

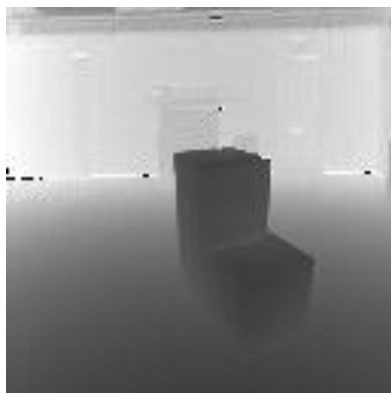
ECE 6310 – Introduction to Computer Vision – LAB 8 REPORT**RANGE SEGMENTATION****TASK****Segment a range image based upon surface normal.**

Segmentation will use the image grid for grouping pixels but will use the 3D coordinates for calculating surface normal for region predicates.

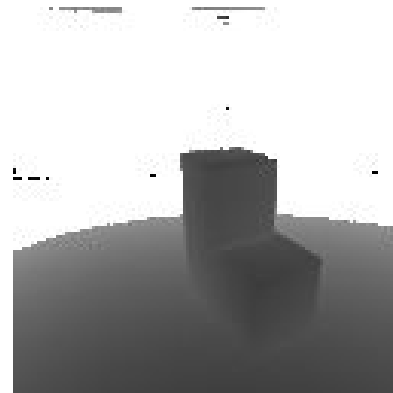
1. Mask image by thresholding at a distance that removes the background and leaves only floor and chair.
2. Calculate 3D coordinates for the pixels.
3. Calculate surface normal using cross-product method.
4. Use region growing to segment regions, using the queue-based C code.
 - a. The region predicates
 - i. A pixel can join if its orientation is within a threshold of the average orientation of pixels already in the region.
 - b. Calculate angular distance using dot product.
 - c. Recalculate average after every new pixel joins the region.
 - d. Seed pixels for region growing are found by identifying a complete 5x5 window of unlabeled (not masked out in first step) of still-unlabeled region.
 - e. If any pixel within 5x5 region is masked out, or already labeled in a region, pixel cannot seed a new region.
 - f. End region growing when there are no more possible seed pixels.
5. Outputs
 - a. Segmented Image labeled using identifiable colors or visible greys
 - b. Table, (for each region, specify:)
 - i. Number of pixels and average surface normal (x, y, z)
 - ii. Distances chosen for the cross product for calculating surface normal
 - iii. Threshold chosen for removing the background from the image prior to region growing
 - iv. Predicate formula used during region growing

OUTPUTS

Original Image



Thresholded Image (threshold = 143)



The following table summarizes the parameters used in this lab:

| Parameter | Value |
|--|-------|
| Threshold (T) | 143 |
| Pixel Distance for Surface Normal | 3 |
| Pixel Intensity Difference Between Regions | 30 |
| Angular Distance Threshold (Th) | 0.79 |

The predicate for this lab is angular distance, described by the formulas below:

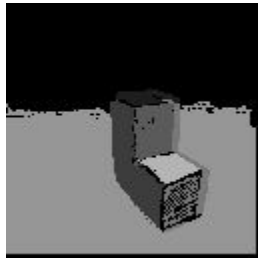
$$\text{dot product} = (x1 * x2) + (y1 * y2) + (z1 * z2)$$

$$\text{distance1} = \sqrt{x1^2 + y1^2 + z1^2}$$

$$\text{distance2} = \sqrt{x2^2 + y2^2 + z2^2}$$

$$\text{angular distance} = \cos^{-1} \left(\frac{\text{dot product}}{\text{distance1} * \text{distance2}} \right)$$

Segmented Image Output (T = 143, Th = 0.79)



The following table summarizes the values for surface normal and number of pixels.

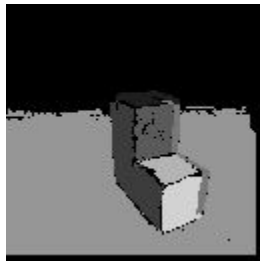
| Region | Number of pixels | Average surface normal X | Average Surface Normal Y | Average Surface Normal Z |
|--------|------------------|--------------------------|--------------------------|--------------------------|
| 1 | 167 | 2.981289 | -327.881033 | 57.798868 |
| 2 | 774 | 50.731124 | -0.871090 | 8.463582 |
| 3 | 478 | -2.569452 | 2.398113 | 4.477929 |
| 4 | 421 | -52.911306 | 1.782188 | 16.076966 |
| 5 | 6848 | 1.499115 | -28.842788 | 8.936392 |
| 6 | 254 | 1.007424 | -8.599574 | 2.37896558 |

As expected, the number of regions segmented comes out to be seven. The largest region is the floor with 6848 pixels in its region. As seen in the output segmented image, there is a distortion on the right end of the chair. This was not rectified because increasing the angular threshold further reduced the number of regions, and decreasing it increased the number of segmented regions. The streak on the right side of the chair appears to have slightly different surface normal values compared to the rest of the surface it is a part of, due to which it always gets segmented as a different region or gets combined with the bottom

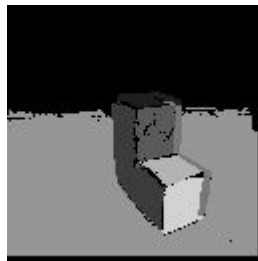
surface of the chair. After trial and error, it was observed that at a threshold = 143, and angular threshold = 0.79, the best output is produced with the desired number of six segmented regions total.

Segmented output images at different angular thresholds:

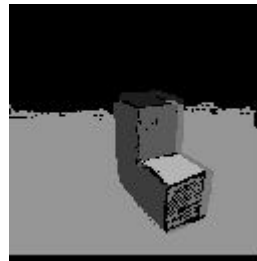
Th = 0.65 → 7 regions



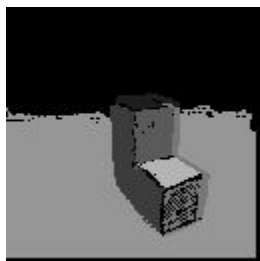
Th = 0.70 → 7 regions



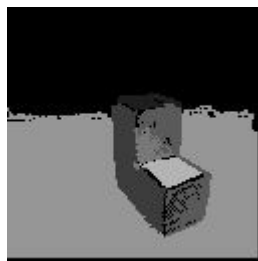
Th = 0.79 → 6 regions



Th = 0.80 → 6 regions



Th = 0.85 → 6 regions



Output Image

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M /c/CV/lab8
Region: 4, label 150 Number of Pixels: 421
Region: 5, label 180 Number of Pixels: 6848
Region: 6, label 210 Number of Pixels: 254

niral@DESKTOP-C5Q0AIR MINGW64 /c/CV/lab8
$ gcc -g -Wall range1.c -o range.exe

niral@DESKTOP-C5Q0AIR MINGW64 /c/CV/lab8
$ ./range chair-range.ppm
X: 2.981289, Y: -327.881033, Z: 57.798868
Region: 1, label 60 Number of Pixels: 167
X: 50.731124, Y: -0.871090, Z: 8.463582
Region: 2, label 90 Number of Pixels: 774
X: -2.569452, Y: 2.398113, Z: 4.477929
Region: 3, label 120 Number of Pixels: 478
X: -52.911306, Y: 1.782188, Z: 16.076966
Region: 4, label 150 Number of Pixels: 421
X: 1.499115, Y: -28.842788, Z: 8.936392
Region: 5, label 180 Number of Pixels: 6848
X: 1.007424, Y: -8.599574, Z: 2.389658
Region: 6, label 210 Number of Pixels: 254

niral@DESKTOP-C5Q0AIR MINGW64 /c/CV/lab8
$ |

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