International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Maximum Likelihood Noise Power Estimation of Sc-Fdma Systems

Y. Girisree[1], S. Abdul Sameer[1], G. Akhila[1], Dr. Ravi Tiwari[2]

[1]UG student, Electronic and Communication Engineering, Madanapalle
[2]Faculty of Electronic and Communication Engineering, Madanapalle

ABSTRACT-

The problem of noise power estimation for single-carrier frequency-division-multiple-access (SC-FDMA), which is employed in long-term evolution, is addressed in this study (LTE). In wireless communication systems, the Signal to Noise Ratio (SNR) or Noise Power is an important quantity. The signal-to-noise ratio (SNR) is the proportion of desired information (signal power) to undesired information (background noise power). It can be utilized in a variety of wireless systems applications, including determining connection quality for adaptive modulation and coding. Using the Maximum likelihood estimation (ML), the noise power will be estimated.

Keywords-SNR, noise power estimation, SC-FDMA and ML.

I. INTRODUCTION

The signal-to-noise ratio (SNR) or noise power plays a very important role in wireless communication systems. The more the ratio is the more the quality of the signal.So, determining the SNR will also explain about the quality of the signal. It isalso used in wireless systems to know link quality for adjustive modulation and commit to writing, and many other things. There are several methods to assess the SNR or noise power at the receiver. These methods will be divided into two groups: data-aided (DA) and non-data-aided (NDA).

In Data-aided approach the transmitted signals are known at the receiver. Normalmaximum-likelihood (ML) estimation will be utilized in this case [4]-[8]. Maximum likelihood estimate is a method for determining the values of a model's parameters. The parameter values are chosen to maximize the probability that the model's described process produced the data that were observed.ML estimation has many advantages. Some of which are,It uses a consistent yet flexible methodology that makes it suited for a wide range of applications, including those in which other models' assumptions are broken. In bigger samples, it yields unbiased estimates.Efficiency is one measure of an estimator. An efficient estimator is the one that has a small variance or mean-squared error.In orthogonal-frequency division multiplexing (OFDM) systems, continuous coaching symbols are used to assess noise power. To estimate noise power, the method uses two sequential OFDM coaching symbols. Because it does not require channel information, it will be executed before channel estimation. A similar concept has also been used to plan several single-carrier (SC) systems.

Single-carrier FDMA (SC-FDMA) is a frequency-division multiple access scheme. It is also called linearly precoded OFDMA (LP-OFDMA).Like other multiple access scheme, it deals with the assignment of multiple users to a shared communication resource.In [14], an overall comparison of moment-based techniques is offered. In addition to the methods described above, the expectation-maximization (EM) algorithm can be used to acquire the necessary noise power in the presence of unknown data symbols [3], [8], and [14]. We look at noise power estimation for SC frequency-division-multiple-access (SC-FDMA), which is employed in the uplink of long-term evolution (LTE) [12]. SNR may be simply calculated from noise power if the channels are known. The base station requires uplink SNR for rate adaptation and many other purposes [2]. Existing SNR estimate methods, on the other hand, cannot be directly applied to SC-FDMA signals. If all of the subcarriers are allocated, the discrete Fourier transform (DFT) precoding transforms the SC-FDMA signal into a Gaussian-like random variable.ML estimation will be used to estimate the noise power in SC-FDMA systems.
The rest of this article is organized as follows. After the system model is introduced in Section II, noise power estimators are discussed in Section III. Then numerical results are presented in Section IV. Finally, conclusions are drawn inSection V.

II. SYSTEM MODEL

The received SC-FDMA signal at the kth sub-carrier of the nth block for the user of interest can be presented by

$$y[n, k] = H[n, k]s[n, k] + w[n, k] \quad (1)$$

where H [n, k] means the channel frequency response to the k-th of the n-th block network, as well as the w [n, k] is a compatible addition to white Gaussian sound with zero meaning and contrast σ2w. If all subcarriers are assigned to a user who is interested in them, the transmitted signal, after the DFT encoding, may be displayed as

$$s[n,k] = \frac{1}{\sqrt{k}} \sum_{m=0}^{k-1} x[n,m] e^{-j\frac{2\pi mk}{k}} \quad (2)$$

when x [n, m] displays the m-th data symbol in the n-th block at a rate of zero with unit variance. Note that we assume that the user who is interested in it provides all sub-carriers for easy forwarding. The proposed scale can also be employed in cases where the user can only use a portion of the bandwidth available. The transmission signal s [n, k] in [2] is a linear combination of several data signals. As a result of the large number law [14], it becomes a randomly distributed Gaussian variation with unit variance and zero mean. If the transmit symbols for various n's and m's are independent, the

$$E(s[n,k]s^*[n1,k1]) = \delta[n-n1]\delta[k-k1] \quad (3)$$

where $\delta[\cdot]$ is the Kronecker delta function.

Since wireless channels are usually time-varying and with frequency selectivity, SNRs for different subcarriers or blocks will be different. SNR at the n-th block of the k-th subcarrier is defined as

$$\gamma[n,k] = \frac{|H[n,k]|^2}{\sigma_w^2} \quad (4)$$

In order to quantify γ [n, k], we only need to estimate sound power σ_w^2, if the channel, H [n, k], is known. As a result, the SNR rating in this case is converted to sound power estimation.

III. ML ESTIMATOR

Assume N different signals that are received at the,

$$p(y(n,k)) = \frac{1}{\pi(\mathcal{H}^2+\sigma^2)} e^{-\frac{y^2}{\mathcal{H}^2+\sigma^2}}$$

Multiply π on both sides

$$\pi p(y(n,k)) = \pi \frac{1}{\pi(\mathcal{H}^2+\sigma^2)} e^{-\frac{y^2}{\mathcal{H}^2+\sigma^2}}$$

$$= \text{-N}\log_{10} \pi(H^2+\sigma^2) - \sum_{n=0}^{N-1} \frac{y^2}{H^2+\sigma^2}$$

differentiate with respect to σ^2

$$= -N \frac{1}{(\mu^2+\sigma^2)} + \sum \frac{y^2}{H^2+\sigma^2}$$

$$= \frac{-N}{H^2+\sigma^2} + \sum \frac{y^2}{H^2+\sigma^2}$$

$$\frac{N}{H^2+\sigma^2} = \sum \frac{y^2}{H^2+\sigma^2}$$

$$H^2+\sigma^2 = \frac{1}{N}\sum y^2$$

$$\sigma^{\wedge 2} = \frac{1}{N}\sum y^2 - H^2$$

Now for mean we have to take expectation:

$$E[\sigma^{\wedge 2}] = E\left[\frac{1}{N}\sum y^2\right] - [H^2]$$

$$E[\sigma^{\wedge 2}] = \sigma^2$$

$$Variance\ [\sigma^{\wedge 2}] = \frac{1}{N} var(\sigma^2)$$

IV. NUMERICAL RESULTS

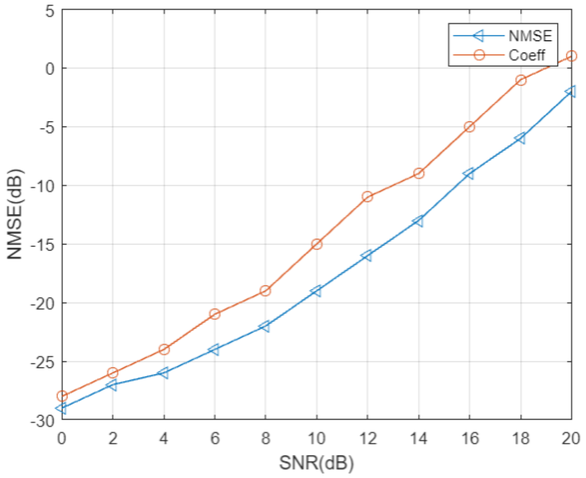

Fig. 1.Normalized Mean Square Error vs SNR

In MATLAB. In Fig.1 In MATLAB. In Fig.5.41 the Normalized mean Square Error is plotted against SNR for different values of N and it is observed that the SNR increases as Normalized Mean Square Error decreases.

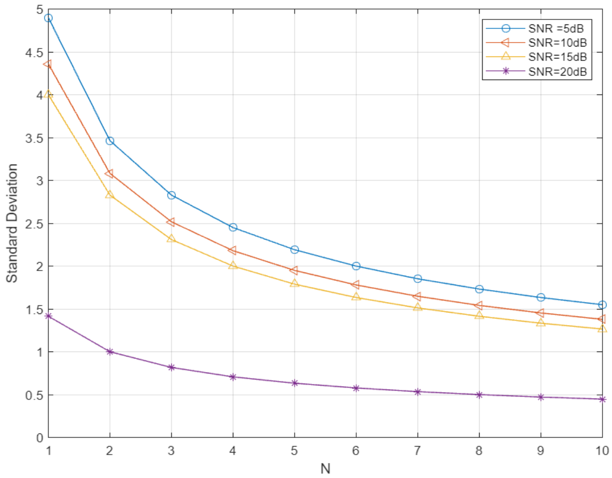

Fig.2. ML for different number of observations N and fixed SNR

In MATLAB. In Fig.5.42 the ML is plotted for different values of N while SNR is fixed at 5dB,10dB,15dB,20dB respectively. It is observed that the Standard Deviation decreases as N increases.

V. CONCLUSION

We developed ML estimator fordetermining the noise power in SC-FDMA systems. Their performance in error-free operations has been explored. The derivation proves that the standard deviation decreases as the number of samples increases. The normalized mean square error decreases as the SNR increases. AndThis research indicates that by incorporating a digital data receiver into ML estimators for SNR, the best performance of ML estimate of SNR may be attained with the least amount of effort.This proves that if number of samples increases the standard deviation decreases.

REFERENCES

[1] A.Goldsmith,*WirelessCommunications(Chineseversion)*.Beijing,China:PostsandTelecomPress, 2007.

[2] F. D. Calabrese, “Scheduling and link adaptation for uplink SC-FDMAsystems-A LTE case study,” Ph.D. dissertation, Dept. Electron. Syst.,AalborgUniv.,Aalborg,Denmark,Apr.2009.

[3] M. A. Boujelben, F. Bellili, S. Affes, and A. Stéphenne, “SNR estima-tion over SIMO channels from linearly modulated signals,” *IEEE Trans.SignalProcess.*,vol.58,no.12,pp.6017–6027,Dec.2010.

[4] D. R. Pauluzzi and N. C. Beaulieu, “A comparison of SNR estimationtechniquesfortheAWGNchannels,”*IEEETrans.Commun.*,vol.48,no.10,pp.1681–1691,Oct. 2000.

[5] C.L.NikiasandA.P.Petropulu,*Higher-OrderSpectraAnalysis*.EnglewoodCliffs,NJ,USA:Prentice-Hall,1993.

[6] Y. Liu, G. Y. Li, Z. Tan, and H. Hu, “MAP based iterative channelestimation for OFDM systems: Approach, convergence and performancebound,” *IEEE Trans. Wireless Commun.*, vol. 13, no. 1, pp. 476–484,Jan.2014.

[7] S.M.Kay,*FundamentalsofStatisticalSignalProcessing,VolumeI:EstimationTheory*.EnglewoodCliffs,NJ,USA:Prentice-Hall,1993.

[8] A. Papoulis and S. U. Pillai, Probability Random Variables and Stochastic Process. New York, NY, USA: McGraw-Hill, 1991.

[9] G. Ren, H. Zhang, and Y. Chang, “SNR estimation algorithm based on the preamble for OFDM systems in frequency selective channels,” IEEE Trans. Commun., vol. 57, no. 8, pp. 2230–2234, Aug. 2009.

[10] S. Boumard, “Novel noise variance and SNR estimation algorithm for wireless MIMO OFDM systems,” in Proc. IEEE GLOBECOM, 2003, pp. 1330–1334.

[11] J. Coon, M. Sandell, M. Beach, and J. McGeehan, “Channel and noise variance estimation and tracking algorithms for unique-word based single-carrier systems,” IEEE Trans. Wireless Commun., vol. 5.

[12] B. Jiang, W. Wang, and X. Gao, “Polynomial-based noise variance estimation for MIMO-SCBT systems,” IEEE Signal Process. Lett., vol. 16, no. 6, pp. 497–500, Jun. 2009.

[13] F. Bellili, R. Meftehi, S. Affes, and A. Stephenne, “Maximum likelihood SNR estimation of linearly-modulated signals over time-varying flat-fading SIMO channels,” IEEE Trans. Signal Process., vol. 63, no. 2, pp. 441–456, Jan. 2015.

[14] T. A. Summers and S. G. Wilson, “SNR mismatch and online estimation in turbo decoding,” IEEE Trans. Commun., vol. 46, no. 4, pp. 421–423, Apr. 19.