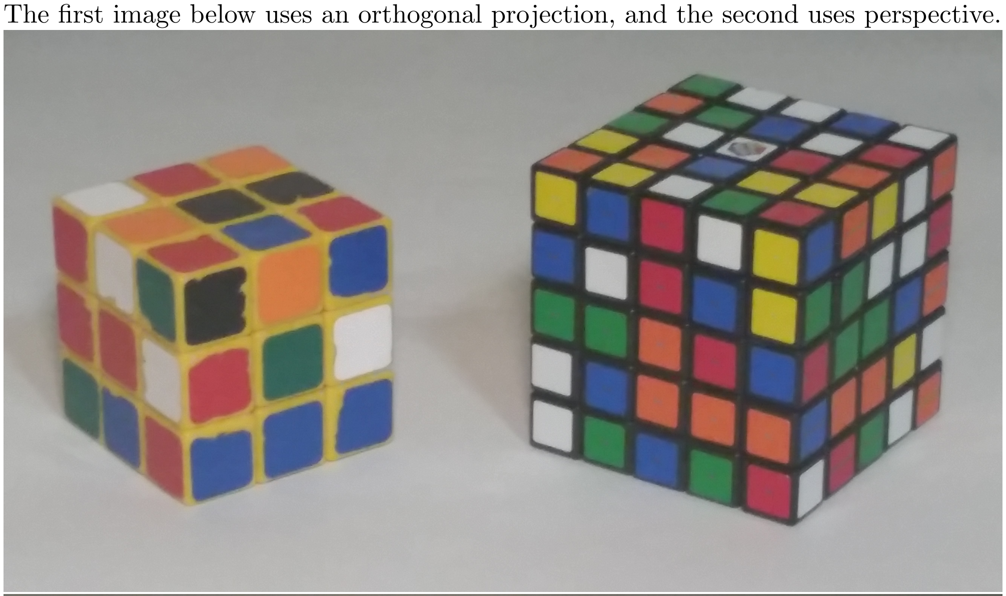
Computer Vision - Pset 1

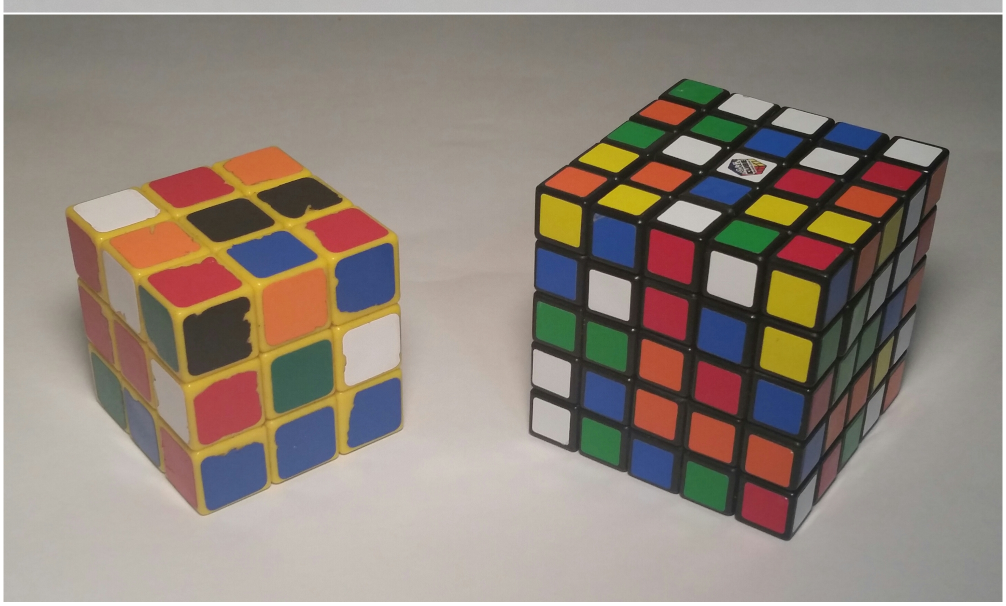
Evan Sandhoefner (Collab. Ryan Kerr)

Sep 15, 2016

Problem 1

The first image below uses an orthogonal projection, and the second uses perspective.





Problem 2

The x axis is parallel to the X axis, and X doesn't get confused with another world variable when projected onto 2D like Y and Z do, so intuitively, x = X.
To demonstrate that y = Ycos(theta) - Zsin(theta), it is helpful to start with base cases. If theta=0, then y=Y. This can be thought of intuitively as placing the camera on the floor. If theta=pi/2, then y=-Z. This can be thought of intuitively as a bird's-eye view. Anywhere in between these extreme cases, y is composed of the Z term plus the Y term, each of which is weighted by the value of its attached trigonometric function. This is simply the geometric expression of the projection of world coordinates in 3D onto image coordinates in 2D.

Problem 3

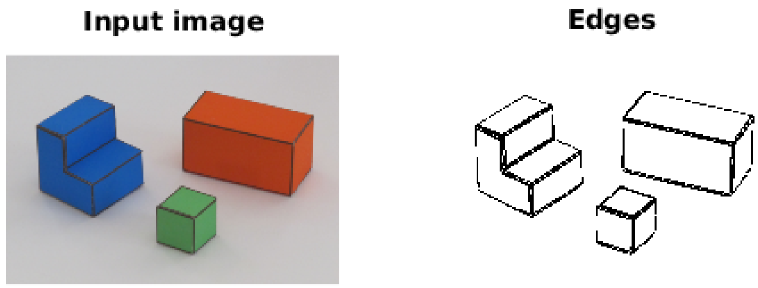
We begin with equation 1.3: y = Ycos(theta) - Zsin(theta).
We rearrange to get Z = (-y + Ycos(theta)) / sin(theta).
Now we can differentiate to find that for a horizontal edge, the partial derivative of Z with respect to y is -1/sin(theta).
Intuitively, for a vertical edge, the partial derivative of Z with respect to t is 0.
Because surfaces are flat, the second derivatives of Z with respect to y, x, and (x and y) are each 0, as they were when we found the constraints for Y.

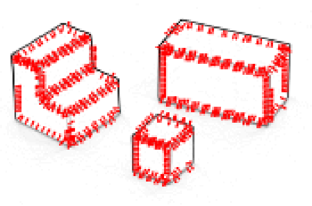
Problem 4

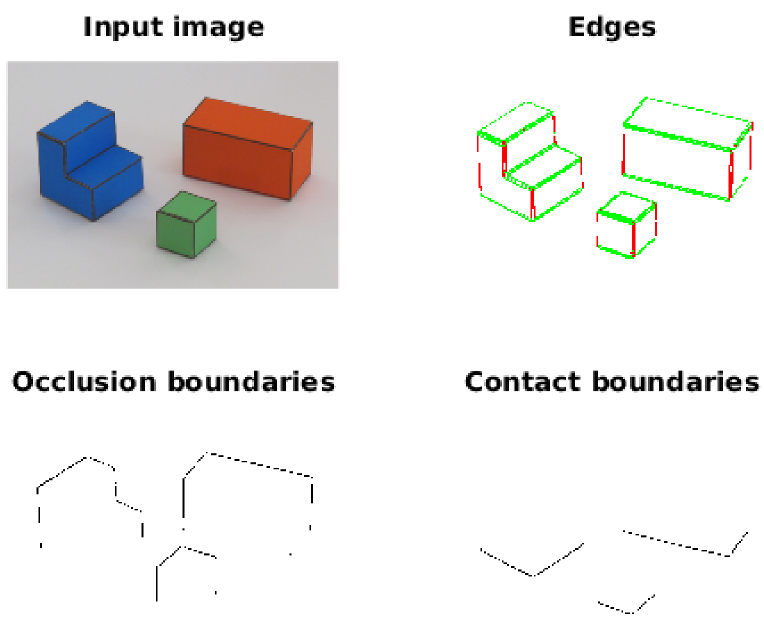
See code.
Aij (: , : , c) = (dx[1 2 1; 0 0 0 ; 1 2 1] dy[1 2 1; 0 0 0 ; 1 2 1]) / 8 ;
Aij (: , : , c) = 0 . 1 [0 1 0 ; 0 2 0 ; 0 1 0] ;
The second kernel is the laplacian with respect to y^2. The first kernel for dY/dt is obtained by -$n_y dY/dx + n_x dY/dy$.

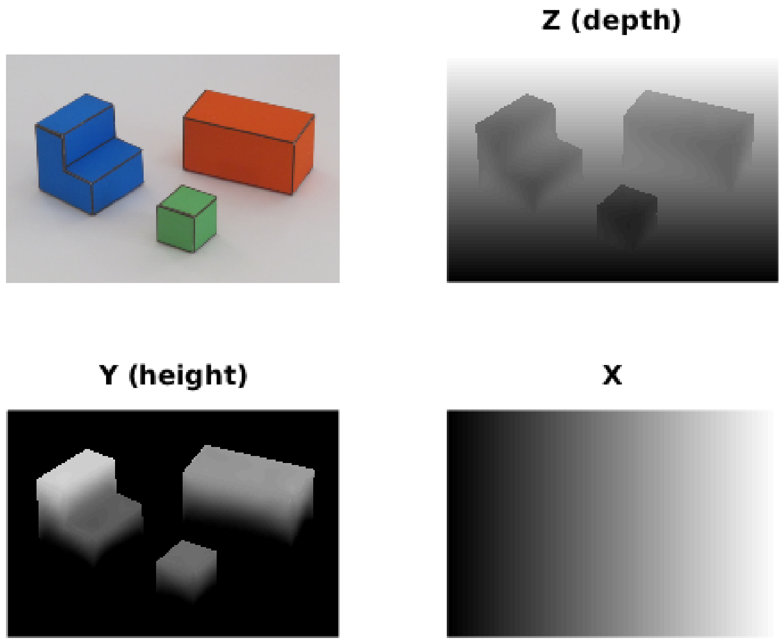
Problem 5

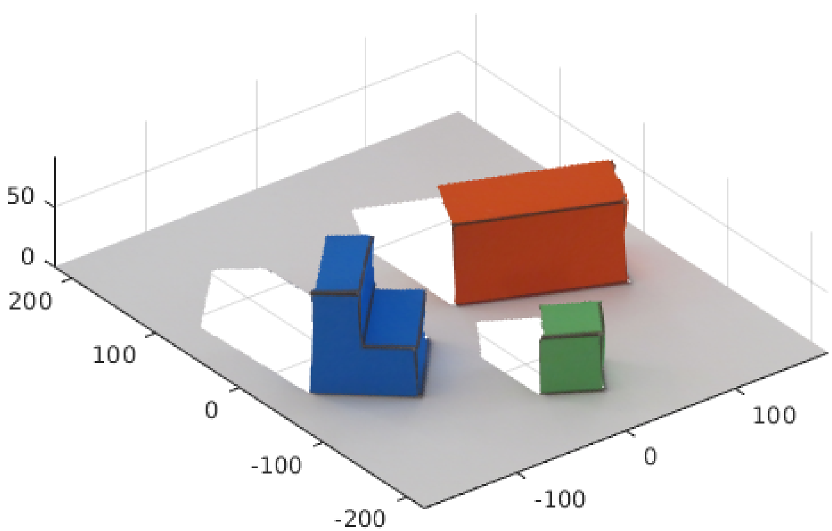
See program output below:





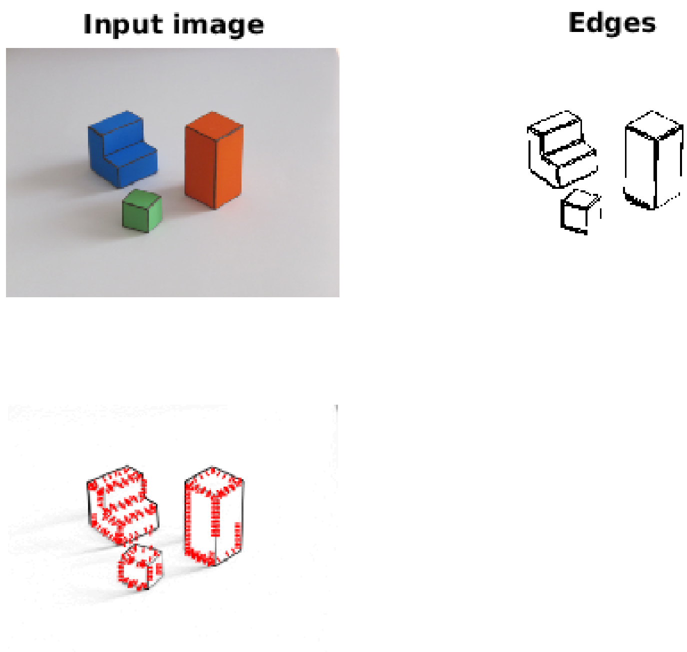


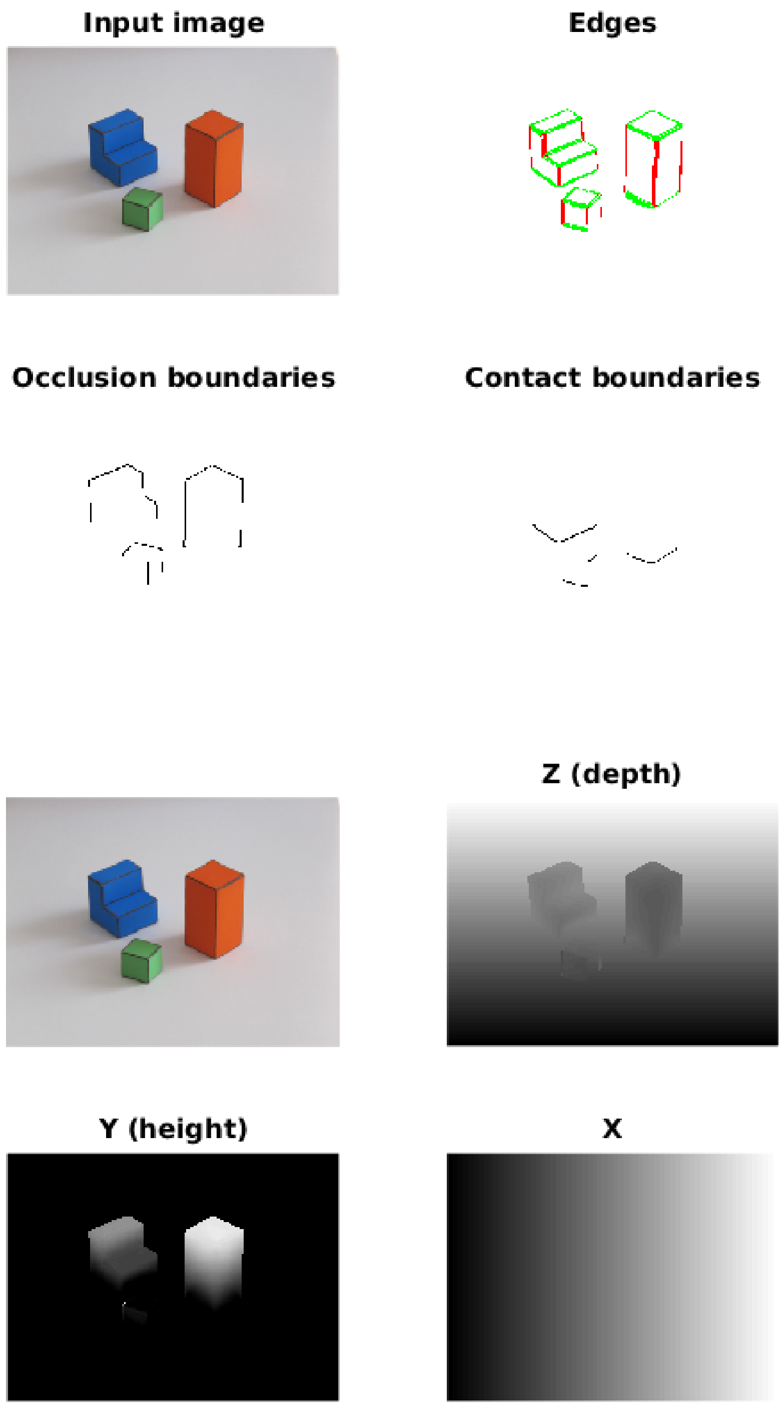

Z (depth)
Y (height)
X

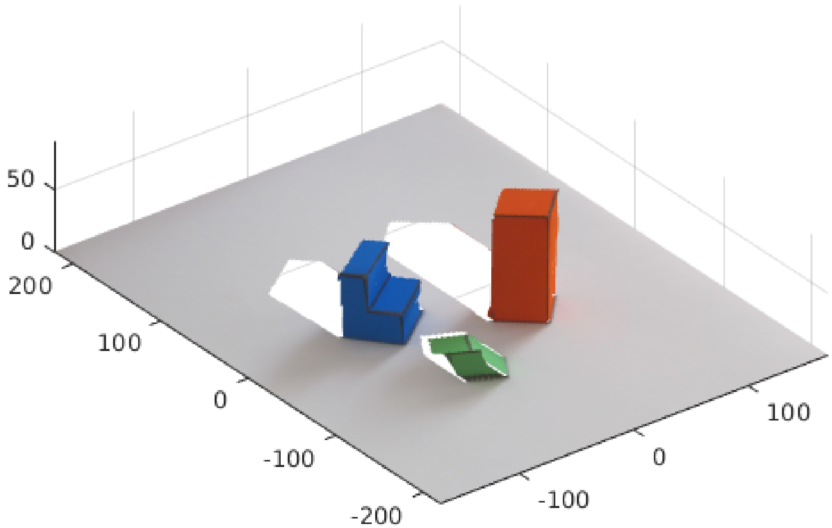

50
0
200
100
0
-100
-200
100
0
-100

Problem 6

The program fails to recreate the green cube below because the shadow from the red block darkens the floor, violating our assumption that the floor is white and making it difficult to tell where the edge of the green cube stops and the floor begins.




Input image
Edges
Occlusion boundaries
Contact boundaries
Z (depth)
Y (height)
X


50
0
200
100
0
-100
-200
-100
0
100