

ECE 579 – Homework 1

Task

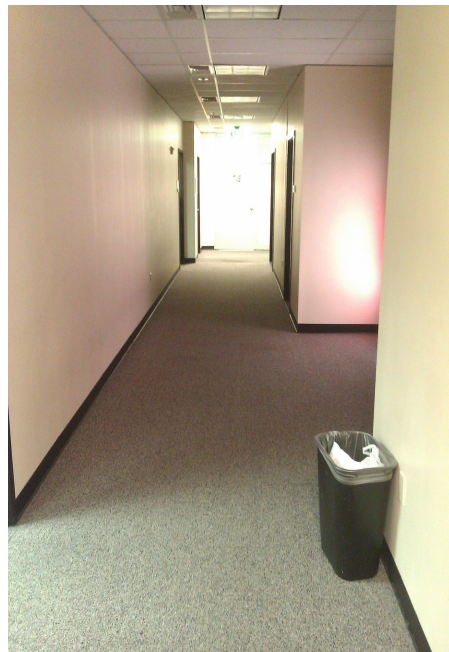
- take pictures of the corridor
- characterize pictures
- use edge detection and morphological operators to process images

Pictures

1.



2.



Picture 1 and 2 are taken from almost the same position, but under different lightening conditions. Characteristics of these images is mainly a long corridor with doors at the left and right, but non in close proximity

3.



4.



Pictures 3 and 4 are taken from the same position. The pictures show slightly different lightening as well as a closed and an open door.

5.



Picture 5 shows a class room with tables as obstacles and a window.

Matlab Code

```
%% Read Image and convert to grayscale
A = imread('IMAG0168.jpg');
%convert to grayscale image
B = rgb2gray(A);

%% Edge detection with threshold to repress weak edges
C = edge(B, 'canny', [0.1 0.4], 2);

%% Dilate image to close gaps after edge detection
SE_dil = [0 0 1 0 0; 0 0 1 0 0; 1 1 1 1 1; 0 0 1 0 0; 0 0 1 0 0];
D = imdilate(C, SE_dil);

%% Hit and Miss for thinning
SE_th = [-1 -1 -1; 0 1 0; 1 1 1]; % horizontal
SE_tv = [-1 0 1; -1 1 1; -1 0 1]; % vertical

K = bwhitmiss(D, SE_th); % thin horizontal lines
L = bwhitmiss(D, SE_tv); % thin vertical lines
M = K+L; % add intermediate results
N = D-M; % subtract from base image

%% Hit and Miss to find corners - not a good method for these pictures
SE_ur = [0 -1 -1; 1 1 -1; 0 1 0]; % upper right corner
SE_ul = [-1 -1 0; -1 1 1; 0 1 0]; % upper left corner
SE_lr = [0 1 0; 1 1 -1; 0 -1 -1]; % lower right corner
SE_ll = [0 1 0; -1 1 1; -1 -1 0]; % lower left corner

F = bwhitmiss(E, SE_ur);
G = bwhitmiss(E, SE_ul);
H = bwhitmiss(E, SE_lr);
I = bwhitmiss(E, SE_ll);
J = F+G+H+I; % merge images

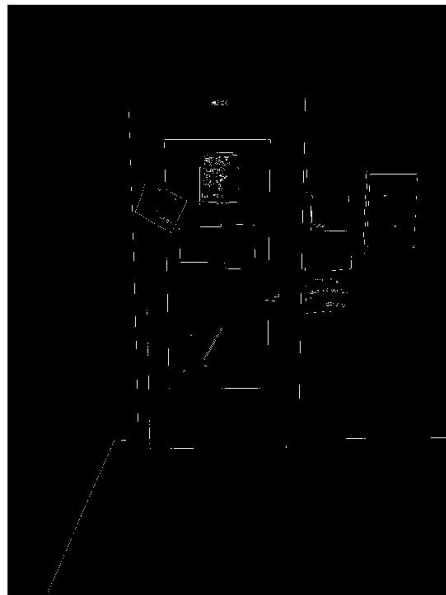
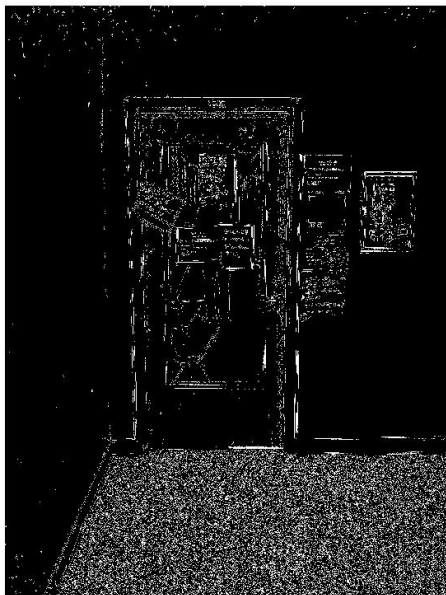
%% Output Images
subplot(1,3,1), imshow(D);
subplot(1,3,2), imshow(N);
subplot(1,3,3), imshow(J);
```

Results

Edge Detection

Edge detection has a major impact on the feature extraction that follows edge detection. The main problem with the images taken was the carpet that created strong salt and pepper like noise. To solve this issue the threshold values for weak and hard edges of the canny edge detector were modified. This allows the resulting image to only show edges with a steep gradient.

The next picture shows the difference in not specifying a threshold in comparison to applying a threshold value. Whereas the left picture contains a lot of “noise” (data that is not of our interest), the right picture almost entirely contains data that is relevant.



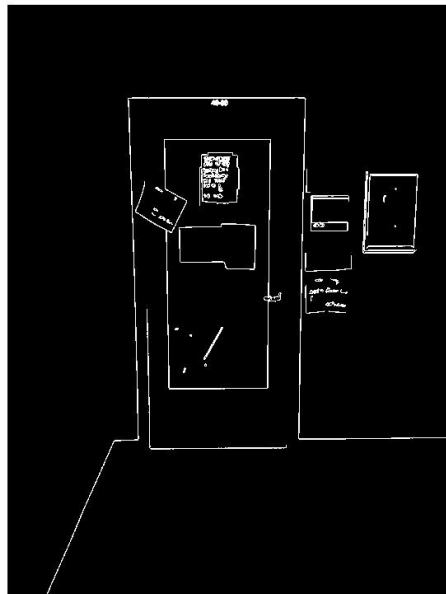
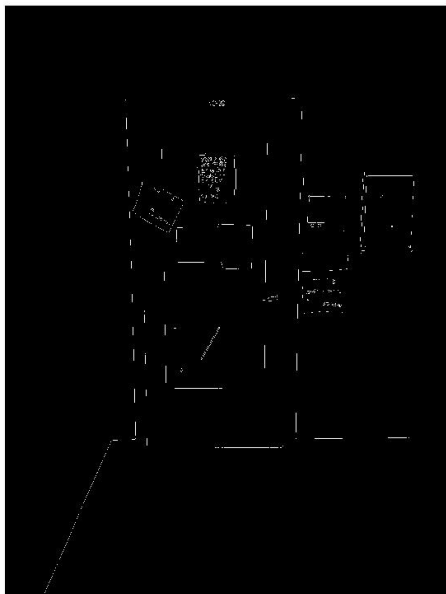
Dilation

As a result of using a hard threshold for the edge detection the found edges are often non-continuous. In this case we apply dilation to close the edges.

As a structuring element a 5x5 matrix was defined to strengthen horizontal and vertical lines:

0	0	1	0	0
0	0	1	0	0
1	1	1	1	1
0	0	1	0	0
0	0	1	0	0

On the left is the result of the edge detection and on the right the result of the dilation.



Thinning

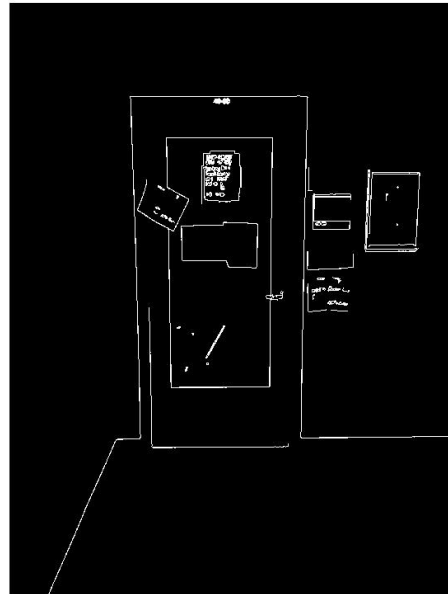
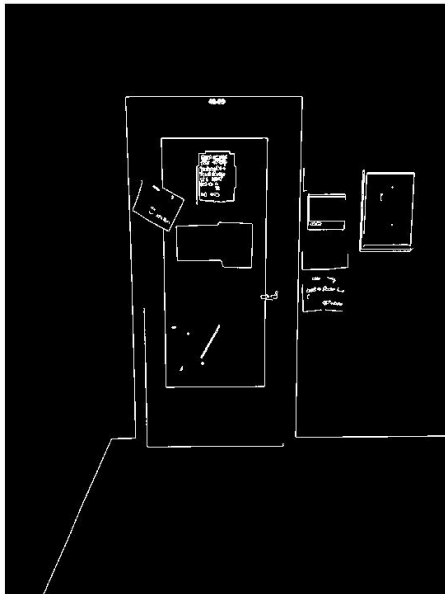
As dilation might create thicker lines than necessary, thinning was applied to the picture. The thinning is done defining two structuring elements, do the hit and miss transform and subtract the result from the original image.

A structuring for horizontal (left) and one for vertical (right) thinning were defined.

0	0	0
	1	
1	1	1

0		1
0	1	1
0		1

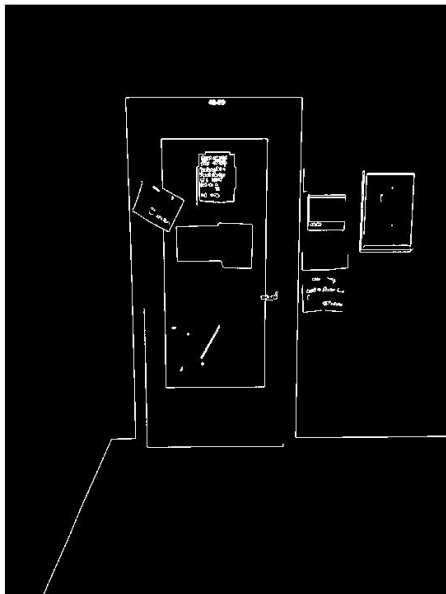
The results of applying the thinning operator are minimal compared to the dilated image as the lines already were rather thin.



Corner detection

To detect corners (to further reduce image information to geometric properties of doors, windows, etc.) the hit and miss transform was applied for four different corners (upper left, upper right, lower left, lower right). These four intermediate images were then added to one image that contains all the corners.

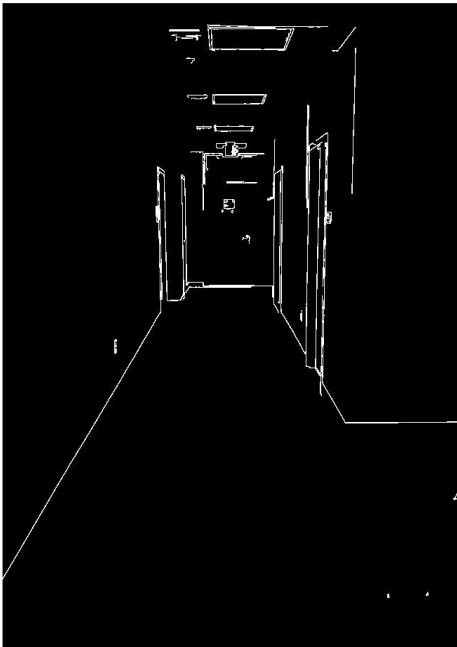
This method does not work too well on the chosen set of images as they contain a lot of objects that are not relevant to the actual navigation task. Therefore working with only corner information might not be sufficient.



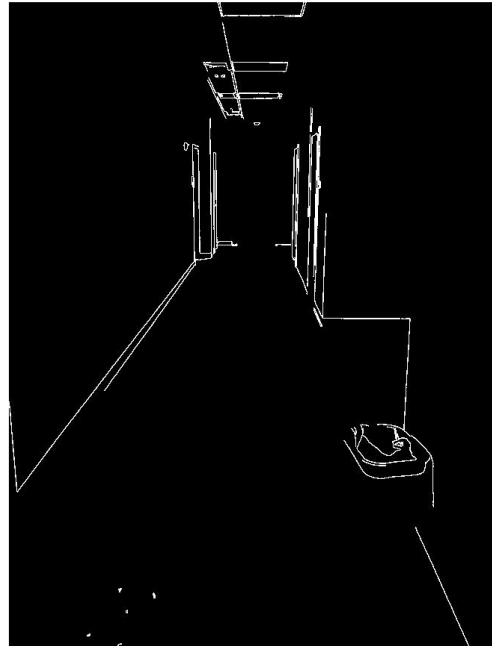
Final Pictures

(Pictures shown are the results after thinning as the corner detection with the hit and miss transform did not provide sufficient results for these pictures)

1.



2.

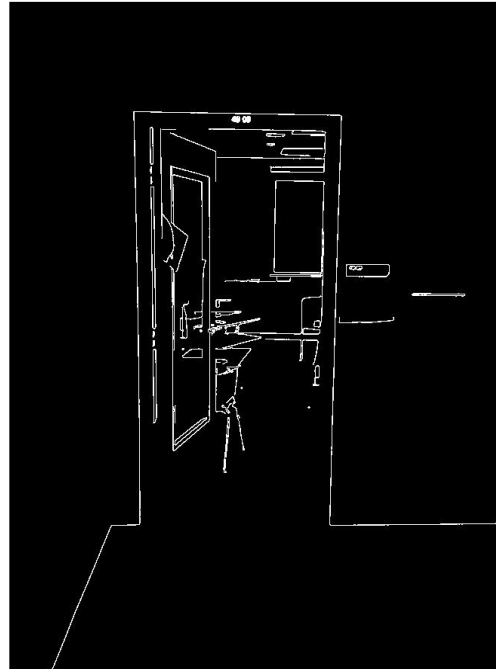


Under different lightning conditions the results vary slightly from each other. The main difference is that in picture 2 the door at the end of the corridor could not be extracted from the original image as this part of the picture was much lighter than the rest and the door had no strong contrast.

3.



4.



Picture 3 and 4 illustrate the differences of the same point of view with an open and a closed door. From these pictures the information on whether the door is open or closed can be extracted based on the angle of the lines that belong to the door as well as the background objects that would not be visible with a closed door. The left picture also allows for detecting the door handle being on the right side of the door.

5.



Picture 5 illustrates the detection of obstacles and the window.