ROB514_F15_HW3
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1. Set of the parameters for the Kalman filter:
a = 1.0
b = 1.0
c = 1.0
q = set to be close to the variance of movement of robot
r = set to be close to the variance of sensor of robot

2. Experiment

This experiment set the robot speed become a linear-decay function:

speed = 1.0 – t/T

So the speed becomes to 0 at t = 100. The position over time is not a straight line. It becomes a curve showing in figure 2.1.

2.1 A perfect robot

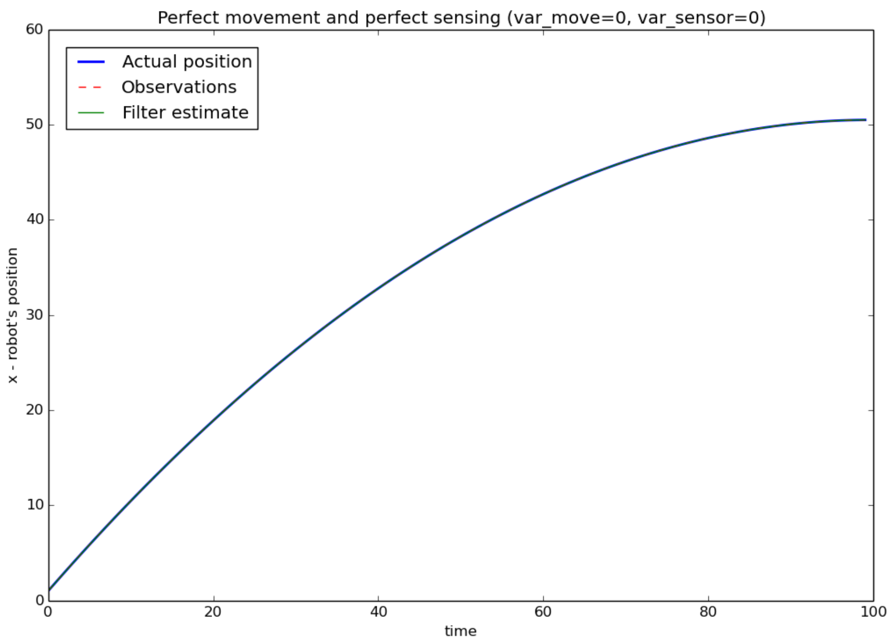

Figure 2.1. Perfect movement and perfect sensing

Perfect movement and perfect sensing mean that the variance of the robot's movement and sensor is 0. So the robot moves to exactly where it aims to and sensor exactly where it is. Thus, the plots shows that the three lines are overlapped.

2.2 Increase the variance of the movement and sensor models in the Kalman filter

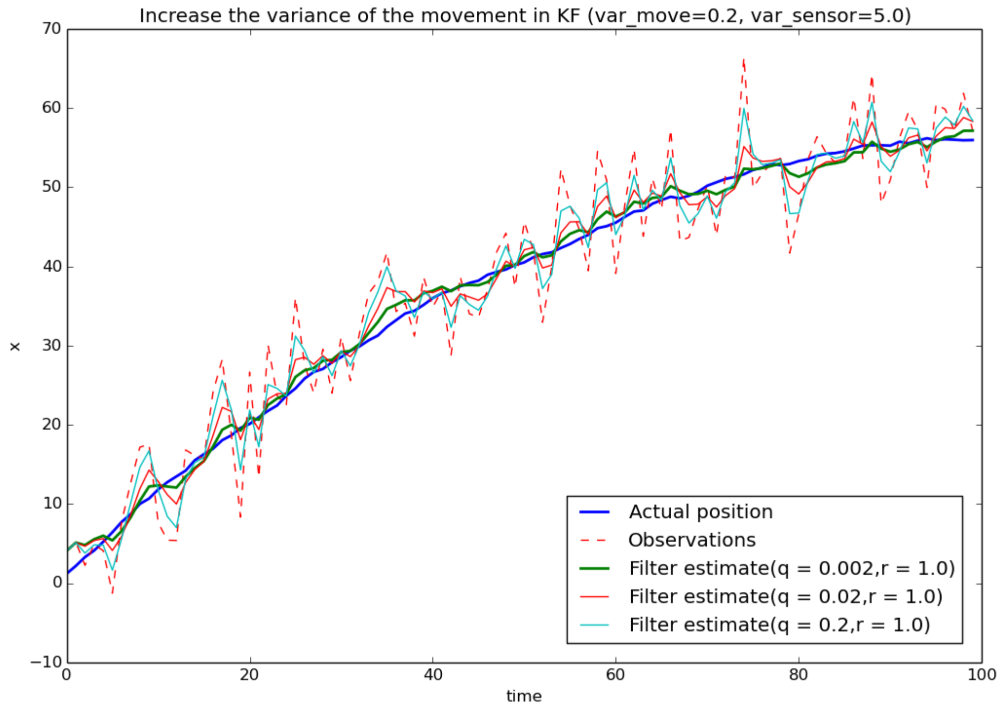

Figure 2.2. Increase the variance of movement in KF

As the variance of the movement (q) increases, the filter estimate is moving from desired position (shows in figure 2.1) to the sensor observation. A large q means less confidence that the robot is close to the desire position. So the robot is more possible to estimate its position by its sensor observations. And it is more likely to ignore the accumulated desired position.

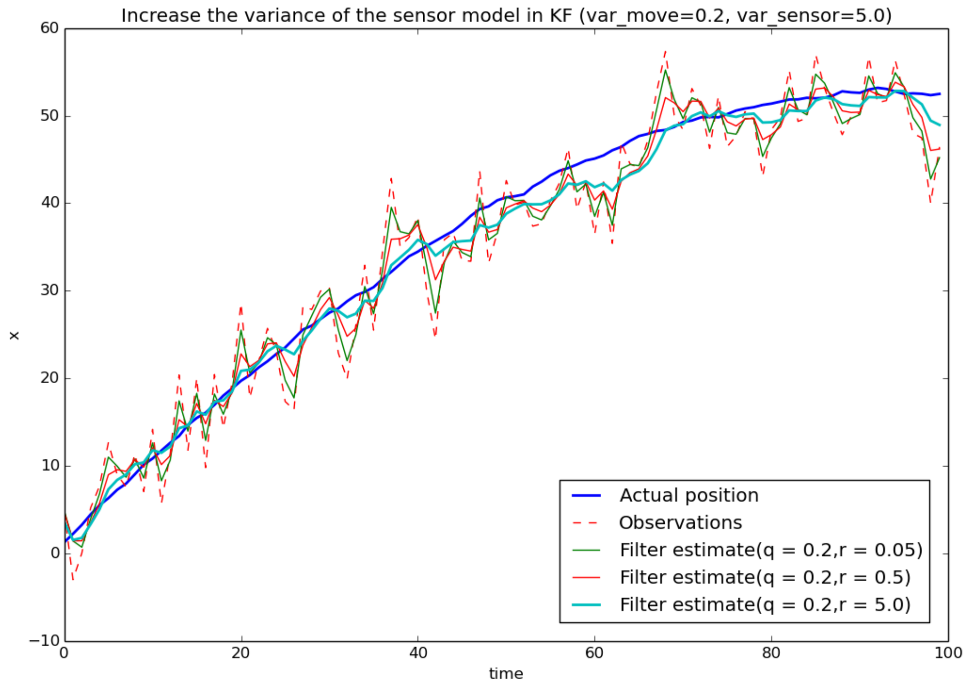

Figure 2.3. Increase the variance of sensor in KF

As the variance of the sensor model (r) increases, the filter estimate is moving toward the actual positions. It trends to ignore the sensor observations. Because a large r lets the filter has less belief on the robot's sensor.

2.3 Incorrect movement or sensor model in KF

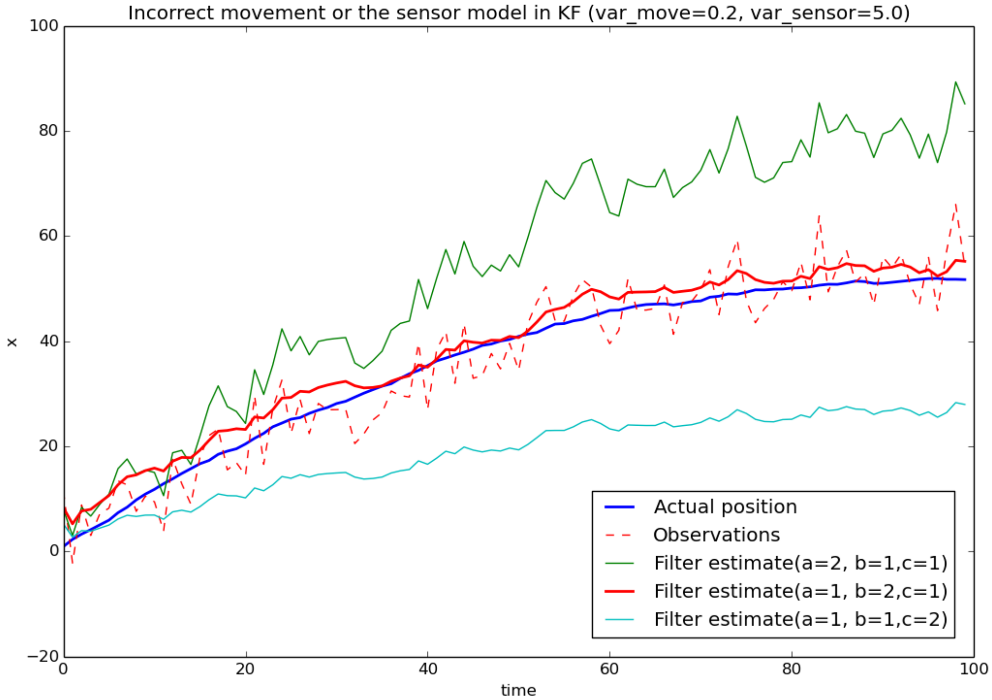

Figure 2.4. Incorrect movement or sensor model in KF

The correct model parameters are: a = 1, b = 1, c = 1

KF parameters are set to be: q = 0.2, r = 5.0

When the state transition model, a, is set to be 2. The filter estimate goes higher and higher. The filter estimation is incorrect.

When the control import model, b, is set to be 2. The filter estimate still follow the actual position. So the system input, u, is doubled. The filter treats the movement as twice as the real movement. But it still adjust the estimation to be near the actual position. Thus, KF is kind of robust to incorrect control import model.

When the observation model, c, is set to be 2. The filter estimate goes lower and away from the actual position.

2.4 Optimal parameters in Kalman filter

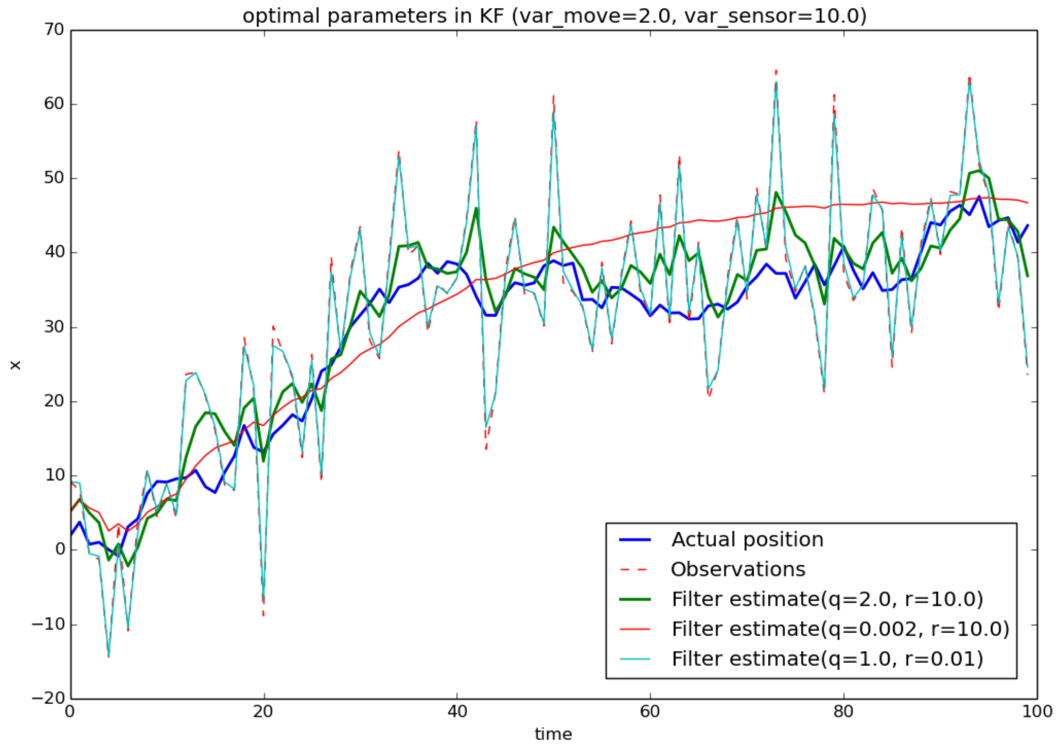

Figure 2.5. Optimal parameters in KF

The robot is set to be a very bad robot with large variance.

variance of movement	= 2.0
variance of sensor	= 10.0

This robot usually reach to very far from the desire position and get observation with huge noise.

In the plot, the red line indicates the filter estimate with very small movement variance in KF. It is close to the desired position (shows in figure 2.1), but far away from the actual positon. So it is not good for this bad robot.

The pale blue line shows the estimate with small sensor variance in KF. It is almost overlapping on the sensor observations, which is a very noisy signal.

The green line in the plot can follow the actual position well. So the optimal parameters are: q = 2.0, r = 10.0. These are same to the robots variance. This means that the Kalman filter has the same confidence to estimate the robots positon as the true robot’s reliability. In real world, the true variance of movement and sensor of a robot is unknown. Thus, we can only guess the optimal parameters via experimented data.

3. Hough Transform

3.1 The Hough transform works well

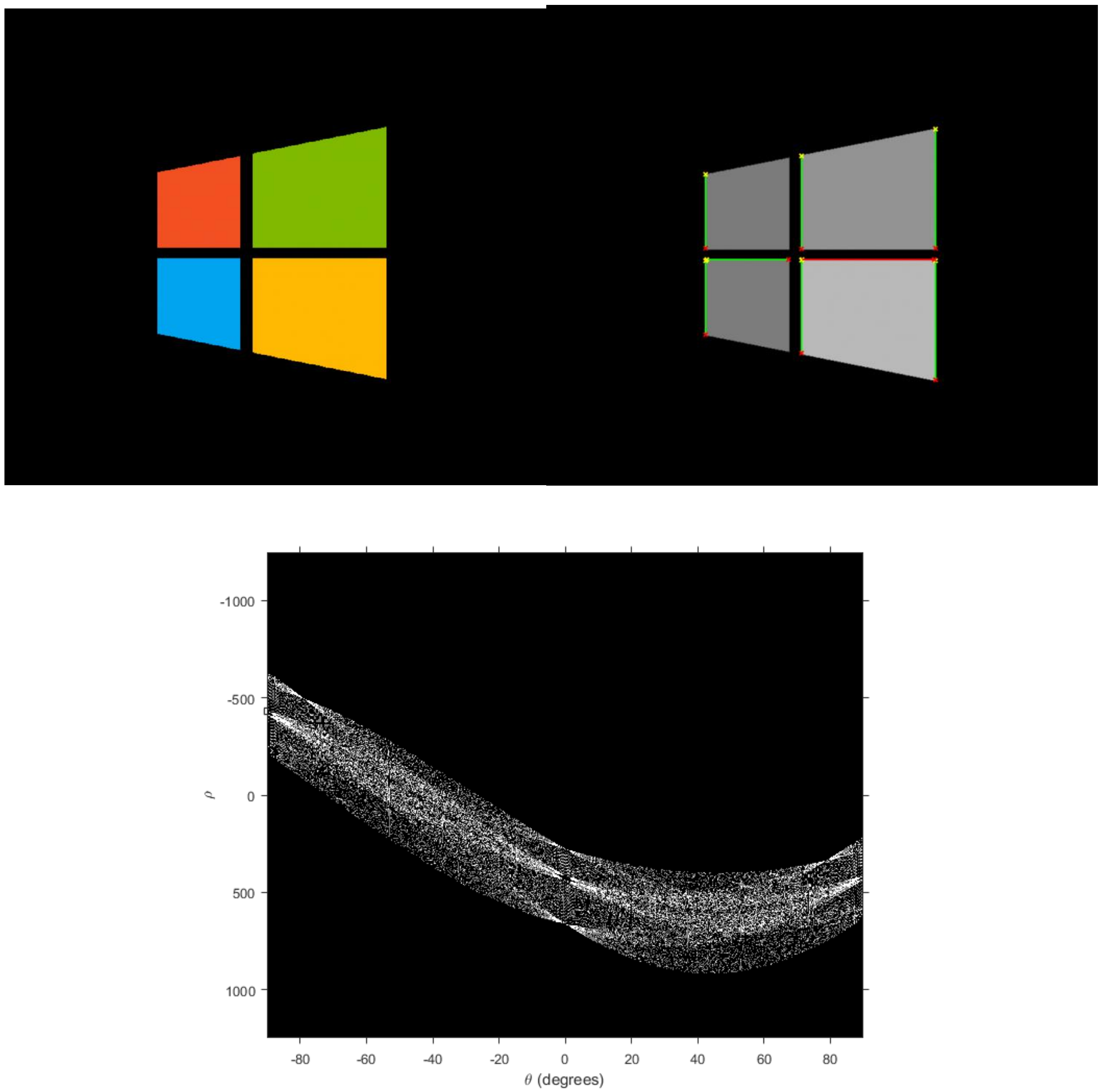

Figure 3.1. Hough transform works well

3.1 The Hough transform works poorly

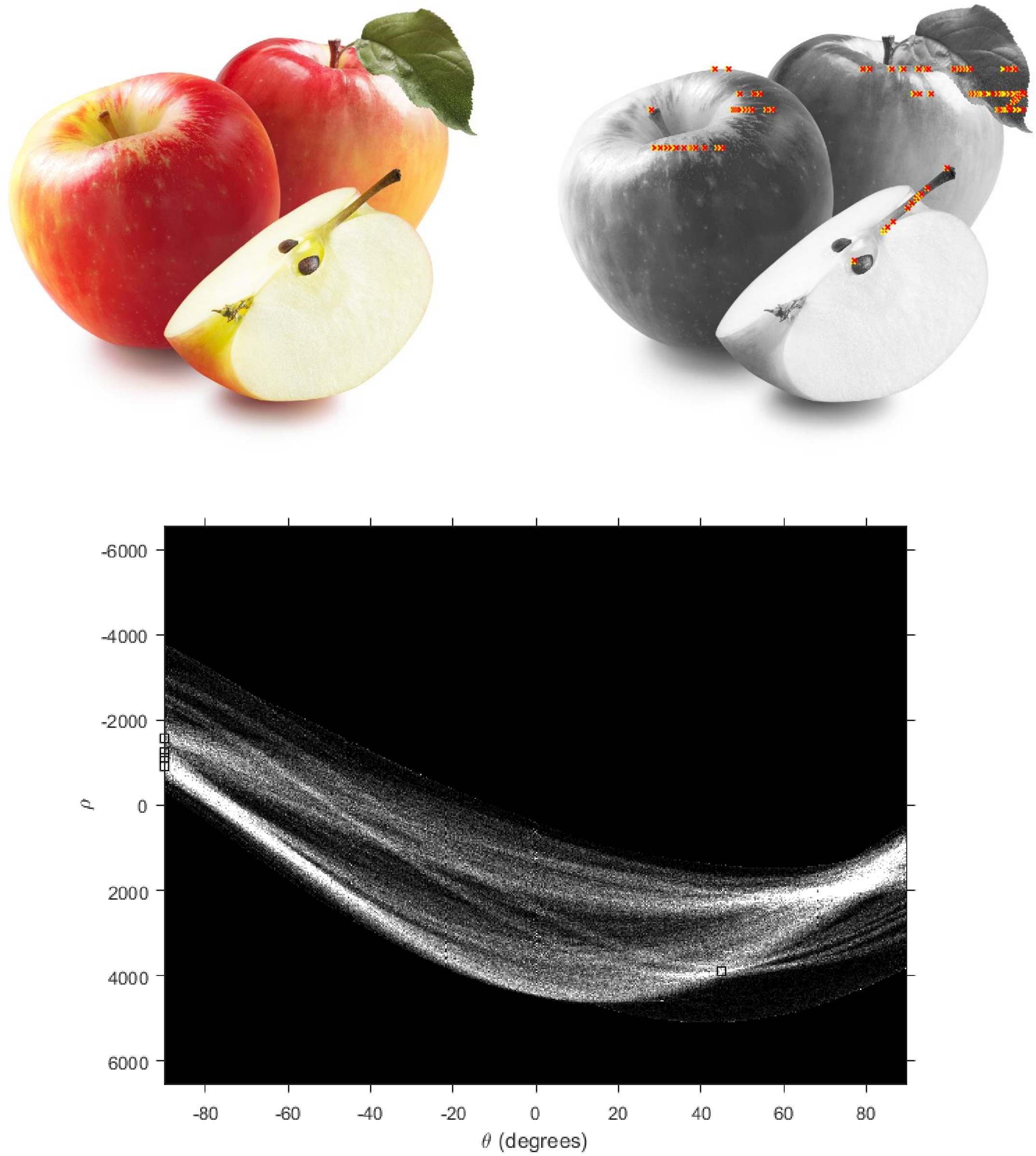

Figure 3.2. Hough transform works poorly

3.1 Odd results

There are lots of straight lines in this image, but the algorithm does not generate them well. The reason might be the canny edge detection is working poorly.

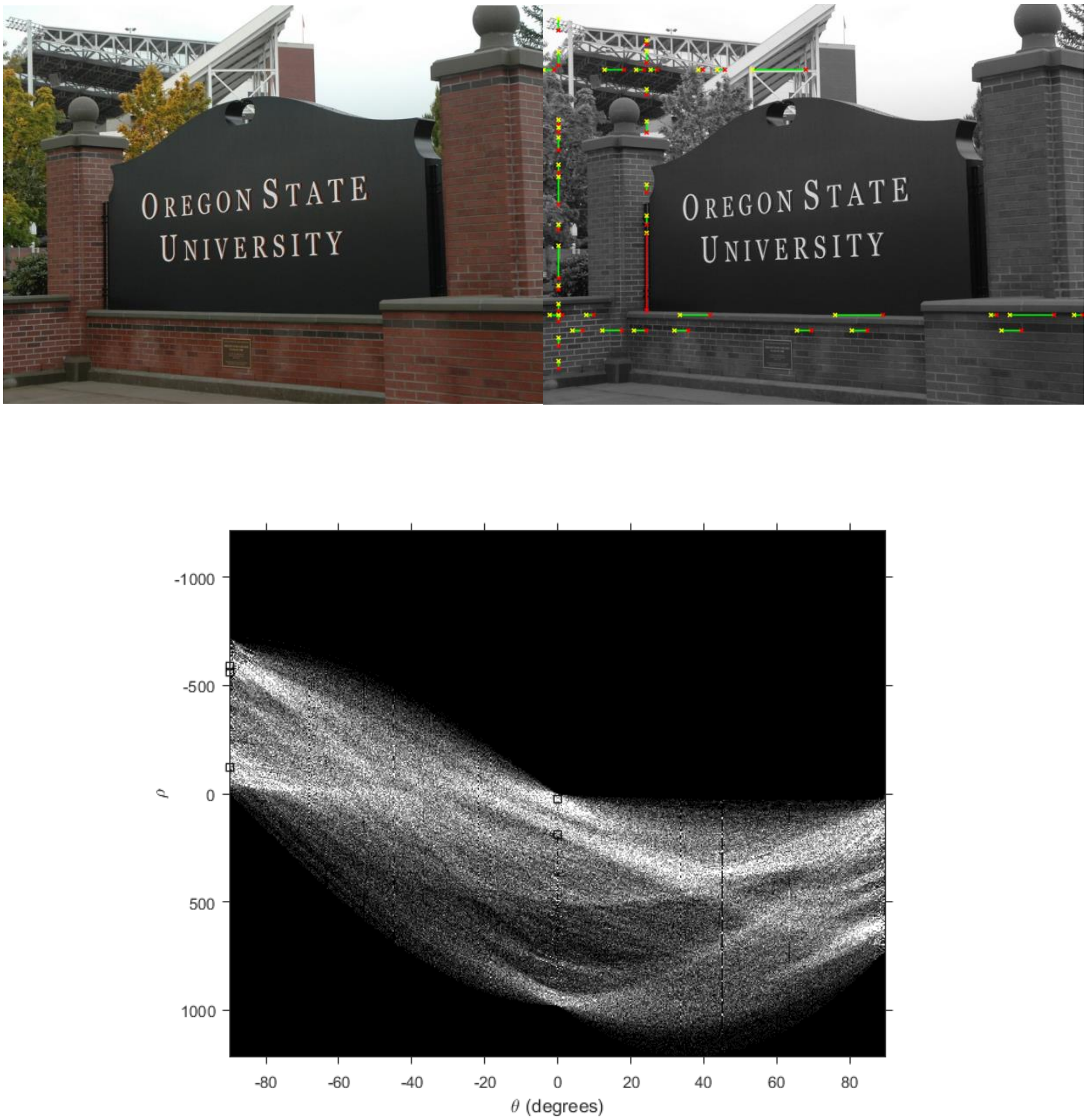

Figure 3.3. Odd results