4. Selective Focus

4.1 Source Image Analysis

Figure 4.1 shows a pair of the stereo image of a girl sitting on a chair. Our objective is to use disparity and depth map from the provided stereo pair to segment object(girl) and background. The scene looks well illuminated in both the left and right image. However, it would be not easy to completely segment the girl's body from the background as the depth of the girl's body, and the chair on which she is sitting is almost the same.

(a) Left image **(b) Right image**

Figure 4.1: Stereo image pair of a girl

4.2 Strategy

We need to create a binary thresholded image (to be used as a mask) to accomplish the task mentioned in the previous section. The mask should have a precise segmentation of the object and the background. The strategy used is as follows.

1. Obtain the best disparity image from the stereo pair by using the code given in appendix section 4. Use the track bar to find out the optimal parameters (number of disparities, block size).
2. Generate a depth image from the disparity image obtained in the last step. According to the formula given in the question, Depth = 1 / (Disparity + K). Use K by assigning some value to it to improve the depth image if needed.
3. Threshold the depth image to accomplish the object-background segmentation. This thresholded image will be used as a mask in the next step.
4. Use the mask with the left (or right) source image to obtain the target image with showing girl and a heavily blurred background.
5. Repeat step 1 to 4 with a different disparity parameter (number of disparities, block size) to compare results.

4.3 Implementation and Result

The following points describe the implementation and result of the strategy mentioned in the previous section.

1. Disparity image, depth image and thresholding: Two optimal disparity parameters (number of disparities, block size) were obtained using the stereo image pair as an input to the code given in appendix section 3.1. Depth image were generated from the disparity images using the formula - depth = 1 / (disparity + k). Here, multiple non-zero values of K were used to improve the depth image. However, the depth image obtained with all non-zero integer values were completely black. Hence, k is set to zero after that. The depth images were then thresholded with Otsu's method that produced a decent binary image segmenting the girl and background. The disparity image, depth image and thresholded image is shown in figure 4.3 for different disparity parameters.

(a) Disparity image **(b) Depth image** **(c) Thresholded depth image**

Figure 4.2: Images obtained with disparity parameters: NoD = 32, BS = 51

(a) Disparity image **(b) Depth image** **(c) Thresholded depth image**

Figure 4.3: Images obtained at disparity parameters: NoD = 64, BS = 37

2. Algorithm to obtain target image:

   (a) Take an input image from the stereo pair shown in figure 4.1. We have selected the left girl image (let us call it girlL) and converted it to a greyscale image for further processing.

   (b) The thresholded depth image created in the last section (figure 4.2(c)) will be used as a mask. It will show the object (girl) portion as white and the background as black. Create an inverse mask by using the bitwise-not operation on the mask. It will show the object (girl) portion as black and the background as white.

   (c) Bitwise-and operation between the girlL image and the mask will change the background to black. The image obtained from this step is shown in figure 4.5(b).

   (d) Blur the girlL image loaded in the first step with a large smoothing kernel. We used a kernel of size (18,18) in this step. Bitwise-and operation between this blurred image and the inverse mask will change the object (girl) portion to black. The image obtained from this step is shown in figure 4.5(c).

   (e) Final Result: Add the output images obtained in the previous two steps to get the desired result where the background is heavily blurred while the girl is focused. The image obtained from this step is shown in figure 4.6.

(a) Stereo Left Image **(b) Output of step c** **(c) Output of step d**

Figure 4.4: Output images after step c and d

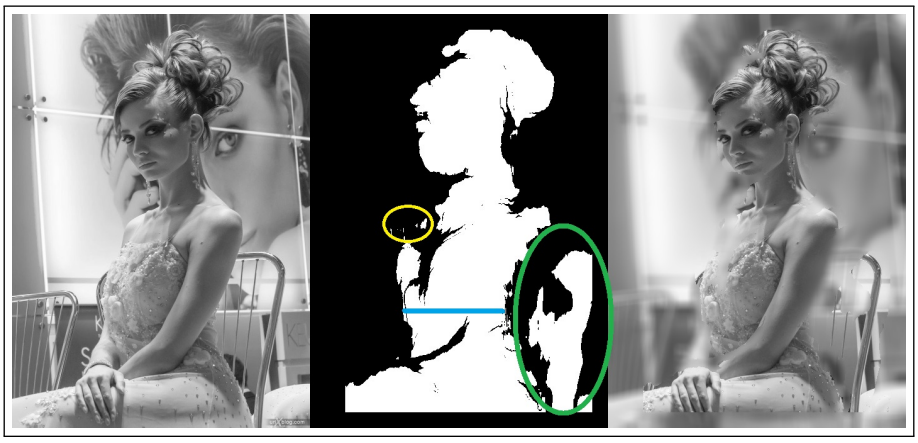
(a) Result obtained from fig 4.2(c) **(b) Result obtained from fig 4.3(c)**

Figure 4.5: Final Result with blurred background

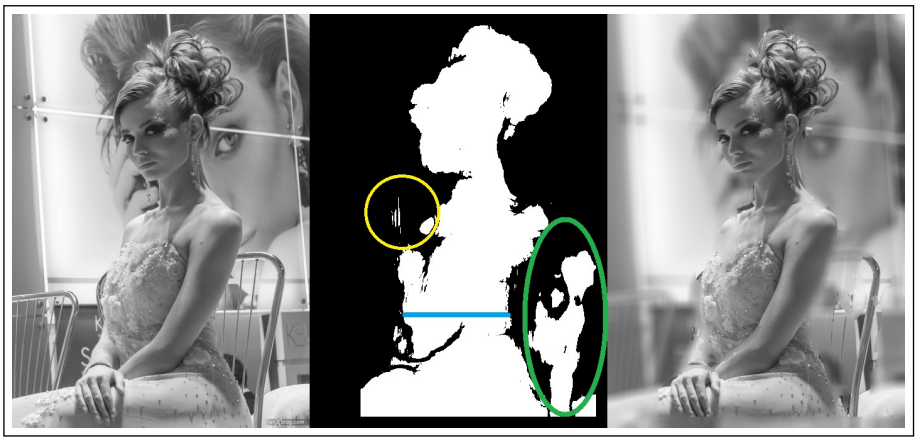
4.4 Discussion

The result obtained from two optimal disparity parameters are shown below. In figure 4.6(a), the object background segmentation is achieved reasonably well. As expected, the depth of the chair and girl is almost identical. As a result, some parts of the chair are also captured as an object (highlighted in green).

In figure 4.6(b), the thresholded depth image captured some background noise (highlighted in yellow) along with the chair (highlighted in green). On the positive side, it captured the girl's body better than figure 4.6(a), as evident from the length of the blue line shown in thresholded part of figure.



(a) Result from disparity parameters: No. of disparities = 32, Block Size = 51



(b) Result from disparity parameters: No. of disparities = 64, Block Size = 37

Figure 4.6: Result obtained with multiple disparity parameters

4.5 Conclusion

As evident from the result obtained above, we can conclude that stereo camera photography is one of the best methods to capture the depth of an image. **The disparity map can accurately hold the depth information corresponding to each pixel of the disparity image.**