2. Theory Questions

Q2.1

The amplitude is the distance from the origin to the point (x, y) in image space. So, amplitude should be $\sqrt{x^2 + y^2}$. The sinusoid should be $\rho = \sqrt{x^2 + y^2}\sin(\theta + \varphi)$, and φ is the phase of the sinusoid. In the image space, ρ get to maximum when the line is perpendicular to the line which connect the origin and the point (x, y).

$$\sin(\theta + \varphi) = 1, sin\theta = \frac{y}{\rho} \rightarrow \varphi = \frac{\pi}{2} - arcsin\frac{y}{\sqrt{x^2 + y^2}}$$

Q2.2

If we parameterize the line in terms of slope and intercept (m, c), we cannot represent the line which is perpendicular to the x-axis. For example, line x=a, a is arbitrary real number. In this condition, the slope is approaching infinity.

$$x cos\theta + y sin\theta = \rho$$

$$y sin\theta = -x cos\theta + \rho$$

$$y = -\frac{1}{tan\theta}x + \frac{\rho}{sin\theta}$$

From the equation above, we can see that the slope is $-\frac{1}{tan\theta}$ and the intercept is $\frac{\rho}{sin\theta}$.

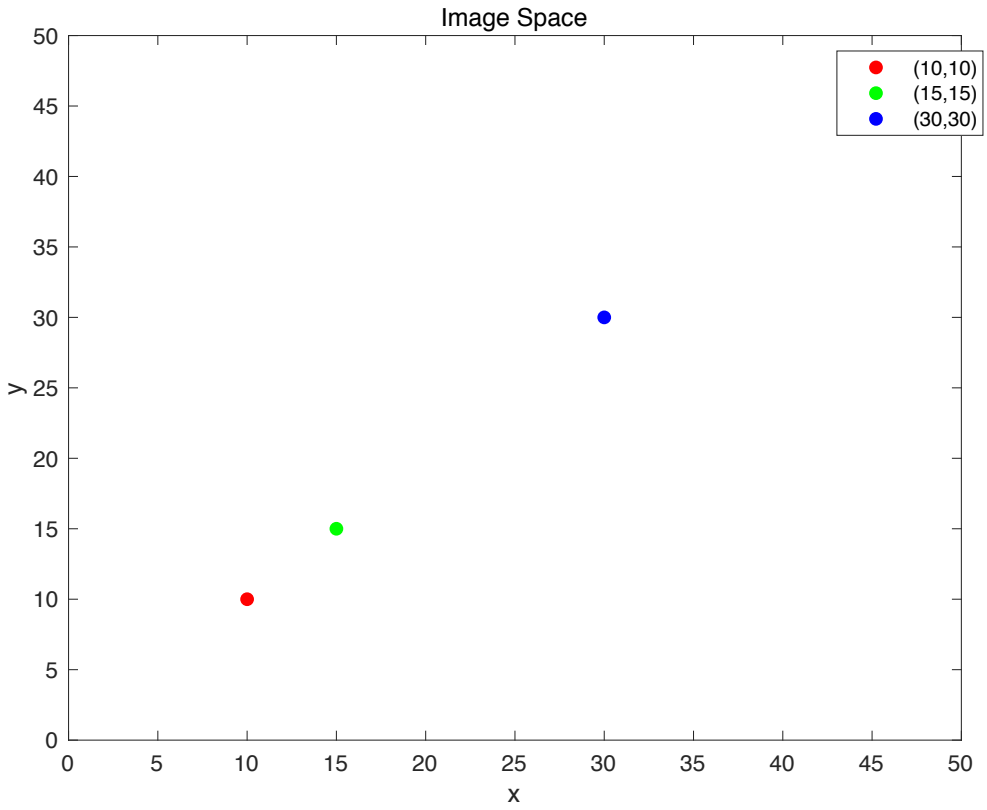
Q2.3

$$\rho_{max} = \sqrt{W^2 + H^2}$$

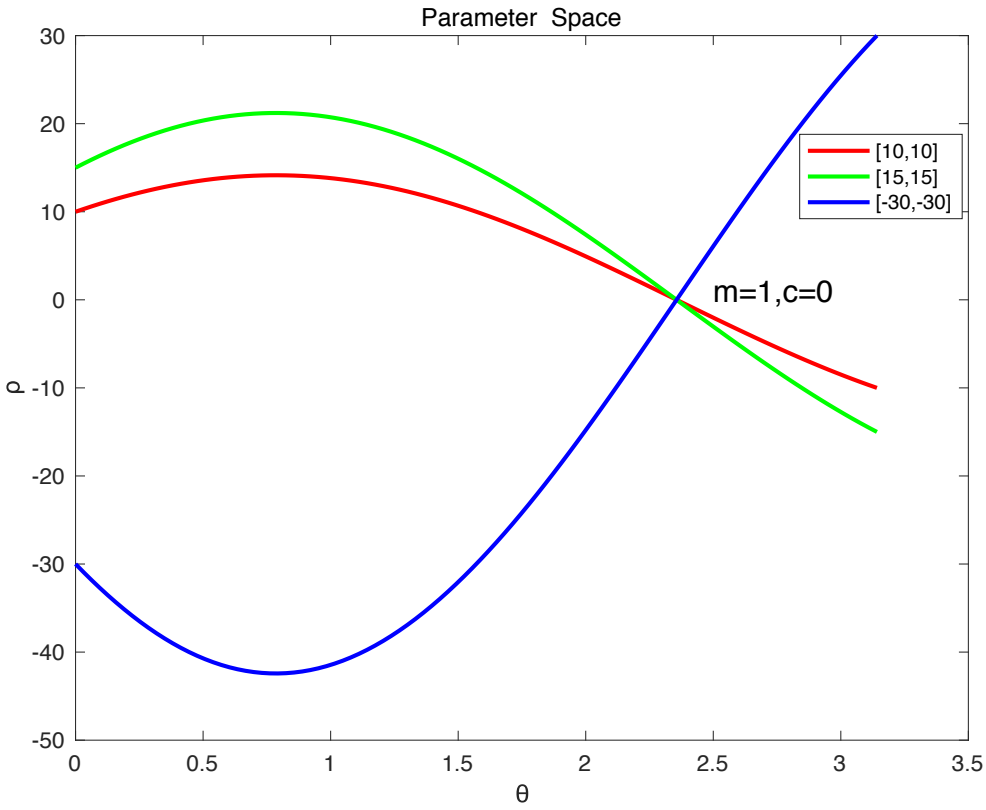
$$\theta \in [\arctan\frac{1}{W}, arctan\mathrm{H}]$$

Q2.4

Image space:



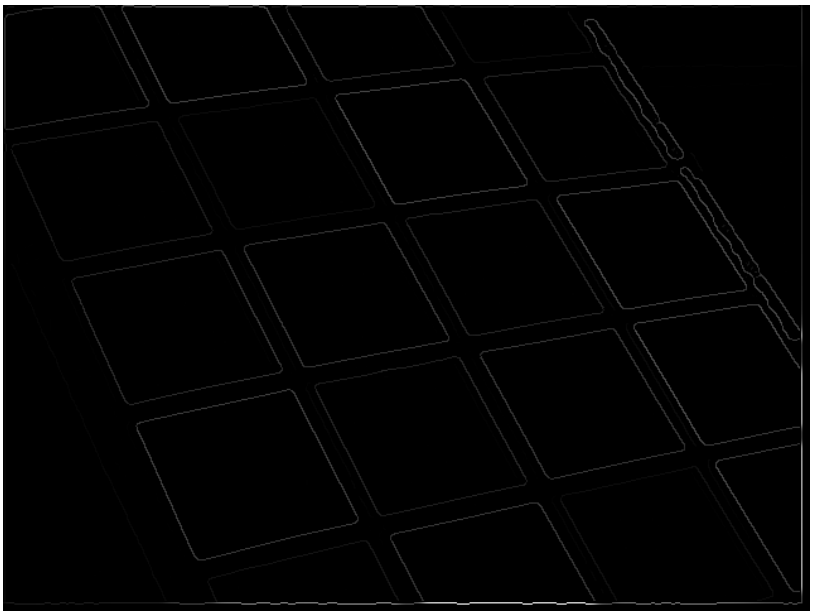
Parameter space:


Parameter Space
30
20
10
0
-10
-20
-30
-40
-50
ρ
0
0.5
1
1.5
2
2.5
3
3.5
θ
[10,10]
[15,15]
[-30,-30]
m=1,c=0

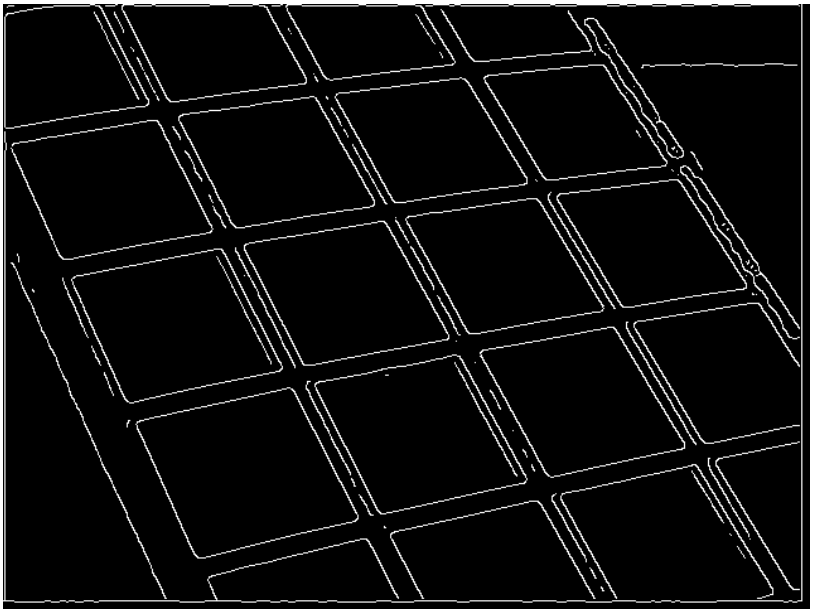
3. Implementation

Take img01 as the example output here.

Output of myEdgeFilter.m

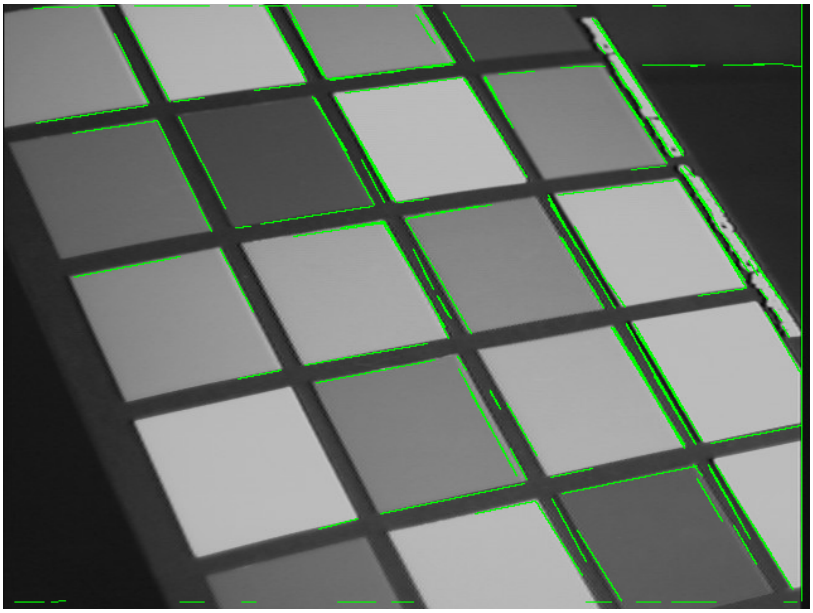


Output of Im > threshold:



Output of myHougLines.m

Output of extracting lines:



4. Experiments

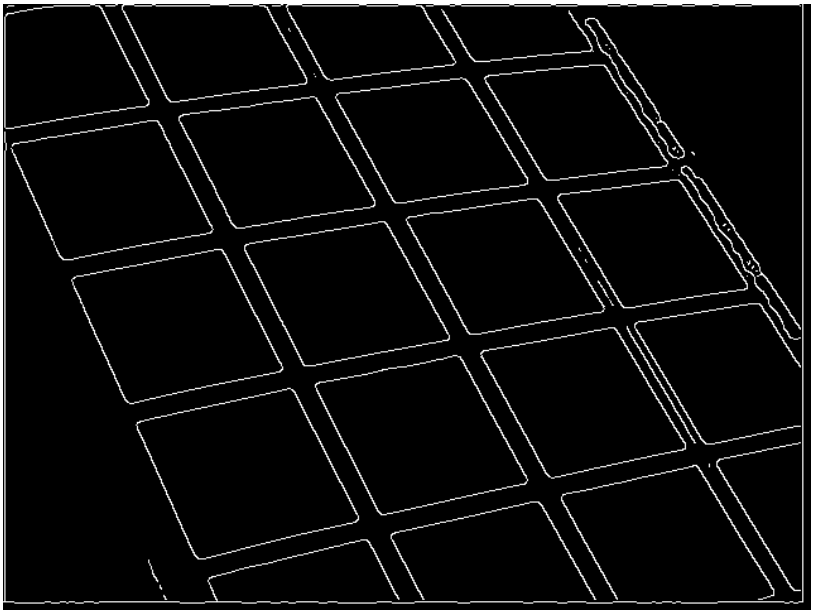
(1) How did the optimal set of parameters vary with images?

As we can see from above, the output shows quite many miscellaneous lines, the output quality seems not work very well.

Several possible reasons:

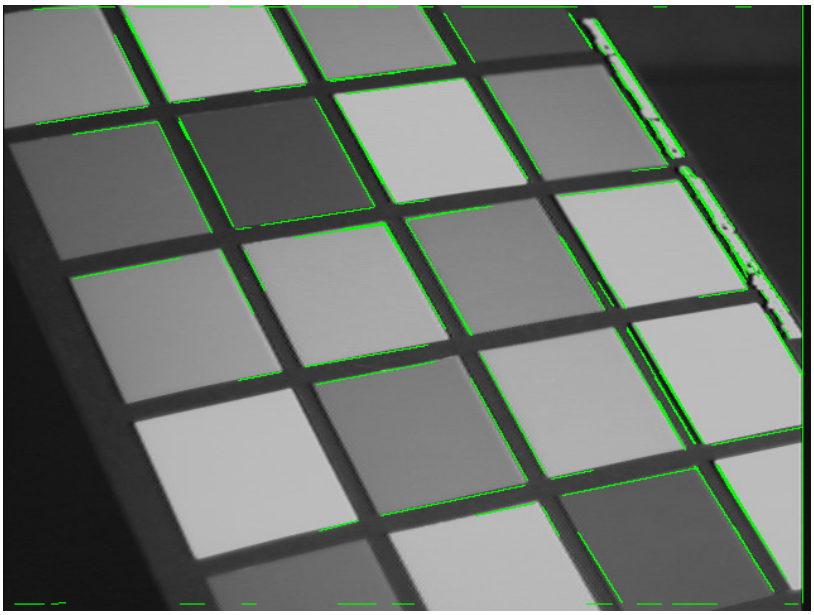
1) The value of threshold is too small, which lead to too much complicated and useless lines showed in image. After the value of threshold was adjusted to 0.1, the output images are attatched.

   Output of Im>threshold:

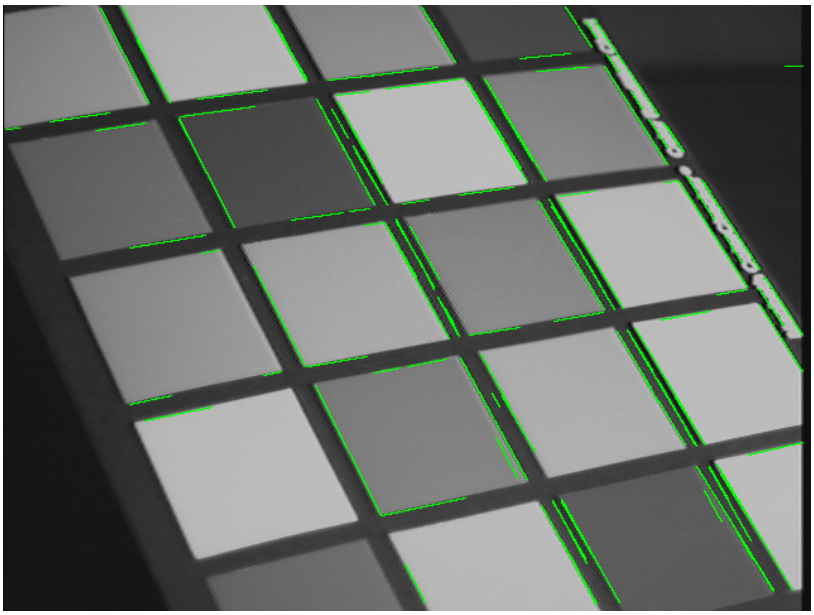


   From the image above, it can be obviously found that the output is clearer with less useless lines. Since the value of threshold has been increased, the image would filter some messy lines which are not explicit. The output shows better performance.

   At the same time, better performance would also be found in the output of extracting lines.



2) The value of thetaRes and rhoRes are too small. For each real point in image, it represents a whole line in Hough space and this whole line should be traversed to decide the Hough transform matrix H. When the thetaRes and rhoRes getting smaller, the step to traverse these lines are getting smaller and the transform process are more accurate. Based on this assumption, thetaRes was then changed to pi/180 and rhoRes was adjusted to 1. Then output of extracting lines has been attached.



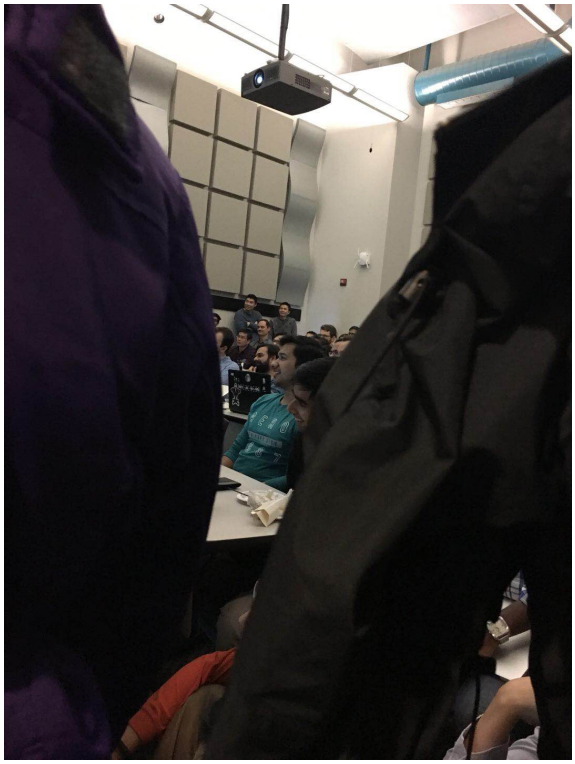
Comparing the above image with the original generated extracting line image, this image obviously shows better match with the real edges.

(2). Which step of the algorithm causes the most problems?

In my first attempt, my code was really time consuming and every time I run the houghScript.m, it would take about 10 minutes to finish this. Then I found function which has the most time consuming part is myHoughTransform function. That is because everyt ime when I try to find the index of rho in rhoScale, I tried to traverse all the elements in rhoScale and compare the value with calculated rho each time, and then finally find the rho index. This step is quite time consuming especially when the size of image is bigger. Then I changed the method, I implemented a help function which names nearestRhoScaleValue function to realize this process. In this function, I have the minimum value of the RhoScale and the maximum value of the RhoScale, as well as rhoRes. This method realized binary search to finish the searching index work. This method was really helpful and save time.

BONUS:

1. Frank Dellaert(RI seminar)



(Sorry for the picture quality, that room is crowed at that time and I'm too short to get a better picture.)

This seminar is quite hard for me, I heard many professional words for the first time and I learned much I have never heard before.

10 things I learned from this seminar:

1). I learned what is simultaneous localization and mapping(SLAM). This technique helps robotics to detect the unknown environment and help the robotics to decide which way to go and update the map.

2). I learned what is structure from motion. Generally speaking, it helps to reconstruct 3D models based on 2D images.

3) I learned what is reverse automatic differentiation.

4) I have a general idea about what is GTSAM toolbox.

5) I learned that how to build reverse automatic differentiation in to GTSAM.

6) I knew the advantages for the reverse automatic differentiation.

7) I learned what is batch and incremental algorithms defined on graphs.

8) I had a general idea of what the Facebook Building 8 is working on.

9) I learned the common sensors the SLAM always use.

10) I learned principle of how the robotics build new maps when exploring new area.

2. SCS Faculty Talk (February 8)

What I learned:

1). I learned what if pruning rules for current human and future automated pruners, can how to develop this from the real pruning problems.

2). I had a general idea of the impact of pruning project, timely completion of tasks required for efficient production.

3). The main challenge the pruning projects are confronted with is the labor challenges.

4). I learned the definition of phenotype, physical characteristic of an organism.

5). The current condition of phenotype, slow and inaccurate.

6). I learned the current approach to solve and improve the above two technologies. The process could be generally described as: acquire image – segment images -3D Reconstruction – curse skeletonization – compute measurements.

7). I learned what is silhouettes image.

8). I learned that the visual hull is a shape from silhouette and is the intersection of the backprojected silhouette cones.

9). However, the silhouette inconsistency effort function continued. And the solution is searching for a minimum and use visual hull.

10). I learned what is hierarchical approach.

Why hired:

1). Really interested in working on computer vision and dealing with agriculture problems. And she is really experienced based on her background.

2). She has a very explicit idea about what is the drawbacks of the current technology and knows how to improve these and make obvious progress.

3). The structure of the presentation is clear and she has a very good logical thinking ability.

Why not:

1). She cannot reply to the questions came up during tech talk explicitly and timely.

2). She had a really low voice which seems unconfident, but she still did a great job in what she is focusing on.

3). I'm not very familiar with this field, so I did not find any technical drawbacks of her talk. From my point of view, she is a really excellent candidate.