Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**MAE 493G/ CpE 493M Mobile Robotics, Spring 2017**

**Homework #3 (10 Points)**

**Assigned: 02/03/2017 Due: 02/10/2017**

*Note: please properly document your homework (including MATLAB code) in a****Microsoft Word*** *file and upload it to* ***eCampus****.*

**Problem #1 (4 Points)**

Carefully read the attached article, “[*Sensor Performance Specifications*](http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=939939)*,*” by Dr. Dennis S. Bernstein and answer in details the following questions:

1. What are the important considerations when evaluating the performance of a sensor?
2. How to achieve better measurement performance with a given sensor?

**ANSWER:**

**1) When evaluating the performance of a sensor it is important to consider the following: input/output impedance, static and dynamic response, resolution, dynamic range, and sensitivity.**

**Ideally, a sensor will have low output impedance or high input impedance, to minimize the feedback into the system which can alter the information being relayed.**

**The dynamic response is how fast, the sensor responds to a changing input, the faster the response the better. The static response is the steady-state response of the sensor to a constant input, and is characterized by the static response curve.**

**2) Sensors can be calibrated to improve the measurement performance**

**Problem #2 (6 Points)**

A set of simulated ultrasonic rangefinder (Sonar) data is stored in the attached file (Sonar\_Cal\_Data.mat). The data is in raw format (i.e., unsigned integer with a 12 bit resolution). The data was collected at 10 positions where the sonar was 0.50m, 1.00m, 1.50m, 2.00m, 2.50m, 3.00m, 3.50m, 4.00m, 4.50m, and 5.00m from an object. At each position, 100 data points were collected (hint: take the average of the 100 points at each position when doing calibration)

1. Use the conversion method in Slide 17 of Lecture 6 to convert the raw data to distances in meters.
2. Perform a manual two-point calibration of the Sonar (using measurements at 0.50m and 5.00m) and write down all the steps.
3. Perform a multipoint calibration of the Sonar using MATLAB.
4. Provide a figure showing the sonar distance measurements before calibration, after two-point calibration, and after multipoint calibration. The figure should look similar to the example below but with three lines.



**ANSWER:**

mesDistRaw=(3.3\*(double(S\_rawdata)/4096))/0.252;

%% Two Point Calibration

halfmetercalavg=mean(mesDistRaw(1,1:100));

fivemetercalavg=mean(mesDistRaw(1,901:1000));

Cslope=(0.5-5)/(halfmetercalavg-fivemetercalavg);

Coffset=0.5-(halfmetercalavg\*Cslope);

mesDistCaltwopoint=Coffset+(Cslope\*mesDistRaw);

%% Multipoint Calibration

p=polyfit(double(S\_rawdata),mesDistRaw,1);

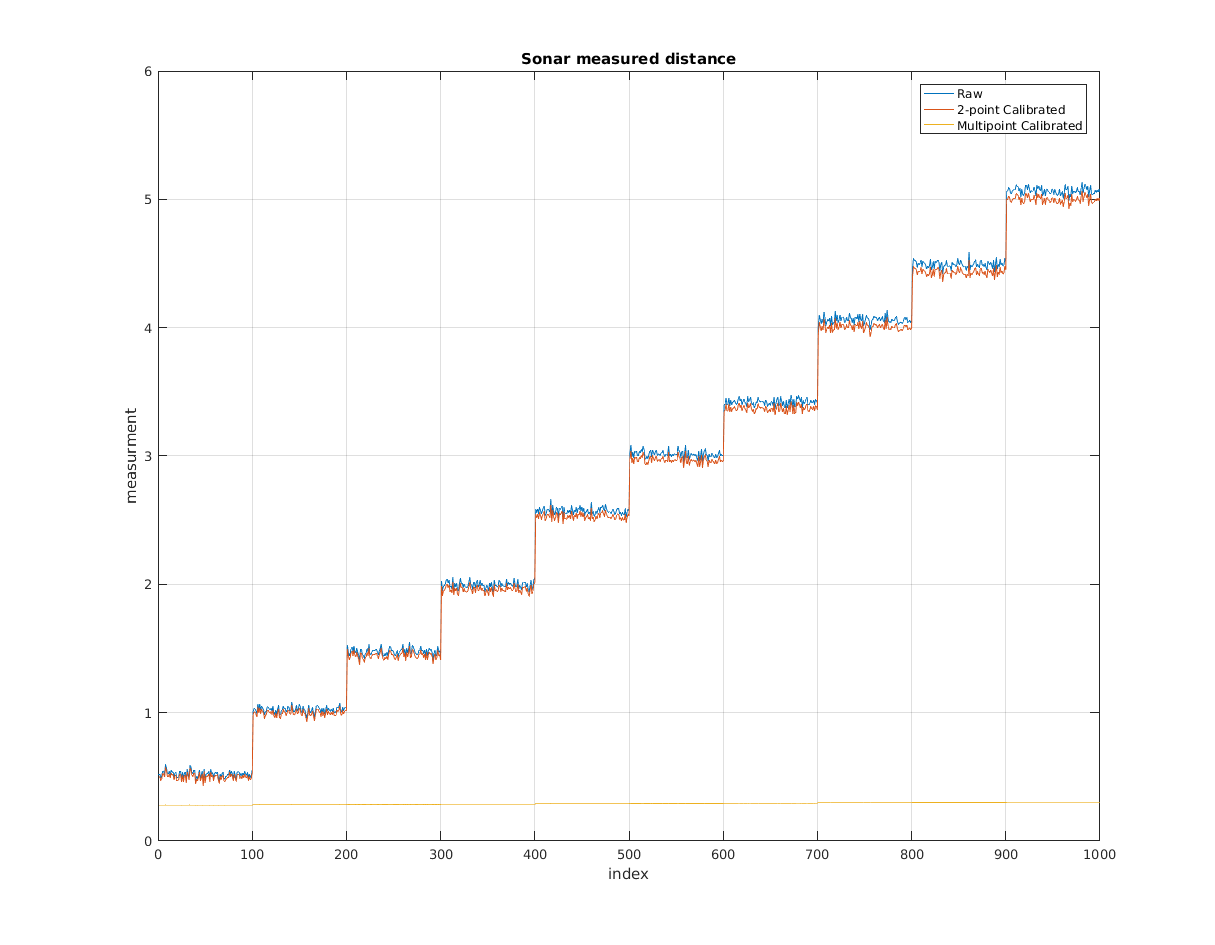
mesDistCalmultipoint=((mesDistRaw\*p(1))+p(2));

plot(1:1000,mesDistRaw,1:1000,mesDistCaltwopoint,1:1000,mesDistCalmultipoint);

legend('Raw','2-point Calibrated','Multipoint Calibrated');

title('Sonar measured distance');grid on

xlabel('index');ylabel('measurment');

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