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]

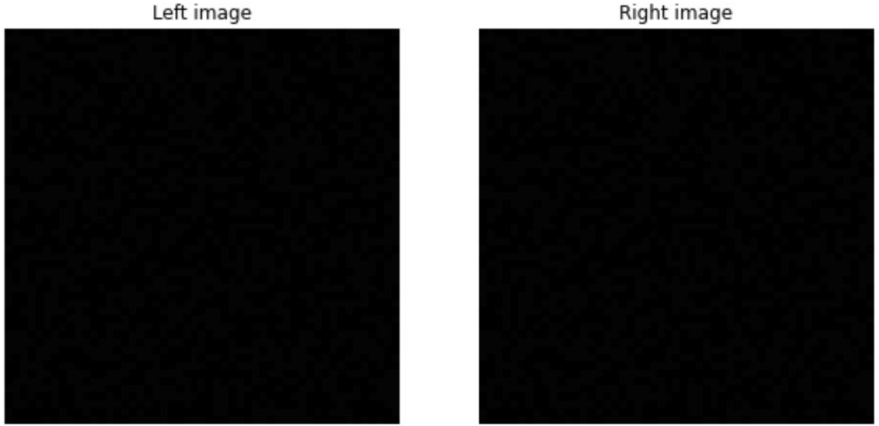
disparity map can be used to compute the depth of an object in stereo. Below is the formula:

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

The formula shows that regions with higher depth (object further away from camera) will have lower disparity while regions, vise versa.

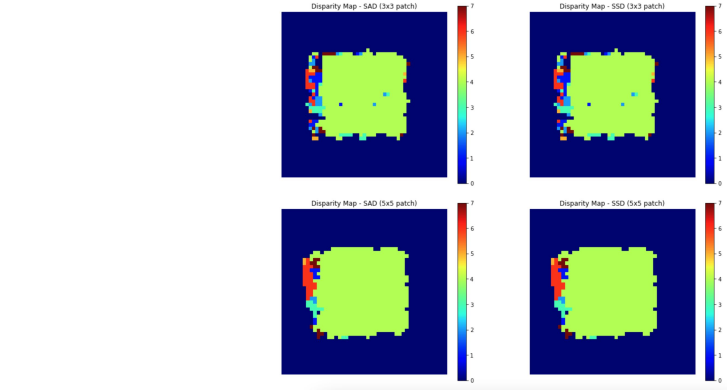
Thus, depth and disparity are in inverse relationship with each other.

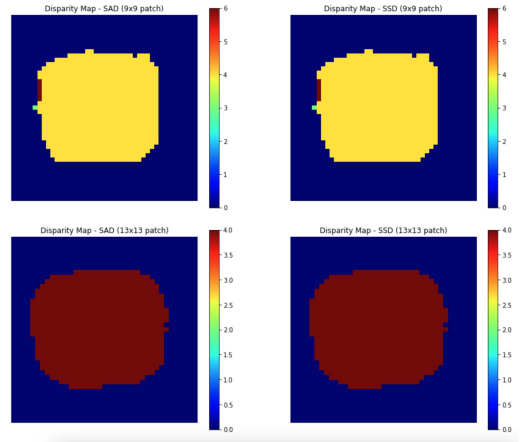
Random dot stereogram image [51x51x3] + Can you judge depth by looking them?



I cannot see anything here other than the black color.

Random dot stereogram disparity maps





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

Increasing the block size increased the disparity value. This could be because more pixels in a patch can increase the error.

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

the result is poor on the left edge because the pixels are started on the right and slide to the left. This means that the pixel positions on the left might go out of bound for being too close to the left edge (when pixel_position is less than the max_search_bound).

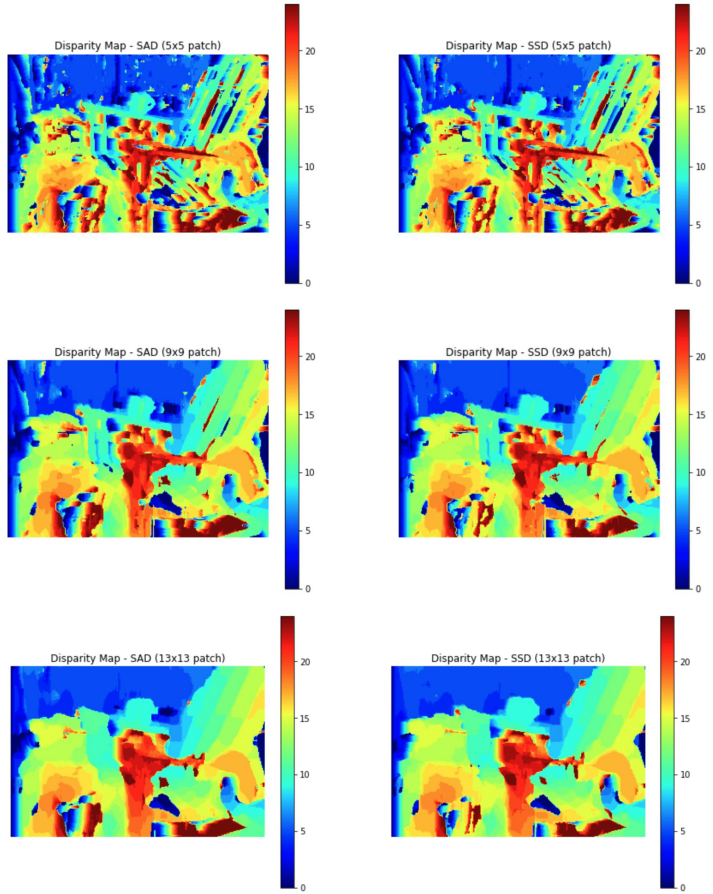
Convex error profile: Can you generalize the type of regions which will generate convex profiles?

For regions that are more smooth and consistent are more likely to have a convex error profile. In addition, repetitive regions tend to not have a convex profile.

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

repetitive and non-smooth regions, where the error might increase or decrease at certain depth.

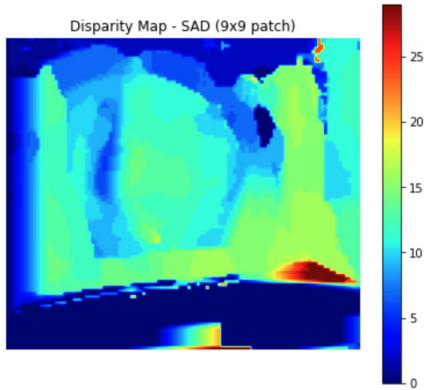
Disparity map for Set 1 (for 3 patch sizes)

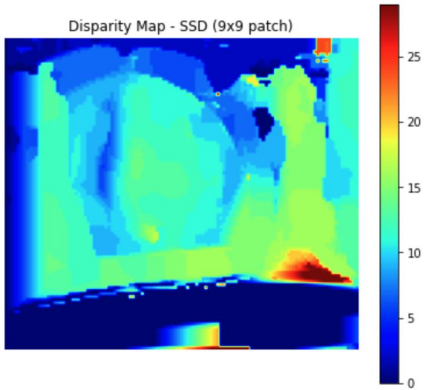


Set 1: Can you think of an explanation as to why the backrest of the chair appears blocky?

It is likely because we used square blocks of a certain size to generate the disparity map. It could also be because the pixels of the backrest of the chair in the image are in a repeating pattern. When the patch on the right is shifting to the left, it might find the same index with minimum error.

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?

In the input, I see that the right bowling pin blocks some of the background walls that is visible in the left. In the disparity map, the color of that region is red, indicating a lot of disparity because it struggles with finding these exact pixels that are occluded by the right image.

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 images in set 4 had smoothing applied to them, while the images in set 3 doesn't have that. Having these effect would prevent disparity map from responding sharply on images that have small pixel changes.

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

When the patch size is smaller, the disparity values shown on the map are much more inconsistent, and this is especially obvious when looking at the wall in the back that is consistent most of the time. When the patch size is big, the colors are shifting in a gradual manner.

Set 6: Gradual shift in disparity values on the wall

Notice that the disparity value on the right of the image is low and gradually changes to high disparity value as it shifts to the left. This is because there is a inverse proportional relationship between disparity and depth. The wall in the right of the image is further away from the camera, and thus have higher depth. Higher depth means lower disparity value. Meanwhile, higher disparity value mens lower depth.

Smoothing

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

the resulting disparity map with smoothing has less inconsistent value comparing the disparity map without smoothing earlier. There is less extreme disparity values popping up comparing to the image without smoothing. In addition, it is able to show more gradual shift on the disparity map comparing to the sharp changes in disparity values on images without smoothing.

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

The smoothing performs well in the arm-rest of the chair that is closer to the camera, because the smoothing allows me to see the gradual shift of depth more clearly. I think it is because smoothing lowers the difference of disparity values.

Smoothing(contd.)

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

The backrest of the chair is not performing as well as the values are similar to each other. I think it is because smoothing lowers the difference of disparity values, even though there is only minor disparity value difference on the backrest.

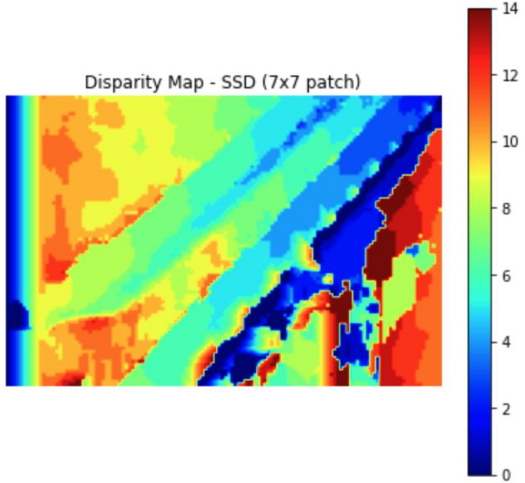
4. Would smoothing still work for images with both a horizontal and vertical shift?

I think it would work either way. A vertical shift can be done simply by rotating both images and shift ho

Extra Credit

I looked into the stairs by applying smoothing to the set 6 images while making the patch size equal to 7 and maximum disparity equal to 15. After smoothing is applied, the region with low depth have higher disparity value than region with high high depth. This is an easy example because the depth is shown very visibly without any visualization effects on the original image.

without smoothing



with smoothing