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RESEARCH ARTICLE

Variable Step-size least mean squares adaptive filters

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Abstract

In this article introduces a new method to improve the performance of Least Mean Square algorithm (LMS); LMS algorithm is studied by choosing proper variable step size. The Least Mean Square works on the principal of Variable step size which generates error and step size. The part of the data is return back to the input to suppress the noise adaptively. The VSSLMS simulations result shows that its rate of speed and Mean Square Error (MSE) are better compared to other algorithms.

The advanced digital transmission generates inter symbol interference. These inter symbol interference (ISI) elements are eliminated by using FIR (finite impulse response) and LMS (least mean square) filters. For easy implementation and flexibility of LMS has given scope for study and research into this extensive field, leading to its implementation in many applications. LMS algorithm can speed up and reduce Steady state MSE at considerable height but they failed to analyze the optimality of variable step size LMS. The rate of speed of convergence of coefficients to reach an optimum values are known as speed of convergence.

The use of VSSLMS (Variable step size least mean square) is found in digital transmission and mobile communication systems [1]. LMS algorithm works on the principle of steepest gradient. In Reference paper [2] presented that VSS (variable step size) is directly proportional to error.

In this paper a variation of gradient adaptive step-size LMS algorithms is presented. The previous study proposes a simplification to a class of the studied algorithms [3]. In reference [4] the VSSLMS proposed based on weighting coefficients bias/variance trade off. Reference [5] this VSSLMS is verified with Gaussian data. In the literature Survey discussed the VLMS using step size data. This new concept of variable step size dependent current time [6].

Related work

This article introduced a new method to reduced the MSE and improve the speed of convergence using LMS algorithm with VSS. The LMS runs iteratively thus MSE reduces to zero and improves the speed of convergence. In this article the step size of an LMS algorithm adjust accordingly with the coefficients. The proposed algorithm results shows improved version of an earlier algorithm. The following equations show the variable step size LMS when mean square error is almost zero.

$$e(n) = d(n) - XT(n) * W(n) \quad \text{------ (1)}$$
$$W(n+1) = W(n) + \mu e(n) X(n) \quad \text{------(2)}$$

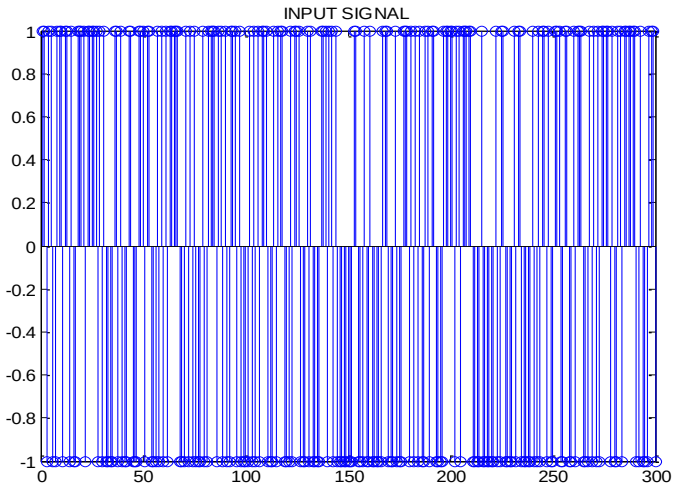
where step is μ, input vector is X(n) , is the coefficient vector of the filter is W (n), d(n) is the expected output value e(n) is the deviation error.

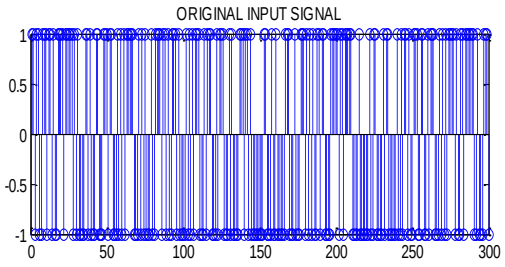
For choosing the step size which decides the optimum value that should be half of the step size. Step size must be chosen in such way that it should not decrease the rate of speed and Mean Square Error.

Simulation resulst

To see the performance of EVSSLMS, for channel, number of taps selected for equalizer 18 is taken. Input signal contains total 300 samples generated randomly through uniform distribution shown in Fig (1). Gaussian noise having zero mean and 0.01 standard deviation added with input signal as shown in Fig (2).channel characteristics is given by the vector.
[0.05 -0.063 0.064 -0.087 0.088 -0.126 0.127 -0.023 -0.25 0.9047 0.25 0 0.126 0.038 0.088 0.89 0.90]

After the VSSLMS execution the Signal to noise ratio is 13.0103 this due to noise in the input signal is more and large number of coefficients





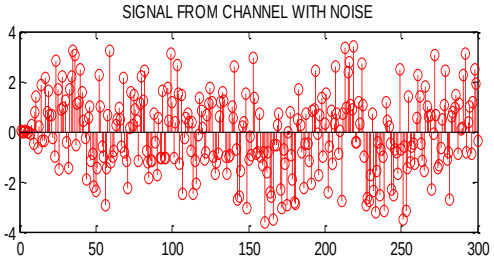


Fig.1.Gaussian noise having zero mean and 0.01 standard deviation

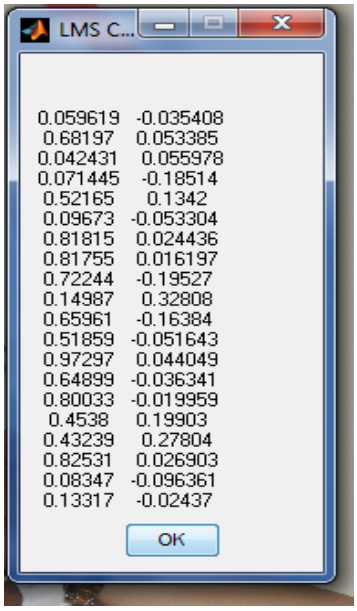


Fig.2. LMS coefficients and corresponding CPU execution

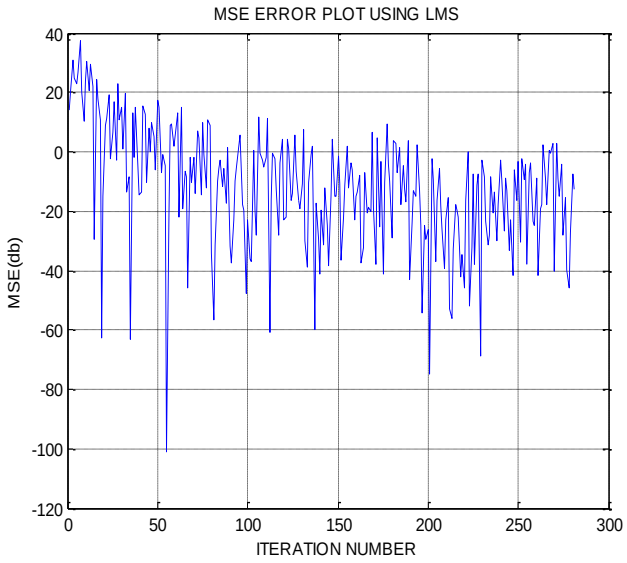


Fig.3. Channel characteristics

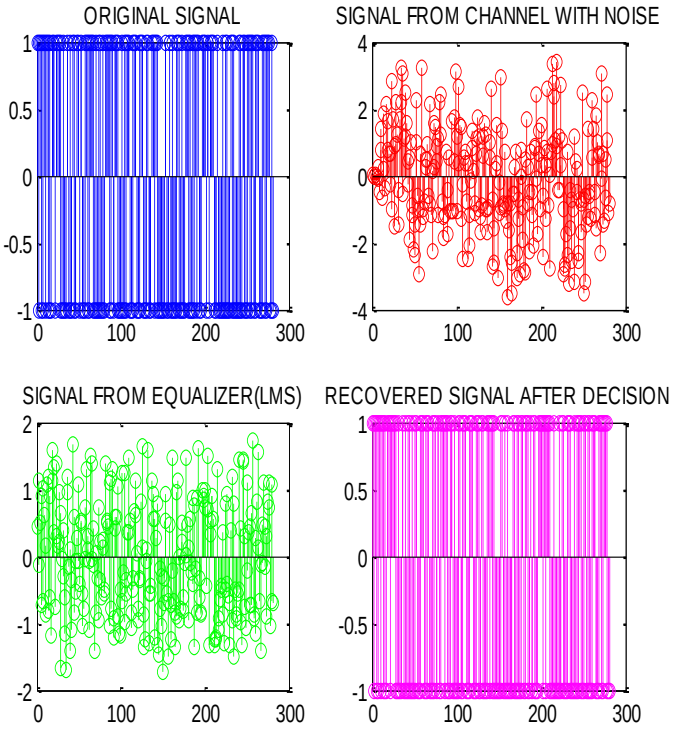


Fig.4 Channel characteristics with Noise suppression out put

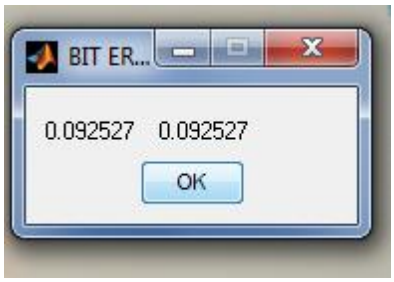


Fig 5.Bit error rate for large number of coefficients

conclusion

This article presents the VSSLMS algorithm based on the Error feedback system. It could adjust the parameters through

the introduction of error factor and solve the manual setting problems for parameters in adaptive fitlers, and the step-size regulating strategy could become more reasonable. The verification on simulation platform shows that the VSSLMS algorithm has the higher convergence rate and higher accuracy than algorithm in Reference [4], meanwhile, the feasibility and superiority was verified.

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