Digital Signal Processing

Lab 1

Working with Signals Using MATLAB Live Editor

Reminder

- Order your lab kits through Ken Garland
  - Email -- kpgiee@rit.edu
- Instructions are in myCourses
  - Tiger Bucks
  - Provide UID
  - Address if you are shipping
- Resistors required
  - 220K, 100K, 47K, 2.2K, 47

Group Organization

- Pick a Team Lead for each Lab
  - Rotate the Team Lead Role each week
- Team Lead coordinates the group
  - Responsible for lab submission
  - Submits a work breakdown document (who did what)
  - Indicate the Team Lead on the submission
- Collaboration among all team members during lab session and outside of lab works the best
- Some groups collaborate by sharing screen in ZOOM and work together throughout the lab.

What are we doing in Lab 1?

- In DSP we will take analog signals and sample them then turn them into numbers
- Often these signals come from imperfect sensors or other external sources
- Our signals will often have impairments
  - Drift
  - Noise

What are we doing in Lab 1?

- This lab will use MATLAB to perform calculations and investigate these impairments

What is drift?

- Signal with drift
  - Drift is a slow change in amplitude that is correlated to the time
  - Often modeled as a linear change in value

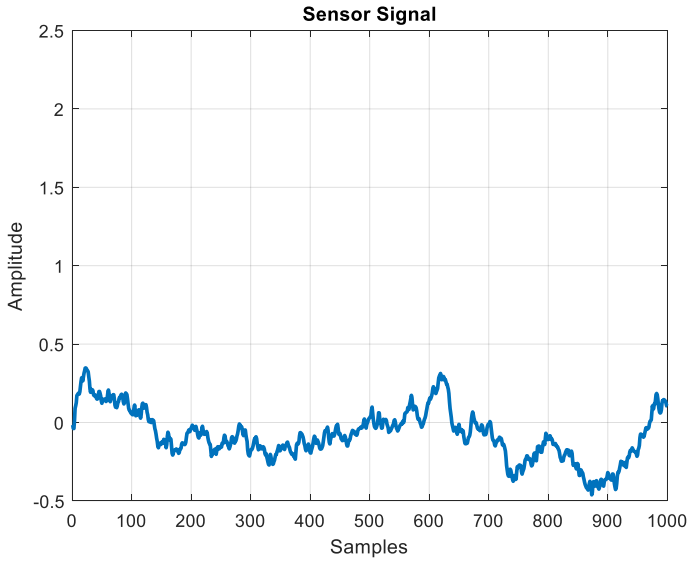
$$drift = mt + b$$

Drift slope - m

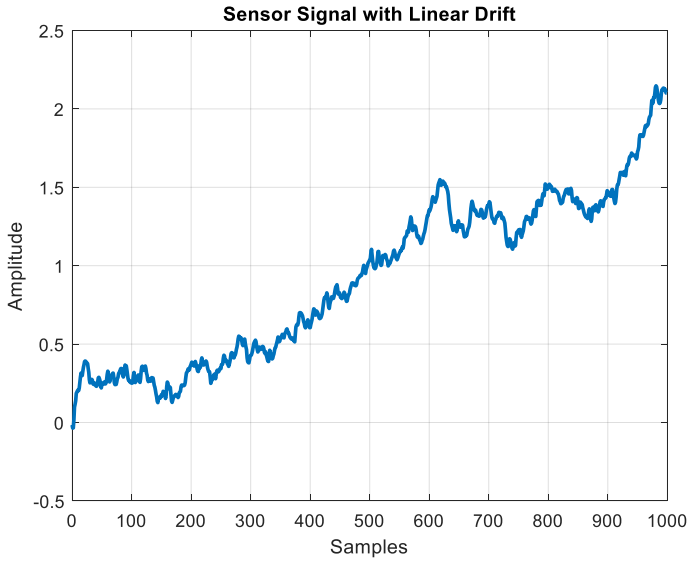
Drift intercept - b

What is drift?

- The average value of the signal increasing or decreasing slowly over time



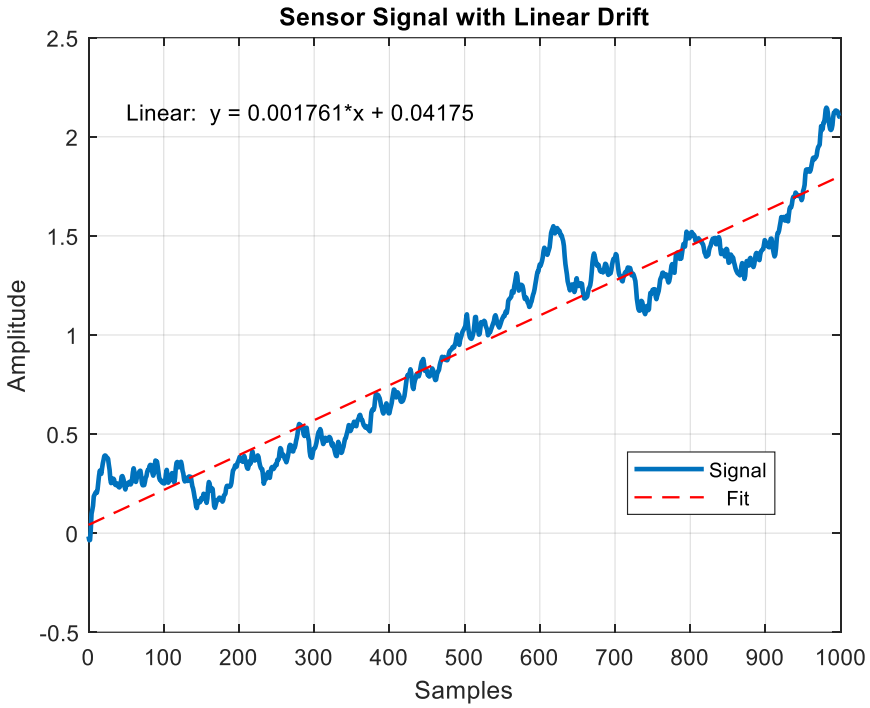
Sensor Signal



Sensor Signal
With Linear Drift

How can we estimate drift?

- Fit a straight line to the data using MATLAB polyfit function



Fit the y variable to a line

coeffs = polyfit(x,y,order)

For a straight line order = 1

slope = coeffs(1)
intercept = coeffs(2)

Removing the effects of drift

- Create a signal that models the drift. This is a straight line.
- Subtract the drift from the signal with drift.

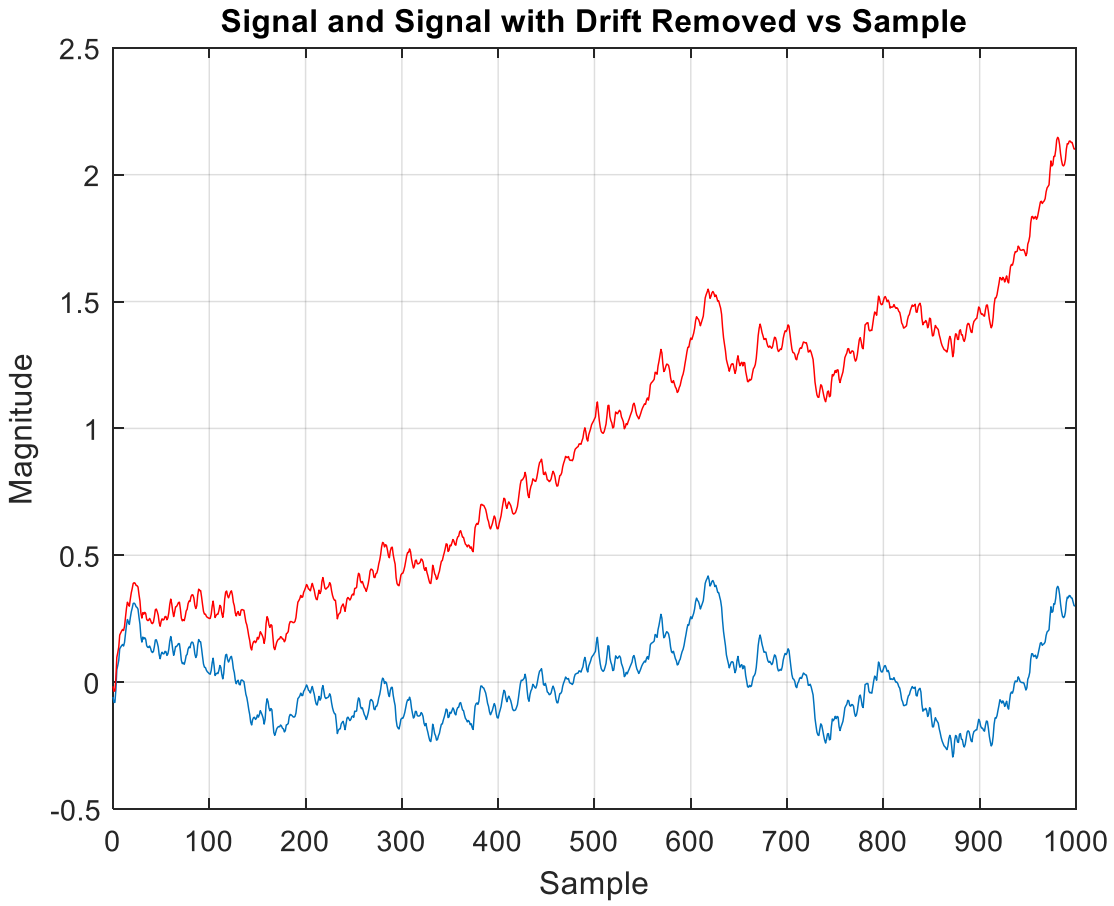
$$\mathrm{D}rift = (mT + b)$$

$$Drift = 0.001992 \times sample + .023027$$

- Subtract this from the original signal

Drift Slope = .001992 per sample
Intercept = .023027

Removing the Drift



What is noise?

- Noise can come from different sources
  - Noise naturally on the signal
  - Noise introduced by the sensor
  - Noise from sampling process
  - Noise from computation

Separating Signal from Noise

- Filtering is a way to remove noise from a signal
- We will subtract the signal from the noisy signal and leave just the noise
  - Assume that we have identified the signal
- Then estimate the signal and the noise power

Estimating the Signal Power

- We'll use statistics to characterize the signal and noise
- Often the power in the signal or the noise is estimated by the *variance* of those quantities

- Variance is similar to the RMS voltage squared

$$P = \frac{V_{rms}^2}{R} \qquad P = \sigma^2 \quad \text{Where } R = 1\Omega$$

Lab 1

- Your team is given a signal that has been gathered from a sensor. The sensor is picking up a sinewave
  - "Lab1_Signal_Data.mat"
- The sensor has some linear drift and noise
- Your team's job is to remove the drift, then separate the signal from the noise and then estimate the signal to noise ratio
- All calculations will be done in MATLAB Live Editor
- Submit your Live Editor file in PDF format to the Assignments section of myCourses