

### **Threshold Image and Surface Norms:**

The range image is first run through an intensity threshold of 125 to yield a binary image of pixels to consider for the region growing. Then, the surface norms of the image are found for every pixel by taking the cross product of in a window size of 5 around each valid point on the image. This means that the distance between each point of the cross product to the reference pixel is 3 pixels. To get the cross product, the X, Y, and Z coordinates of the two selected points were used to create two 3D vectors with which to perform the cross product. The cross product was performed in such a way that the right-hand-rule yields a vector out of the page.

### **Region Growing:**

Region growing was performed by first checking all pixels of the image within a 5x5 sliding window. For the pixel to be considered for seeding a region grow, all pixels in the image had to be within the threshold value, and the current pixel had to not have already been seeded. If the pixel is a valid candidate for seeding a region grow, the region grow code using queues provided by Dr. Hoover is used to begin growing the region from that pixel.

The region grow queue code had to be modified to allow for tracking of X, Y, and Z coordinate averages. These averages are calculated with every pixel added to the region, and these averages were used with the current pixel's surface normal coordinates to yield a dot product at the current pixel being considered for the region grow. Then, the angle at the pixel was determined by using the formula  $angle = \arccos\left(\frac{AvgVec \cdot SurfNorm}{\sqrt{SurfaceNorm[X]^2 + SurfaceNorm[Y]^2 + SurfaceNorm[Z]^2}}\right)$  where *AvgVec* is the current average of all surface normal in the region and *SurfaceNorm* is the surface normal at a given coordinate, X, Y, or Z. This angle is then filtered through a threshold of .8 and any angle under that threshold is added to the region.

After a region is grown fully, any region with less than 20 pixels in it is disregarded, and the region number, size of region, and the averages for X, Y, and Z coordinates are printed out as shown in Figure 1 and Figure 2 if it contains more than 20 pixels. Finally, the resulting image is saved as shown in Figure 3.

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```
bshumin@DESKTOP-2F1JA77:~/compvis/lab8$ ./a.out
Enter range image file name: chair-range.ppm
Up(-1), Down(1) or Neither(0)? 1

+++Region 1+++
Pixels in region: 61
AvgX: -2.182 AvgY: +18.570 AvgZ: -6.448

+++Region 2+++
Pixels in region: 36
AvgX: -17.925 AvgY: -16.881 AvgZ: -4.010

+++Region 3+++
Pixels in region: 489
AvgX: +2.412 AvgY: -2.285 AvgZ: -4.461

+++Region 4+++
Pixels in region: 648
AvgX: -9.408 AvgY: -1.440 AvgZ: -4.458

+++Region 5+++
Pixels in region: 594
AvgX: +34.178 AvgY: -2.699 AvgZ: -11.914

+++Region 6+++
Pixels in region: 256
AvgX: -0.966 AvgY: +8.443 AvgZ: -2.420

+++Region 7+++
Pixels in region: 5115
AvgX: -0.626 AvgY: +8.760 AvgZ: -2.847

+++Region 8+++
Pixels in region: 75
AvgX: -41.995 AvgY: +10.278 AvgZ: -7.112

bshumin@DESKTOP-2F1JA77:~/compvis/lab8$
```

Figure 1: Terminal command view after running the program

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Region	Pixel #	X Avg	Y Avg	Z Avg
1	61	0.2182	18.57	-6.448
2	36	-17.925	-16.881	-4.01
3	489	2.412	-2.285	-4.461
4	648	-9.408	-1.44	-4.458
5	594	34.178	-2.699	-11.914
6	256	-0.966	8.443	-2.42
7	5115	-0.626	8.76	-2.847
8	75	-41.995	10.278	-7.112

Figure 2: Average values and pixel number printed out in table form

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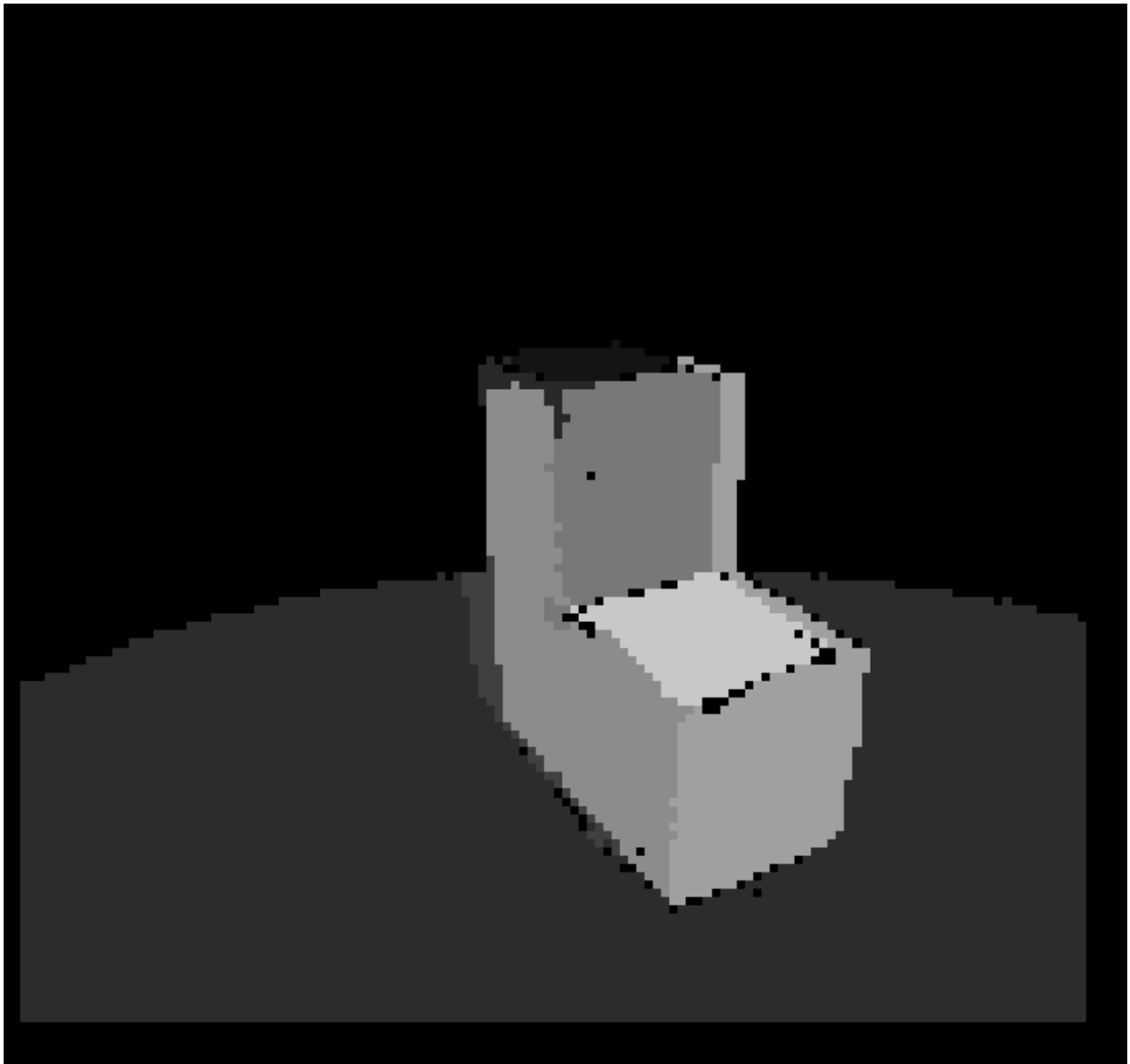


Figure 3: Final segmented image from program