CS 6320 Project 5.1

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What is the relation between disparity map and depth? [Text/Equations/Drawing whatever you feel is relevant]

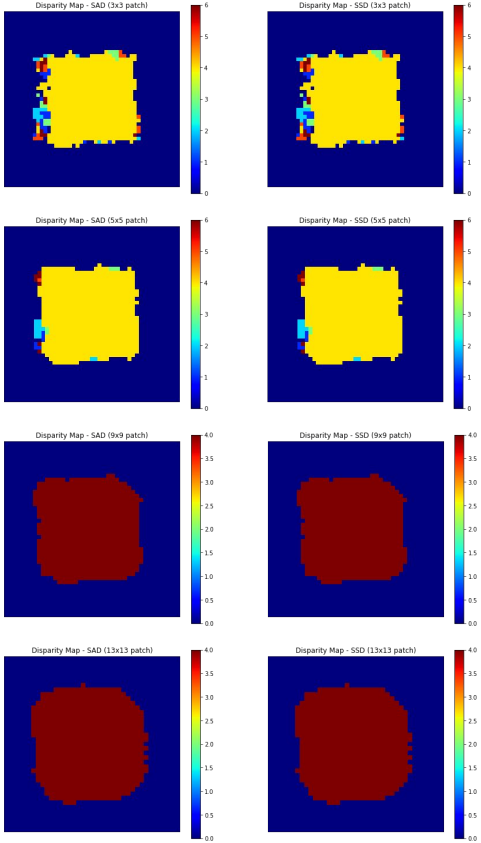
$$Z = f\frac{B}{d}$$

Where, Z is the depth, B is baseline, i.e. distance between camera centers, f is the focal length of camera and d is the disparity. Depth is inversely proportional to disparity; objects farther will have more disparity or shift as compared to near objects.

Random dot stereogram image [51x51x3] + Can you judge depth by looking them?

No, one cannot judge the depth by looking at them, one needs to see them stereoscopically i.e. overlap them to see the 3d structure or have a perception of depth.

Random dot stereogram disparity maps



What is the effect of increasing the block size? Explain the reasoning behind it?

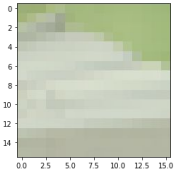
When calculating disparity map we use block of fixed size and find for each block the corresponding block in another image with best match. If block size is too small the it will try to match very fine details and won't have sufficient intensity variation. Increasing the block size will make the algorithm more robust to noise as now it can capture more intensity variations, but increasing it too much also increases the magnitude of estimation error and gives a more spreaded output, as it might also contain pixels with very varied disparity.

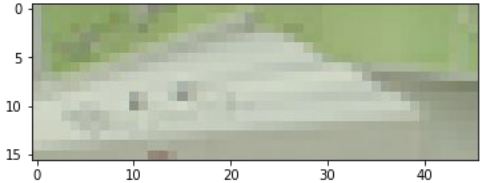
Random dot stereogram: Why is the result poor on the left edge and not on the other edges?

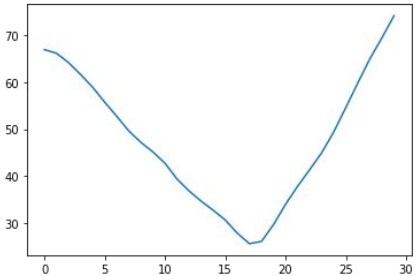
One reason for this might be that when creating random dot stereogram we extract the center window and shifting it left resulting in more similar areas in left side when calculating the disparity.

Convex error profile: Can you generalize the type of regions which will generate convex profiles?

While calculating disparity map we take window from one image and slide in over search region horizontally to find a match. If the window has unique match over the search region, i.e. no other part in the search region is too similar then it will generate a convex error profile.

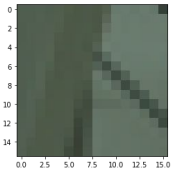


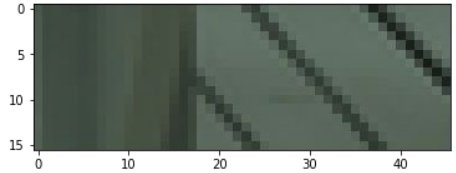


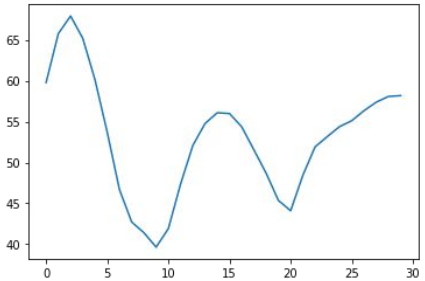


Nonconvex error profile: Can you generalize the type of regions which will generate non-convex profiles?

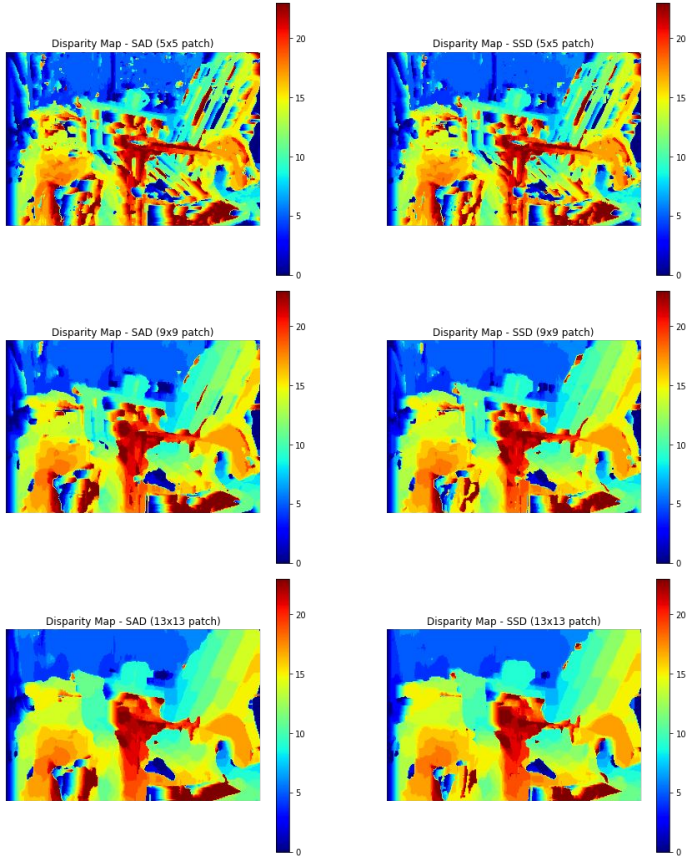
While calculating disparity map we take window from one image and slide in over search region horizontally to find a match. If the search region has multiple places where it is similar to the window then generate a non-convex error profile.







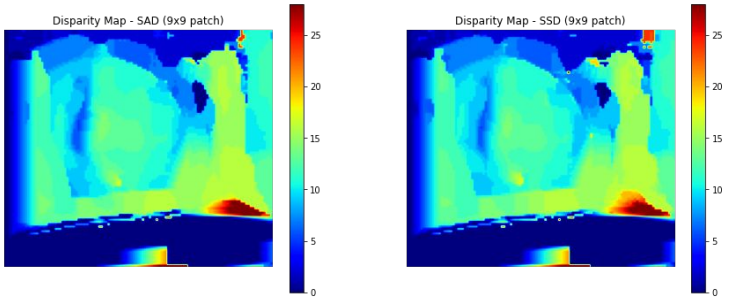
Disparity map for Set 1 (for 3 patch sizes)



Set 1: Can you think of an explanation as to why the backrest of the chair appears blocky?

The backrest of the chair is not a continuous surface, it has some gaps in between so each block seems to be treated as separate object.

Set 4 disparity maps (only one patch size)



Set 3, 4: peculiar behaviour of the disparity maps near right bowling pin: what do you see in input there and can you explain disparity map there?

On the upper right corner we see high variation in disparity; there are some some blue blocks over the top right region in one image that is not in another image (occlusion) which might the cause of this high disparity value.

Set 3, 4: What was the change between set 3 and set 4? What effect did it have on the disparity? Can you generalize the reasons where disparity calculations wont

The difference is in between the color of table, in set 3, the color seems blocky with some yellowish tint in between but in set 4 the color of table is smooth white and uniform. As a result of this the disparity drops to 0 in set 4 for the table region. One can generalize that if the color is smooth and uniform throughout then the disparity calculation won't work.

Set 6: Effect on block size on the stairs in disparity maps

We see more block like structures in disparity map when using the small window size and lots of noise in middle like the random red dots along the railings, one can also see more refined structure for the right angled stairs and false positive for the stairs (blue) when clearly it is farther than wall. As we increase the block size we get more information like corners, edges etc. inside the block; hence the algorithm is able to calculate the disparity better, making it more robust to noise and outliers hence the block like structure in middle and noise disappears.

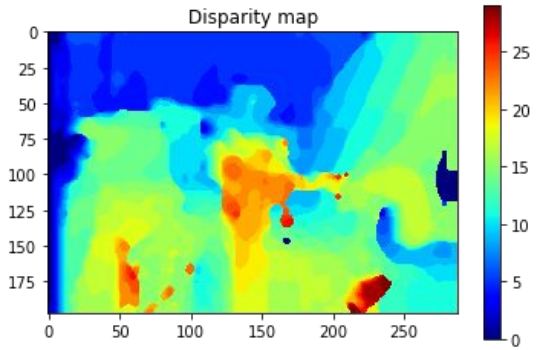
Set 6: Gradual shift in disparity values on the wall

Although one can infer that the wall has same uniform color but the lighting in the scene creates a gradient in wall color hence we can see the gradual shift in disparity on the wall.

Smoothing

1. Compare these results on the chair image qualitatively to the output of the chair image without smoothing.

   One sees more gradual or constant increase in disparity value from objects near to camera towards far with smoothing as compared to more noisy output without smoothing.



2. What regions of the image does smoothing seem to perform better on and why do you think that is?

If you see the leg region of chair or the table where book is placed in these regions have noisy disparity map, with some regions even showing disparity zeros or some blue to red gradient. Whereas with smoothing they seem to perform much better and we do not see the noisy weird disparity, this happens as in smoothing we have an additional constraints that nearby region will have similar disparity as this is what is happening here, this regions mentioned above are large continuous uniform color regions (textured surfaces) so when calculating disparity without smoothing constraint they doesn't appear moving and hence the algorithm fails to properly predicts the result but with smoothing it predicts better.

Smoothing(contd.)

3. What regions of the image does smoothing seem to perform worse on and why do you think that is?

One can see from image that although smoothing gives a more uniform output for disparity it also reduces the information corresponding to when their is a smooth surfaces or surface with some orientation, although the leg of chair is less noisy compared to without smoothing but we also lost the depth information regarding it, it is clearly near the camera but shown far according to the disparity map; or the book which is placed at some angle, it clearly needs to have a increasing depth but is shown as sort of constant here. This is due to constrain that neighbourhood pixels have same disparity so the angled or smooth surfaces will give same disparity.

4. Would smoothing still work for images with both a horizontal and vertical shift?

No, out algorithm takes a window and moves it horizontally to calculate disparity map, vertical movement will require a whole new constraints to solve for and smoothing alone won't work.

Extra Credit

<Discuss What extra credit you did and analyze it. Include Images of results as well >