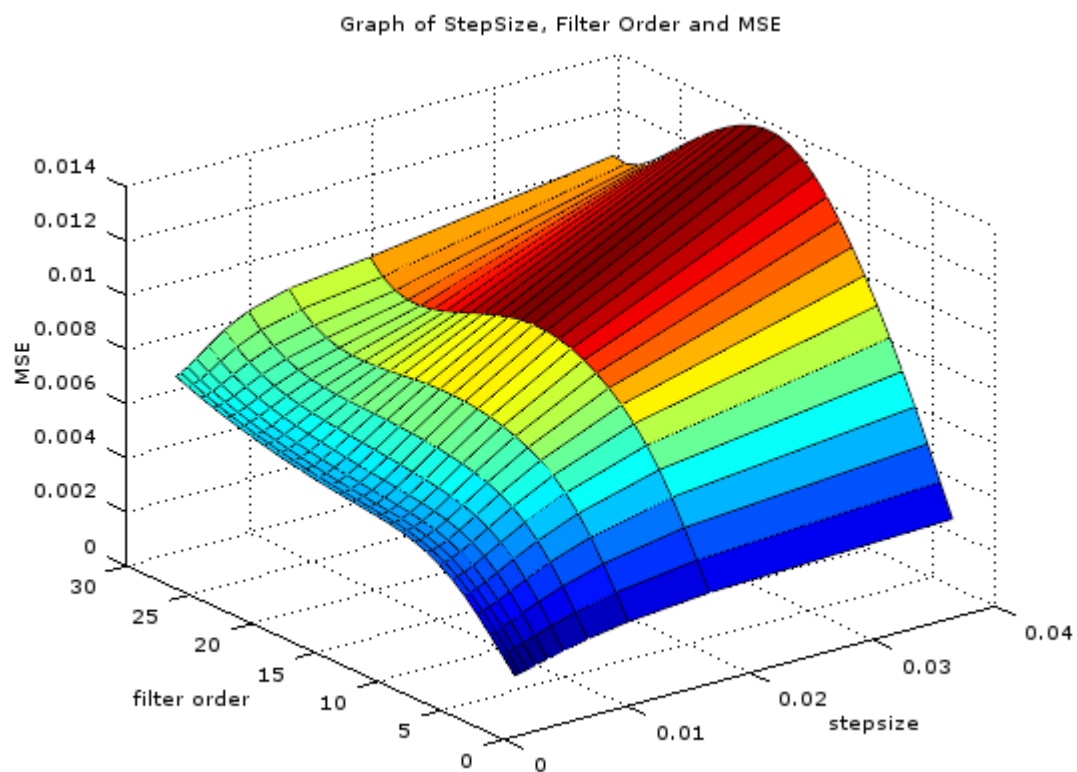


Q1)

Below is the plot of MSE , filter parameter and step-size.

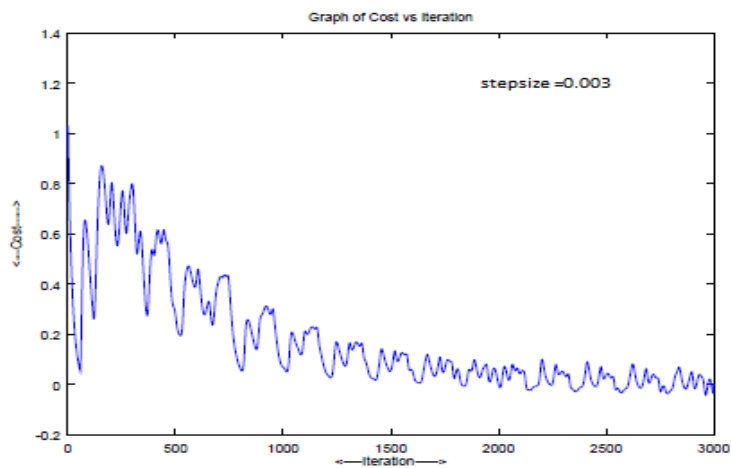


Step-size and filter order are related to each other as a proper combination of step-size and filter error gives us a specific Mean square Error (MSE). Also it is clearly seen from the graph that, different step-size and filter combination values have different MSE values.

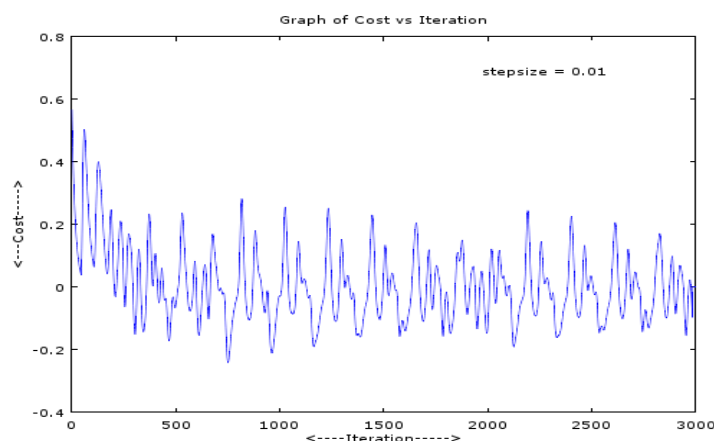
02) Below are the comparison details of learning curve:

The minimum error or minimum cost occurs at filter order 3 and step-size 0.003 . I have plotted more for two step-sizes with steps = 0.01 and 0.04 . Learning becomes slow as step-size increases

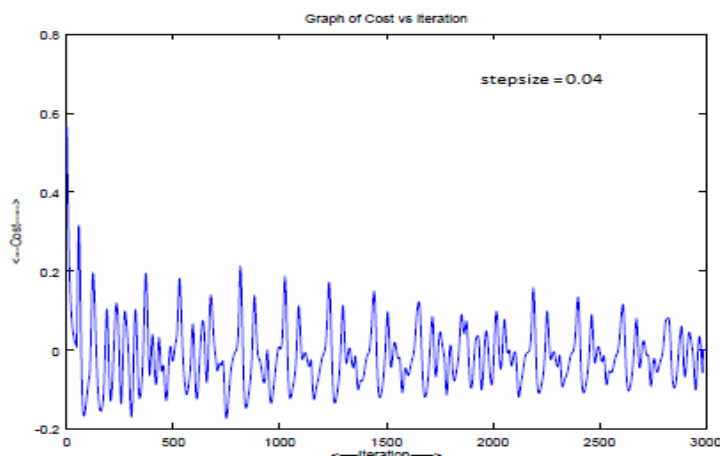
- Learning curve with step-size = 0.003 and filter-order 3.



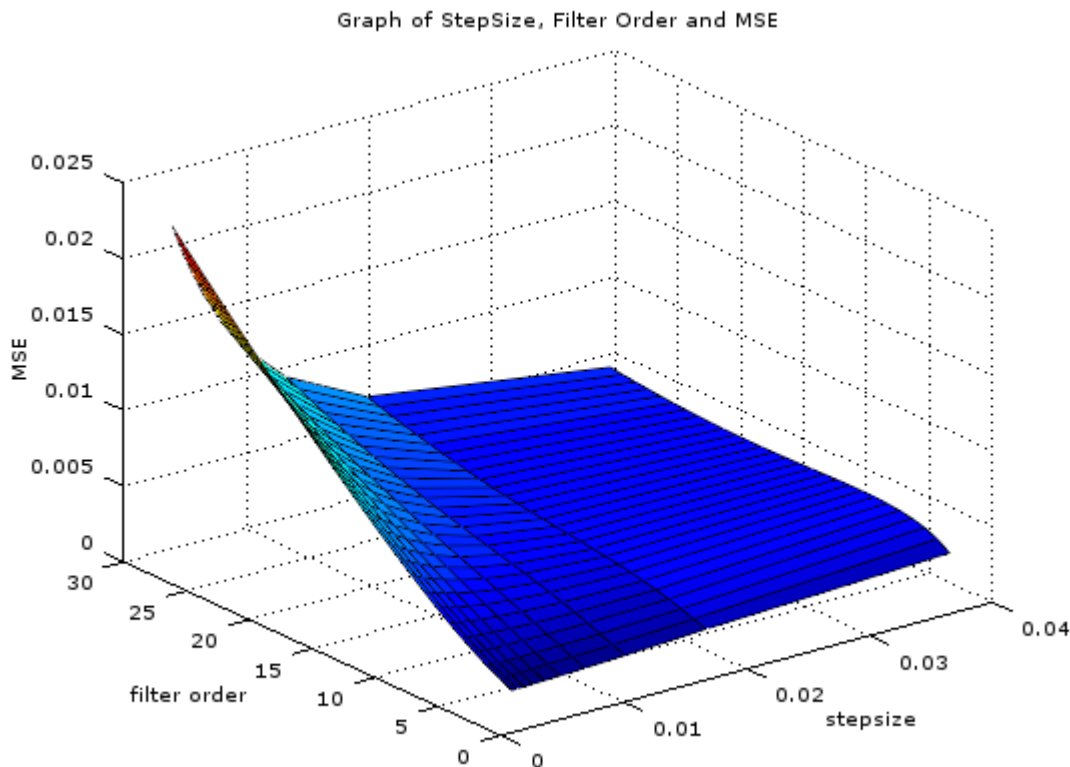
- Learning curve with step-size : 0.01 and filter-order 3.



- Learning curve with step-size : 0.04 and filter-order 3.



Q3) Here is the plot related to Normalized MSE algorithm.



Least Mean Square method is sensitive to scaled input. This makes it very difficult to choose a learning rate μ for stability of algorithm. NLMS is a variant of LMS that solves the problem by normalising the power of input. Also, one another primary disadvantage of LMS algorithm is having fixed step-size parameter for every iteration. This therefore requires understanding of input signal prior to commencing adaptive filtering operation. NLMS overcomes this by calculating the maximum step size value.

So, if we do not have any prior knowledge of input signal or input may be scaled, we should use NLMS without any hesitation.

04)

LMS algorithm works better than least squares, as minimum error for LMS algorithm is less than least squares. Also, least squares coefficients were generated using the data once and then used subsequently, with the assumption of stationarity. In other words design and utilization were decoupled. On contrast, LMS uses adaptive filters, where coefficients are continually adjusted on a step-by-step basis during filtering operation. Unlike the static least squares filter, which assume the stationarity of the input, adaptive filters can track slowly changing statistics in the input waveform.

References :

- 1) Discussion with friends – Kunal Bajaj, Ruturaj Zadbuke, Devyash Sanghai .
- 2) Hw2 help documents.

Note :

- 1) No code file has been attached as per request. Code for the questions have been programmed by myself completely.