**A Priority-Based Collaborative FLAF**

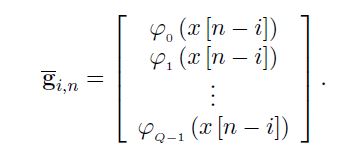
**Exploiting Different Functional Expansions**

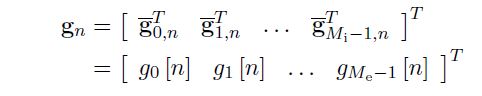
**Introduction**

We introduce FLAF an algorithm which is design to map signal into high dimensional feature space. In the project, we implement two variation of FLAF, namely CFLAF and PBCLAF in three different expansion type. Which are Chebyshev Polynomial expansion, Legendre polynomial expansion and trigonometric polynomial expansion type.

**Method**

First, we extract the input signal using the FLAF and convert into vector **x [[n]……….x [n-1]] T**using the FLAF. The FLAF has two part FEB (Function Expansion Block) and Function link Φ = [φ0 (·), φ1 (·), . . . , φQ−1 (·)]T.

First the input signal x[n] is pass through phi[n] it will give us sub vector the concatenation of the vector give us as an expanded buffer g[n] in R(Me). With Expanded buffer we as:



And, we computed output which is a dot product of linear weighted adaptive filter and gn (expanded buffer)

**Yf[n] = gTn.Wf, n-1**

We computed error signal which is given as:

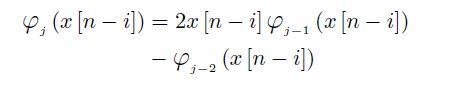
**ef [n]=df[n]-yf[n]**

This used for the adaptation of Wf,n. the Df,n is given as the desired output signal of the Nonlinear model the main of the FLAF model is based on the minimization of the mean squared error.

Expansion type explained as follows:

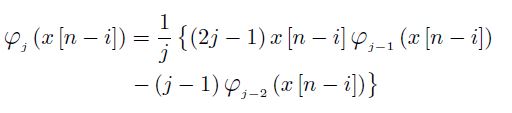
*Chebyshev polynomial expansion*

Chebyshev set of polynomial functions are endowed with powerful nonlinear approximation capability. The effectiveness of Chebyshev polynomial expansion is mainly due to the fact that it includes functions of previously computed functions.



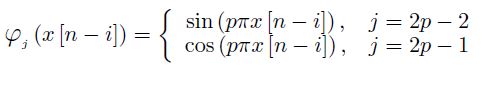
*Legendre polynomial expansion*

Legendre polynomial expansions have been used for applications like channel equalization, in which Legendre-based *quadrature amplitude modulation*

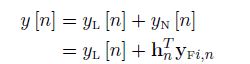
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*Trigonometric series expansion*

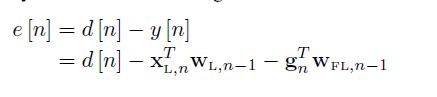
When trigonometric polynomials are used in upstream, i.e. before the adaptive filtering, the weight estimate will approximate the desired impulse response in terms of multidimensional Fourier series decomposition.



Collaborative FLAF (CFLAF), is composed of the FLAF, in this case it is defined by different expansion types, this composed of overall output YL (N) nonlinear one. This is computed for the output of the expansion type is given as:



Where h is known as shrinkage parameter in RL and L being the number of nonlinear path involved by the architecture. Each shrinkage parameter aims at weighting the output of the corresponding nonlinear FLAF, thus allowing it to be added or not to the overall output signal.

Priority-based CLAF (PBCLAF), is proposed based on a given order of properties, the PBCLAF is adapted by using a different error signal. The aim of PBCLAF using linear filter WLM, is minimize the overall error signal i.e. 

**EXPERIMENT**

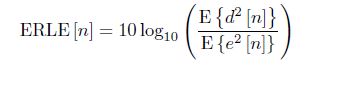
**Computation performance**

We have to truncate the input signal to 300 samples to compute performance FLAF on each of the expansion types. We found out that Chebyshev outperformed the other expansion CFLAF types and the Traditional NLMS.

In overall performance, using the shrinkage parameter, Trigonometric expansion of the CFLAF variant outperformed the Rest of the expansion.

**Computation Analysis in ERLE**

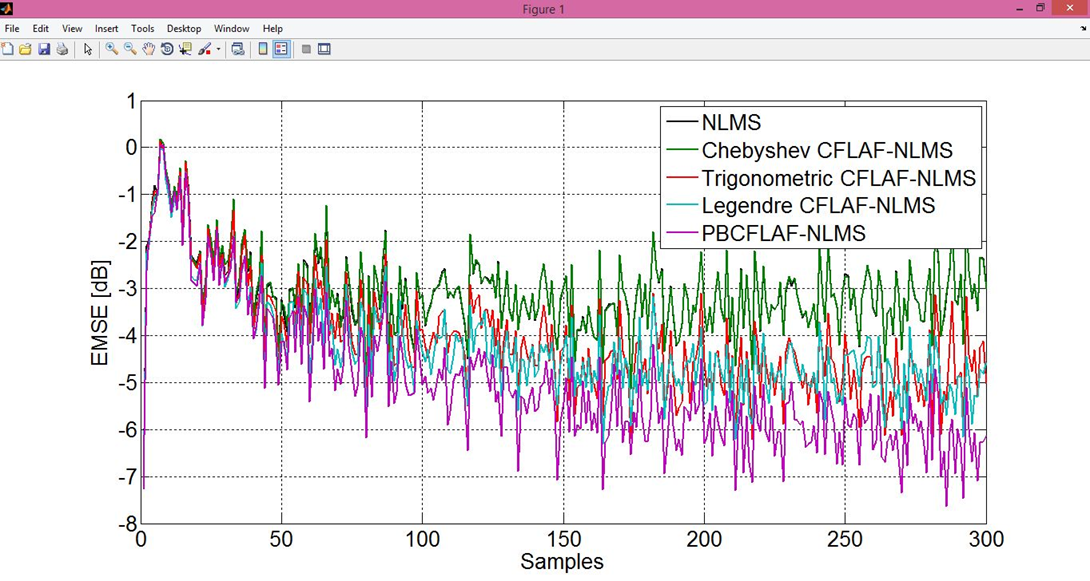
We computed the ERLE which is defined as the *echo return loss enhancement* (ERLE), which is the most significant index that is used in acoustic echo cancellation (AEC) applications. In this context, the ERLE measures the amount of echo signal, in decibels, which is cancelled from the microphone signal, and it is expressed as:



In these part, we computed the CFLAF variants to which of the CFLAF outperformed the other. At the end of our experiment, the Overall experiment showed the PBCLAF outperformed the rest of the CFLAF variants and their expansion types.

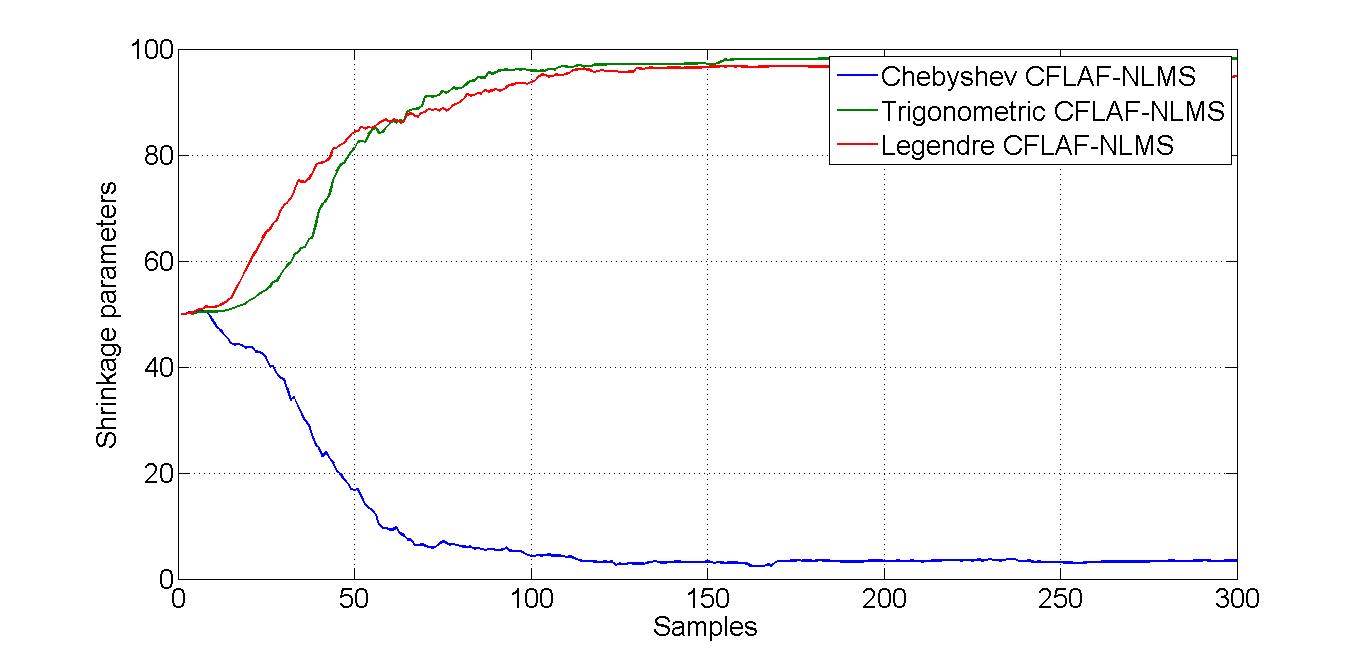
**EXPERIMENTAL RESULTS**

Overall performance of the Different variant of CFLAF and the Traditional NLMS



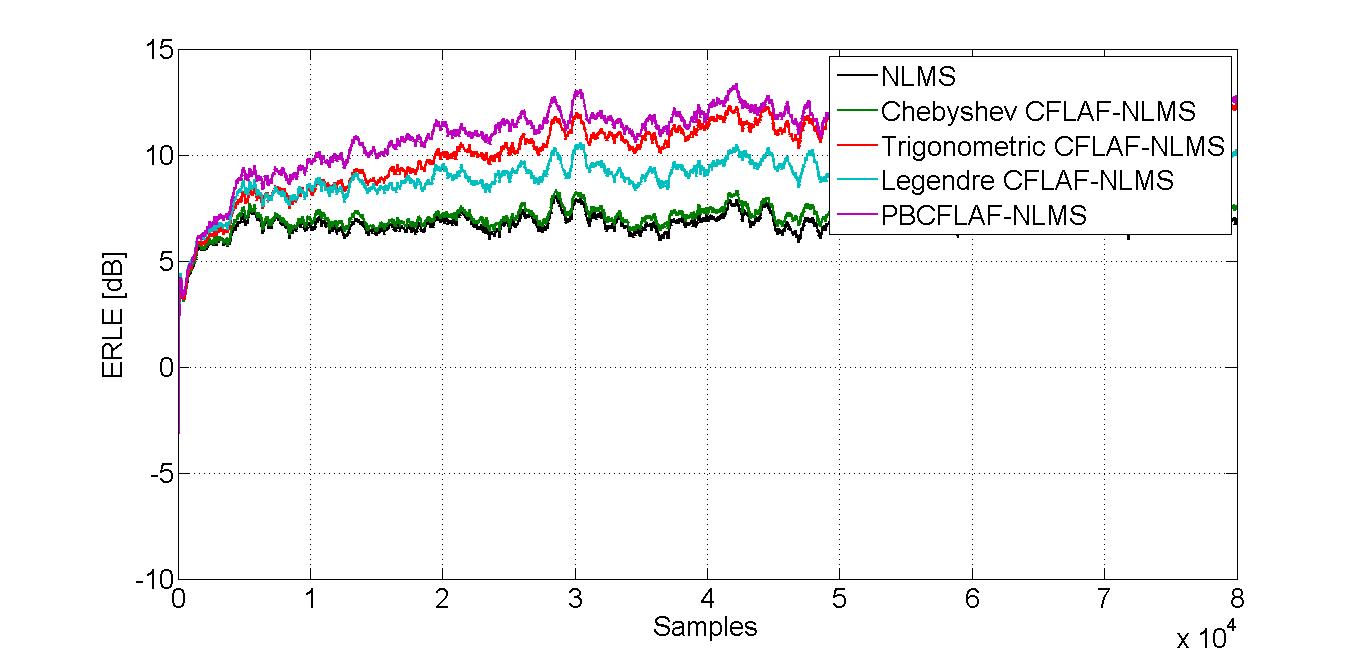
The result shows that PBCFLAF outperformed the rest of the CFLAF variant, in this experiment we selected the model 1, which is designed handle to the linear case.

**SHRINKAGE PARAMETERS (EMSE)**

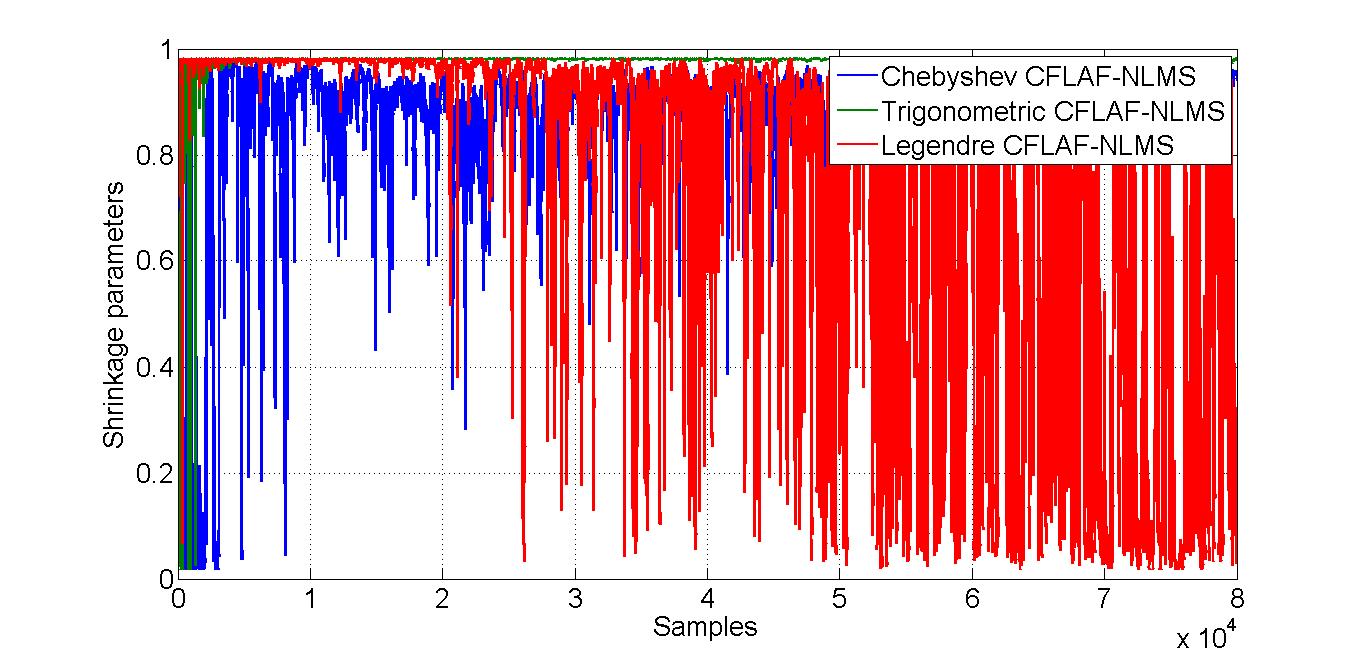


The different variant of the CFLAF-NLMS show that trigonometric expansion variant of the CFLAF outperformed the rest.

**ERLE Result(db)**



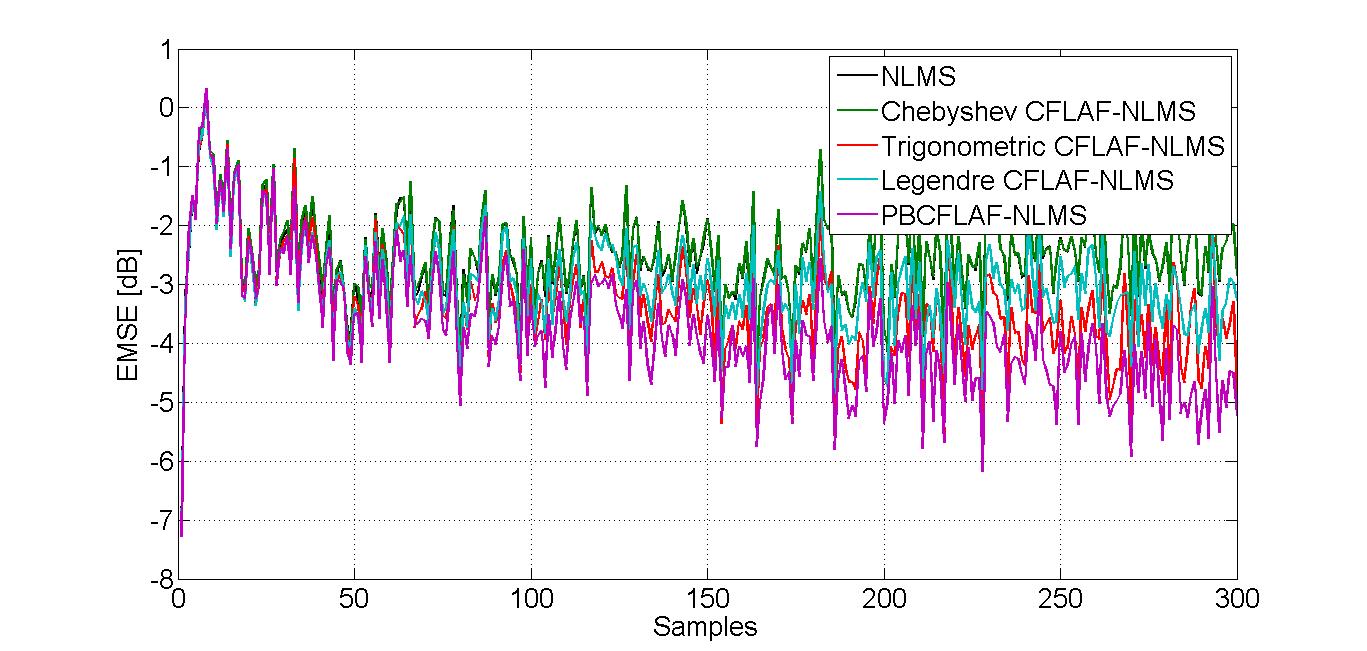
PBCLAF outperformed of the other FLAF variant and Chebyshev is almost the same as the traditional NLMS.



Using the shrinkage parameter to test the overall ERLE performance among the three Expansion type of the CFLAF variant, we can see the trigonometric outperformed the Legendre and Chebyshev.

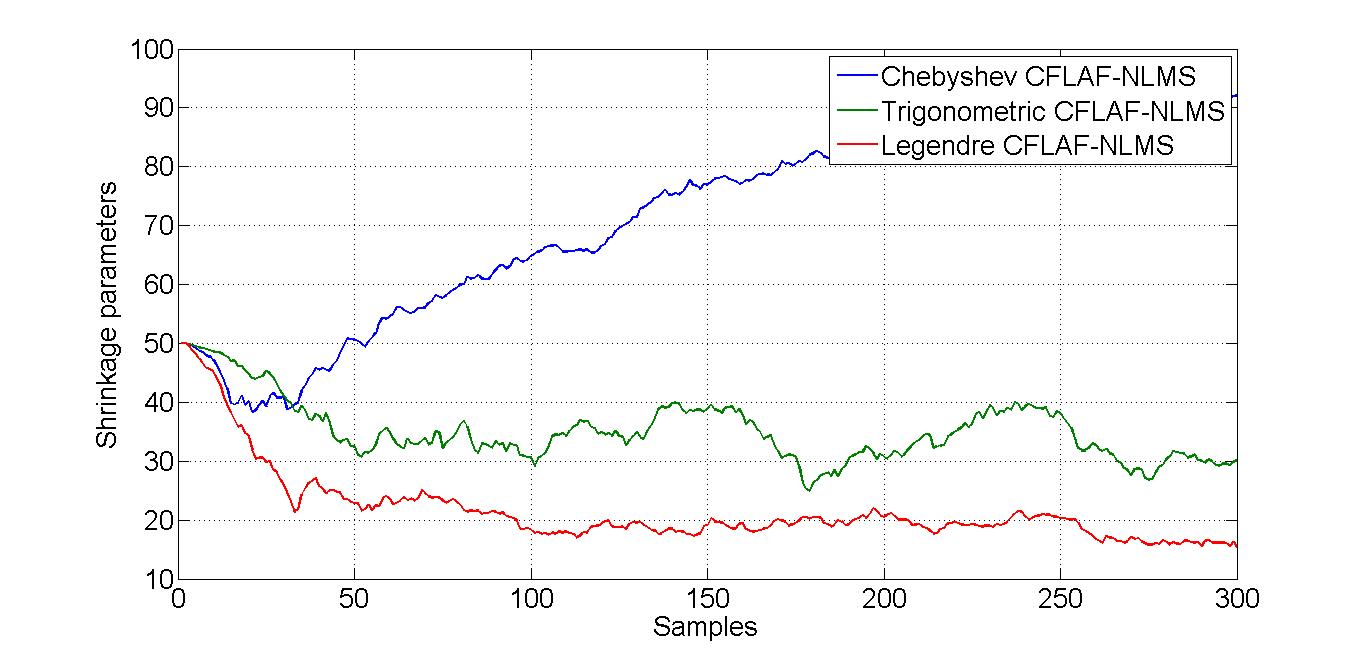
**SIGNAL GENERATION (SIGEN) –PERFORMANCE (EMSE)**

We change the signal generator to model one, we got different result but not too different from the first one.



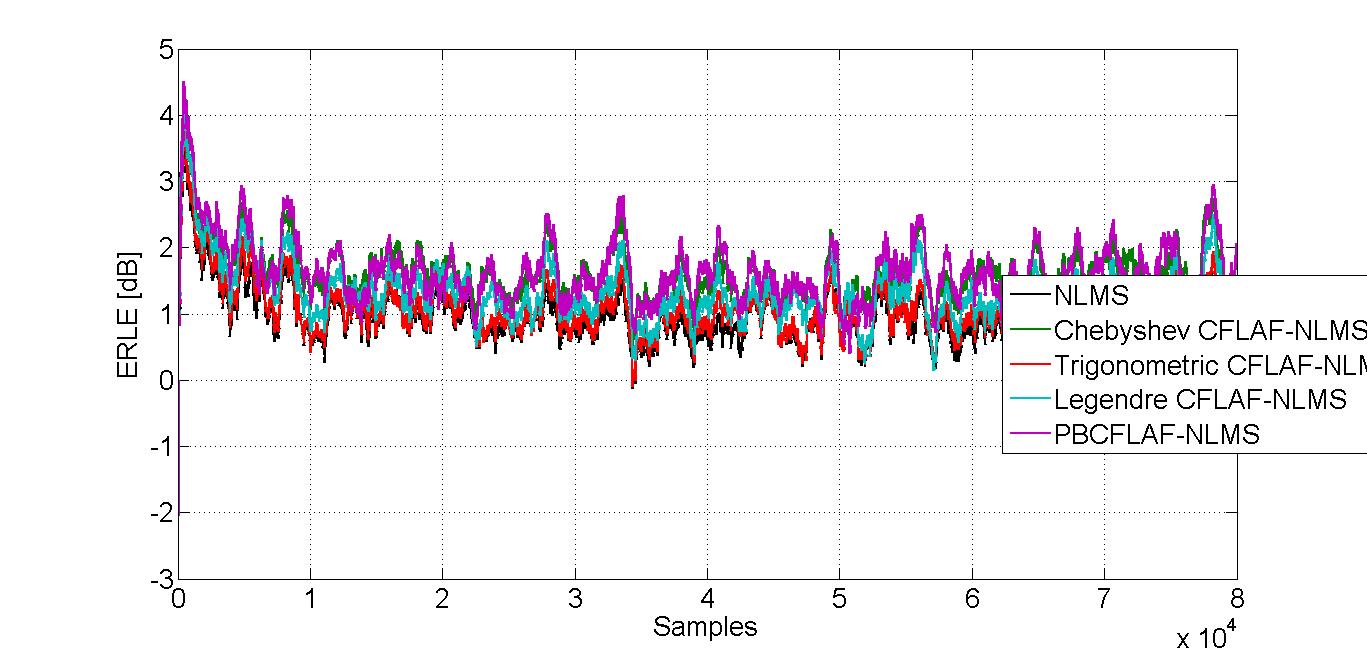
Changing the model of the signal generator we got a different result unlike the model result above whose signal generation is set to model 2, which designed to do a soft clipping of the signal using a 0.05 threshold. In the result, we can see the PBCFLAF has performed better than the other FLAF variant and traditional NLMS.

**SIGEN PERFORMANCE – (SHRINKAGE PARAMETER (EMSE))**



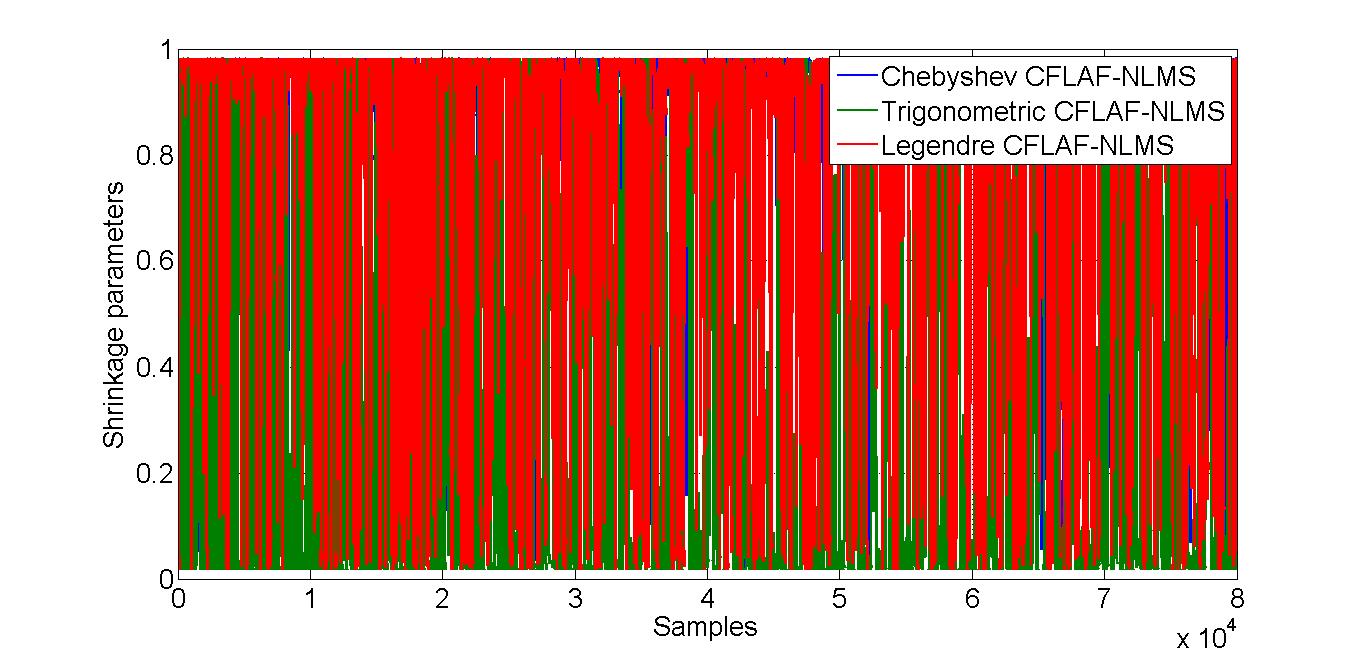
Changing the model of signal generator change into 1, we will see that the Chebyshev outperformed the other two expansion CFLAF-NLMS types.

**ERLE SIGNAL GENERATOR PERFORMANCE**



PBCLAF, barely outperformed the other variant of CFLAF-NLMS in ERLE evaluation when the sigen model is changed to 1 which is used for handling linear case signal generation .

**ERLE SIGNAL GENERATOR (SHRINKAGE PARAMETER) - PERFORMANCE**

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legendre CFLAF-NLMS outperformed the other CFLAF variant this pass through shrinkage parameters

**Conclusion**

Differently from other collaborative models, the proposed architecture allows an exchange of information between the involved FLAFs based on an order of priorities. The resulting model is efficiently capable of modelling nonlinearities regardless of their nature and the unknown system to identify. We also saw the performance of each FLAF variant in the three expansion types explained above and the end we can conclude that PBCFLAF has the best performance.