Assignment 3

All assignment submissions are to be made on LEARN Quiz by 11:59 PM on the assigned due date. No extensions will be given, and assignments will not be accepted after the due date.

Problem Statement: Three 2D Anisotropic Magnetoresistor (AMR) sensors are used to measure the orientation of a permanent magnet. In an experiment, the magnet was rotated while its magnetic field direction was measured by three AMR sensors placed in close vicinity of each other.

See the data: **Assignmet3_data.mat**

Angle_new: indicates the orientation of the magnet (θ) in a 2D plane

$AMRij$: indicates ith AMR sensor jth axis

$i \in \{1,2,3\}, j \in \{x, y\}$;

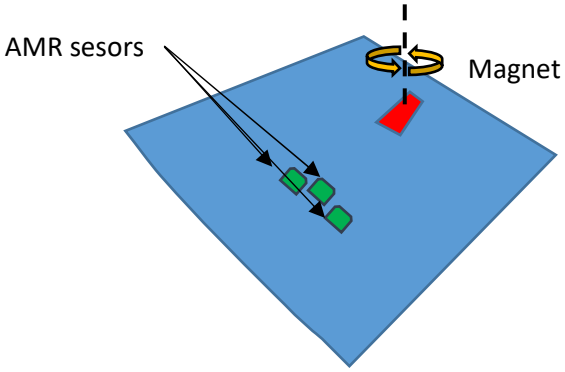

Figure 1. a schematic of AMR sensors and a parmanenet magnet.

For instance, $AMR2x$ includes the recordings of sensor 2's X channel and

$AMR3y$ includes the recordings of sensor 3's Y channel

A physical relation between the sensors channel measurements and orientation of the magent was obtained:

$$W_{i1}AMR_{ix} + W_{i0} = \sin(\theta)$$

$$W_{i3}AMR_{iy} + W_{i2} = \cos(\theta)$$

1. Using **ordinary least squares** and linear regression, find Ws for each of the three sensors.
   Note that you need to find 4 weights for each sensor.

Also note that θ is not a linear function of sensor reading, but its sin() and cos() are linear functions of sensor readings.

a. **Answer the question about the values of the weights.**

Angle estimators can then be built based on each sensor model

$$\hat{\theta}_i = atan2\left(\frac{W_{i1}AMR_{ix} + W_{i0}}{W_{i3}AMR_{iy} + W_{i2}}\right)$$

2. Build estimation of magnet angles based on each sensor separately, $\hat{\theta}_1, \hat{\theta}_2 \; and \; \hat{\theta}_3$.

   Compute the error for each estimator

   $$E_i = \theta - \hat{\theta}_i$$

   Compute each estimator's mean error and variance of error.

   a. **Answer the relative question to the performance of the estimators.**

3. Now fuse the three estimators using weighted sum fusion (See Weak 3, Lecture 8, recorded session 9) based on inverse of their error variance.

   a. **Answer the question regarding the fused estimator performance.**
   b. **Is the fused estimator's performance, both in the sense of variance and mean error, superior to Sensor 1 (AMR1 estimator)?**
   c. **Is the fused estimator's performance, both in the sense of variance and mean error, superior to Sensor 3 (AMR3 estimator)?**