Robots! HW3

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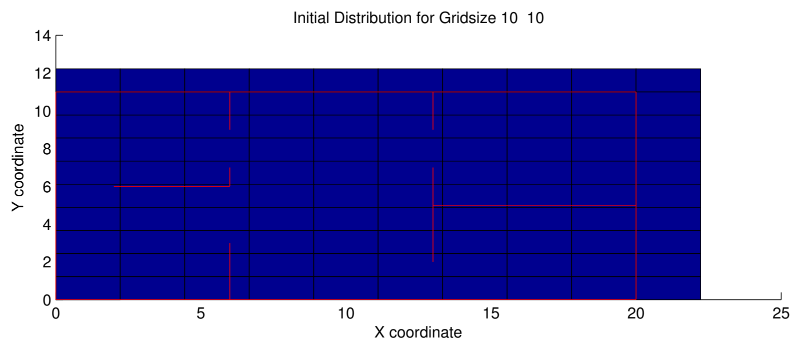
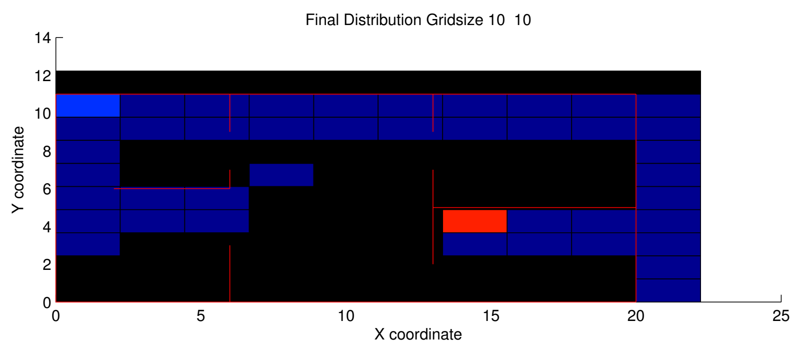
Grid localization

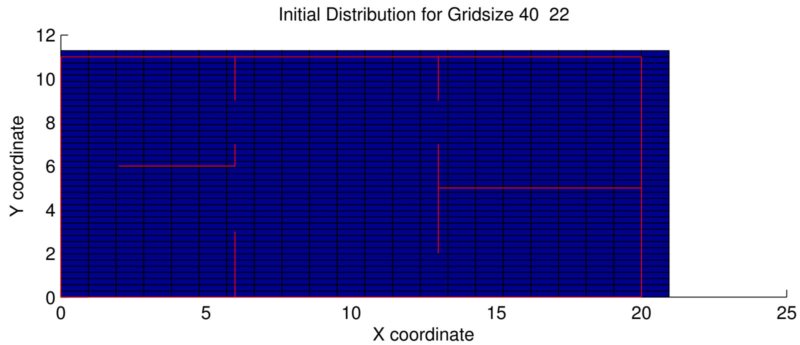
1. My implementation of gridLocalizationStationary.m deals with the measurement issue by assuming the robot is at the center of any grid box.

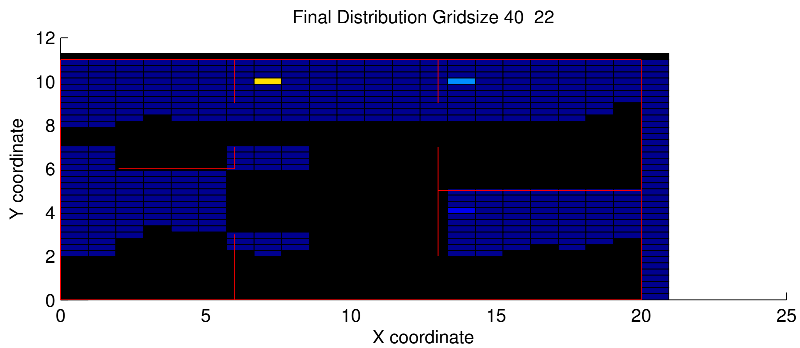
2. With no prior knowledge, the initial probability distribution for a 10x10 grid would assign each grid box an equal $P = \frac{1}{100}$

3.





4. 



   This difference happens because the possible positions are at the centers of grid boxes (or whatever fixed point on the grid box you choose.) In a rougher grid, the true position might be far away from the center of a grid box, making the 'best' position somewhere other than near the true position.

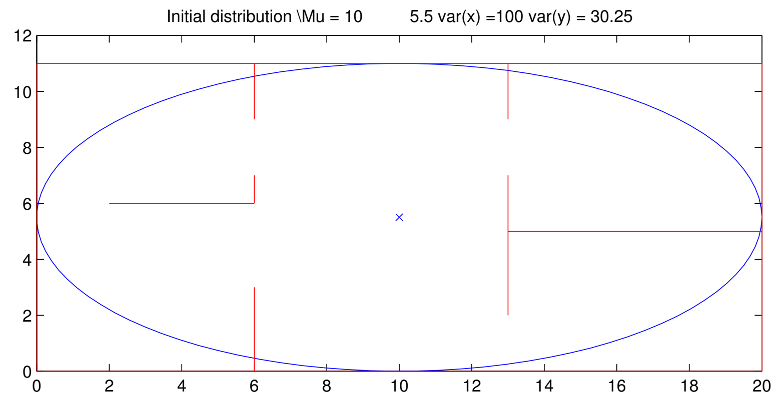
Kalman filter

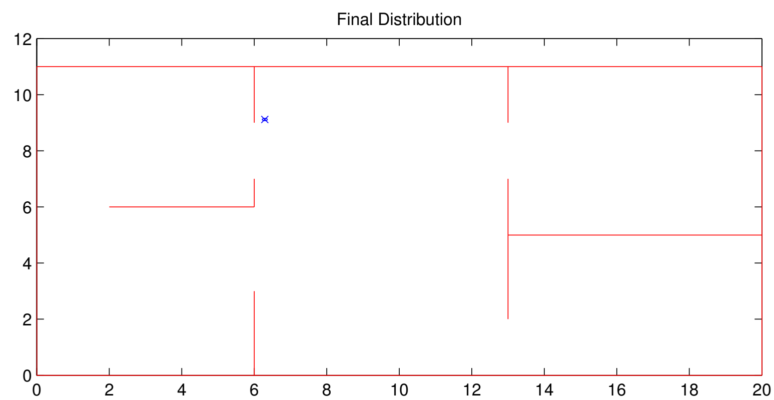
2. The update is performed by the kalman update equations:

$$k_t = \bar{\Sigma}_t C^T \left(C \bar{\Sigma}_t C^T + Q \right)^{-1} \text{ : Kalman gain}$$
$$\mu_t = \bar{\mu}_t + k_t \left(z_t - z_{\text{expected}} \right) \text{: Update } \mu$$
$$\Sigma_t = \left(I - k_t C \right) \bar{\Sigma}_t \text{: Update } \Sigma$$

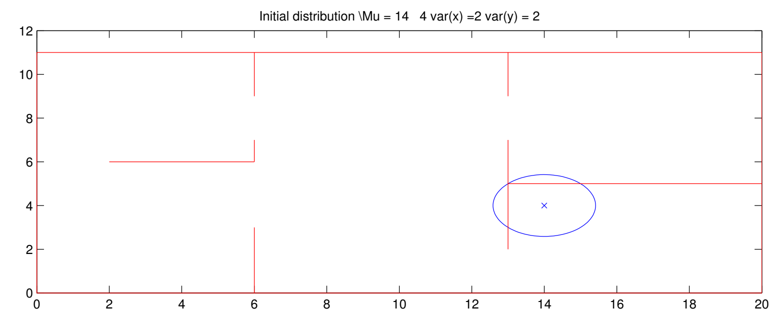
3. My initial distribution has μ at the center of the map and Σ such that the edges of the map correspond to 1 σ in x and y.

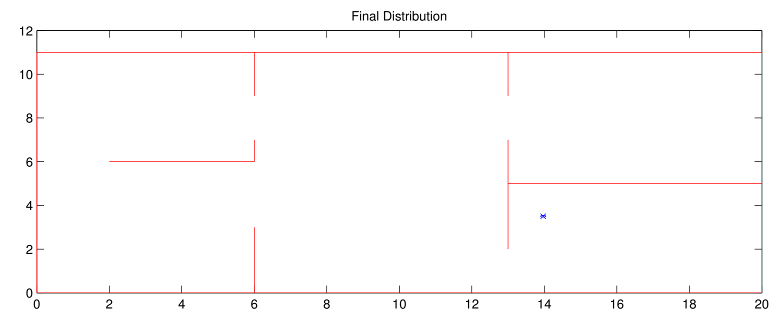
4.


Initial distribution \Mu = 10 5.5 var(x) =100 var(y) = 30.25
12
10
8
6
4
2
0
0 2 4 6 8 10 12 14 16 18 20


Final Distribution
12
10
8
6
4
2
0
0 2 4 6 8 10 12 14 16 18 20

5.





The initial distribution affects the final position estimate. If the initial distribution isn't close enough to the true-ish position, the Kalman updates will drive the μ somewhere incorrect, but continue to reduce the distribution's covariance.

7. An EKF wouldn't help in this situation. The measurement function is linear here, as the normal Kalman filter assumes, but it is piecewise linear. An EKF is better at handling continuous nonlinearities, not discontinuous ones.

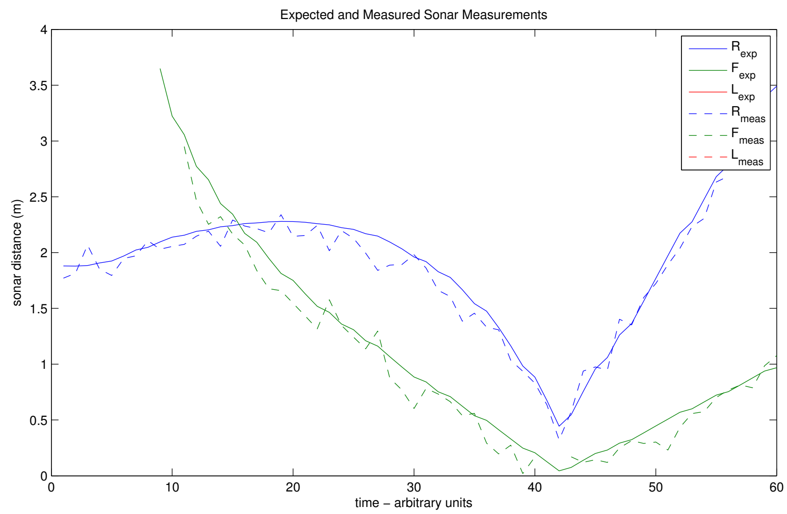
Location estimate

1. Both filters wouldn't find the location perfectly even with perfect sensor information. Grid localization would need an infinitely fine grid size (and infinite time to check every grid point.) A Kalman filter would still fail to localize if your initial estimate was not close enough to the true position because it doesn't take the piecewise linearity of the map into account.

2. If we know that $y < 8$ I can use my human intuition to estimate that the robot is probably right around $(14, 4)$ - all the previous pdfs as well as the measurement data itself support that corner as the only real option.

Expected sonar Measurement

2. Map is just a vertical wall.

3. 

The measured and expected measurements are not identical. They both follow approximately the same curve, but the sensor measurements have additional noise (unsurprisingly.) The real measurements also return NaN if the range is too small.