though.

2. How does the patch size affect the results?
   - As the patch size increases, it seems to output smoother, more “solid” results i.e. fewer noise pixels in the resulting images.
     With smaller patches, we see that we get irrelevant pixels at some points (for example, one white among many grey/black).

3. How does the order-preserving assumption affect the results?
   - The order-preserving assumption causes the result to be better because when we preserve the order we don’t go in the opposite direction and search for the next patches. It might be that there is a patch in the opposite direction that is better in terms of similarity between patches but the actual patch’s match is in the preserved order region.

4. Which regions have more errors? Why?
    - The region that has more errors is the upper-right quadrant because the edges are less sharp - there are a lot of changes of pixels' colors on the wall, and many changes in depths too, due to the many items there.
      The patches in this region are quite similar which causes the algorithm to detect wrong matches.

Part E:

1. Suggest a method to remove outliers when you have three general images of the same scene.
    - Multi-view stereo: Using three images, we can find the epipolar lines for all the points. Then, by looking at the intersection of the epipolar lines, we can verify the correspondence for each point and keep only those that are consistent between all images.

    - We would like to know if one of these options makes sense too because we're curious:
        - Would doing RANSAC twice remove outliers with a better probability? (one RANSAC per camera a,b and another for b,c?
        - By using 3 images, you can detect if there is an outlier pixel.
          For example, if 2 of the images detect a pixel as white and grey, the 3rd image can be the decisive one (if it agrees with at least one of the other images), and then you would perform the process in section D1.
        - Calculate 2 depth maps (one for every two images, left and center cameras, and center and right cameras). Then verify the relative depths for every pixel given in the first depth map (assuming you have the necessary focal length and distance between the center-camera and the right-camera) and the second depth map.
          If you find a discrepancy, you can assign the average relative calculated depth for that point.

2. Compare the following two methods to remove outliers: (i) Use RANSAC with the homography model (we will learn it in class 6); (ii) Use RANSAC with the epipolar geometry (fundamental matrix) model. When do you expect (i) to give better results, and when do you expect (ii) to give better results? Explain your answer.
    - We expect (i) to give better results when there exists a planar surface in the image because then we can randomly select only 4 corresponding points with RANSAC and find H. Because H (the Homography matrix) has 8 degrees of freedom, every 2 points give us 2 linear equations (one for X and one for Y), so we have 8 linear equations overall (that's what we need to solve 8 linear equation with 8 variables).

When there is no planar surface in the image (or we don't know if there is one), we will need to find F (the fundamental matrix) for which the inequality can be solved with 8 matching points by using the epipolar geometry ("the fundamental matrix") model.
In summary, (i) yields better results, and requires fewer matching points with planar objects, and (ii) for the rest of the cases and requires 8 matching points.

3. Why is C=nullspace(M)? (Go over the proof in Class 4 slides 52-55. It is nice!)
   Answer:
   a. Why is the degree of M at most 3?
   - The degree (rank) of M is at most 3 since M is 3X4 and the rank of a matrix is the minimum between its rows and columns → min(n,m).

   b. Let A and B be two 3D points such that B is not on the 3D line that connects A and the center of projection COP.
   Is it possible that MA=MB? Give a short explanation for your answer.
   - It is NOT possible that MA=MB because all points on the line between A and C are projected to the same point on the image plane, and we're told that B is not on this line so it cannot be projected to the same point on the image plane. (The only way they can defer in a coordinate and still be projected to the same 2D point is if they would lie on the Z-axis (0, 0, Z), but we're told they don't lie on the same line).
     - If the points are close to one another at infinity, the result of MA can equal MB (approximately).

   c. Why is M(1−λ)C=0 (where C is in homogeneous coordinates)?
   - M(1− λ)C=0 (where C is in homogeneous coordinates) because C is the nullspace of M and so MC=0 (lecture 4).
     (1- λ) is a scalar and we know that in homogeneous coordinates, MC=0 up to multiplication with a scalar.
     M(1− λ)C === (1− λ)MC = (1− λ)*0 = 0