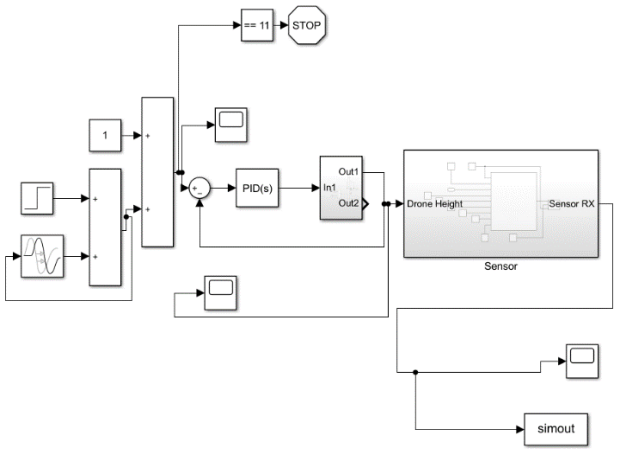
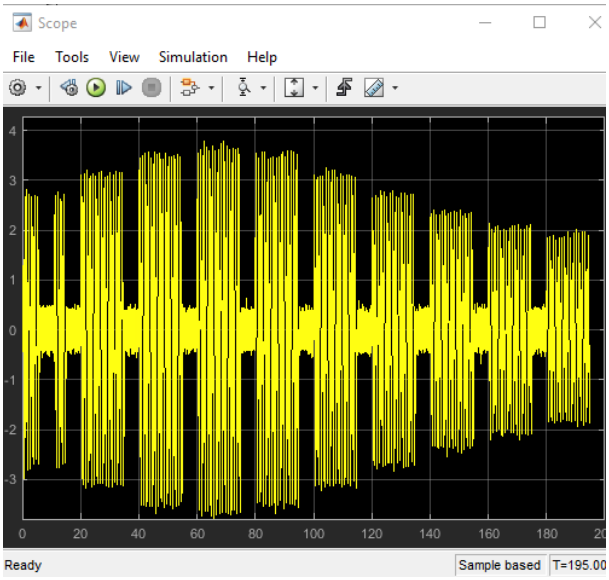
Sarda 104940016

Objective

- Design a controller that sweeps the line x = 0 to record incoming signals.
- Design a filter that removes the noise from the recorded signals
- Design an algorithm to estimate the coordinates of the source from the observed signals.



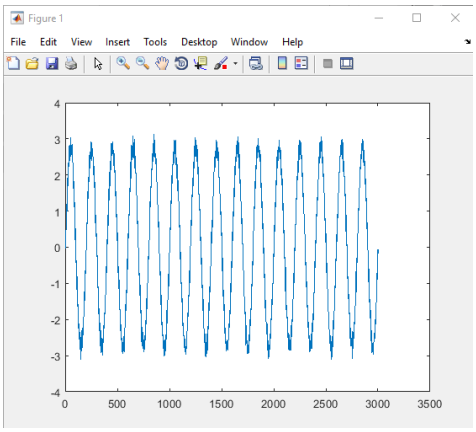
Controller



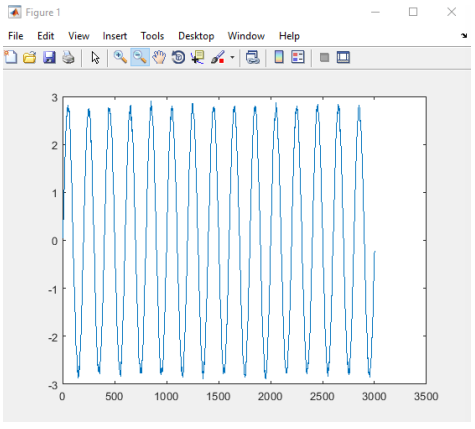
Outputted Signal from Sensor

Controller

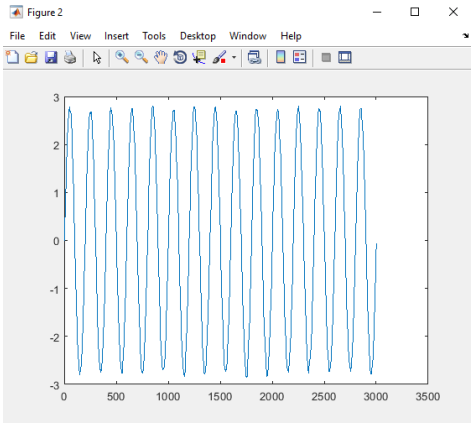
The controller is based off a feedback loop that creates a step staircase from 1 to 10 that feeds into the PD controller for a quad-rotor. This results in the drone height incrementally changing from 2 m to 10 m with a step time of 20 s (at 1 m it has a step time of 15s). This is done so that the overshoot lines up with the source not emitting a signal. The resultant sensor emits an output signal for the first 15 seconds of each step and noise for the last 5 seconds.



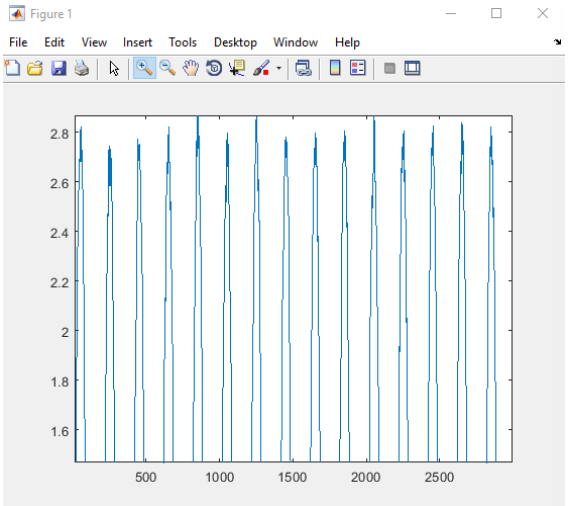
Original Signal



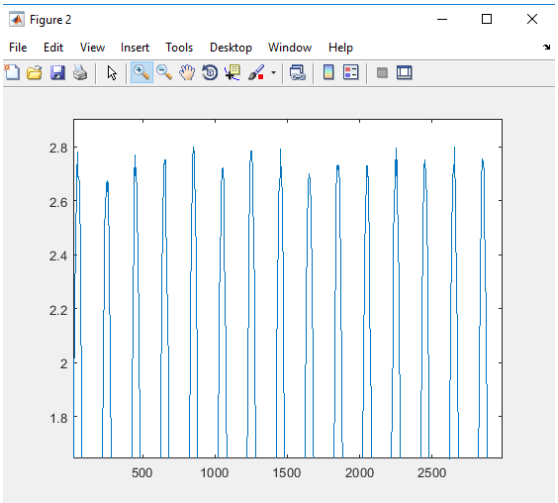
Mean Filter



Median Filter



Mean Zoomed in



Median Zoomed in

Denoising Technique

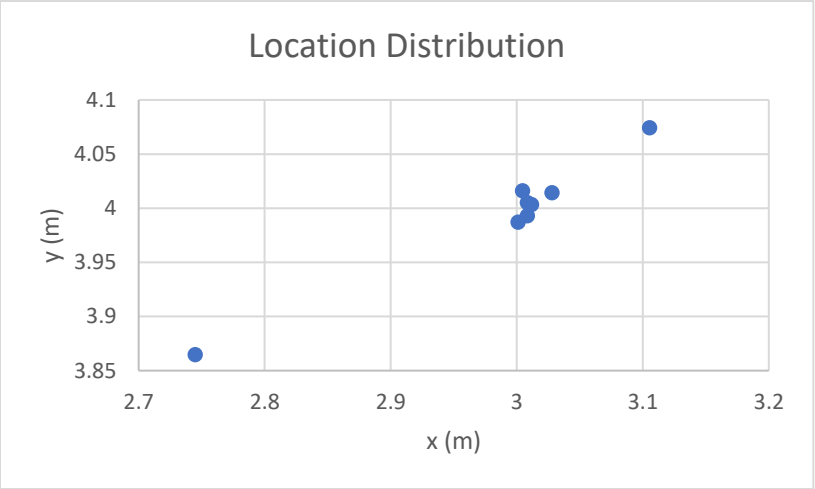
For this project, I used median filtering. While researching filters, I discovered that median filters were more successful in removing outlying "impulse" values in noise and were more edge-preserving compared to mean filters which instead ended up blurring the signal. The images above compare mean and median filters for the same filter coefficient. As can be seen, the median filter does a better job of smoothing and preserving the peaks of the signal.

Data Tables

Let (x, y) be the source position to be determined and (x_l, y_l) be the known coordinates of the sensor. Let the distance between the source and the sensor be denoted by d_l. Denote the source transmitted power by P_t. In the absence of disturbance, the average power received at the sensor, denoted by $P_{r,l}$.

x_l	y_l	d_l	P_t	$P_{r,l}$
0	2	3.6184	50	3.8189
0	3	3.1718	50	4.9699
0	4	3.0083	50	5.5249
0	5	3.1723	50	4.9684
0	6	3.6134	50	3.8295
0	7	4.2523	50	2.7652
0	8	5.0053	50	1.9957
0	9	5.8228	50	1.4747
0	10	6.7212	50	1.1068

x	y
3.004648	4.016147
3.008312	4.00525
3.008309	3.993225
3.011735	4.003522
3.00091	3.987287
3.02781	4.014323
3.105239	4.074348
2.74484	3.864787



Algorithm

The algorithm used was to determine the location of the source by utilizing the information derived from the signal strength of the transmitted signals (using the average power to calculate the distance of the source). This technique works the best because it simplifies the problem into a simple algebraic form.

Conclusion

The x coordinate of the source is 3 and the y coordinate of the source is 4.