Assignment 1

Sensors, Instruments and Experimentation 2021-22

Last date of submission: August 31, 2021

1. Curve fitting

The problem of curve fitting consists of finding an analytic equation between the variables x and y given the data points. Usually a polynomial is found, expressed as follows

$$y = a_0 + a_1 x + a_2 x^2 + - - - a_n x^n$$

And the curve fitting program finds the values of the coefficients a_0, a_1 etc.

Usually larger the number of coefficients better will be the fit. You will generally use the minimum number of coefficients so that error specification is satisfied. In some programming languages the function for finding the coefficients are available.

Excel also provides facility for curve fitting.

a. Now consider the following data and using Excel find the polynomial and plot the fitted curve. (Hint : Study the options on Scatter plot)
   In Excel, you can also check R^2 correlation coefficient value while finding a best fit. Coefficient value should be close to 1.

x	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
y	0	0.213	0.6	1.238	2.2	3.563	5.4	7.788	10.8	14.51	19

b. Now consider the equation of your best fitted polynomial curve. Find y values corresponding to each x value using the curve equation. Make a table of x and $y_{calculated}$=f(x). Find mean squared error and analyse whether your curve is a best fit or not.

   Mean Squared Error (MSE) is: $\frac{1}{n}\sum_{1}^{n}(y_{calculated} - y)^2$

   Where,

   $y_{calculated}$ refers to the values generated from the best fitted curve

   y refers to the desired values (it can be a desired outcome of a sensor)

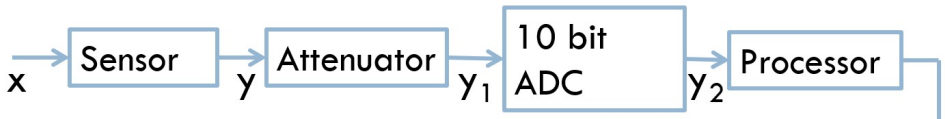
   Less the error better the fit it is!

c. Next consider the following set of x,y values
   When the characteristics is close to a straight line a best fit line is to be found

x	0	1	2	3	4	5	6	7
y	1	3.1	5	7.2	9	11	13	15

Curve fitting is important in the calibration of sensors.

2. Consider a block diagram below. Obtain the expression for Temperature (Temp) in terms of y_2 (ADC count) that a processor will use.



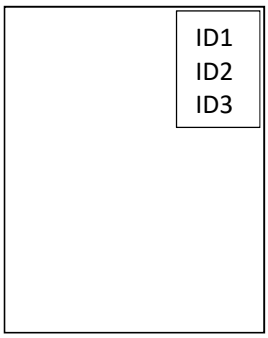
Temp	Y(mV)
-70	100
380	4800

ADC (A to D converter) input voltage range: 0 to 3.3 volts

Display Temp

Important note:

- Assignments will have to be submitted by each group of 3 students. A group will jointly work together and mutually submit only one assignment corresponding to that group. Multiple submissions from a single group will not be considered.
- Assignments will be graded contributing to 11% to your final grades.
- Assignments are to be submitted through LMS portal in PDF files only. Keep yourself updated with LMS.
- PDF file name has to be in the following format:
  "ID1<space>ID2<space>ID3.pdf"
- Also mention your ID numbers on the top right of your PDF submissions.



Should you have any doubts, reach out to me: Professor Sanket Patel