Y. Bhavani Shankar, J.Chandrasekhar Rao, B.Anil Babu / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com
Vol. 2, Issue 3, May-Jun 2012, pp.2561-2563

An Improved SNR Estimation Approach for OFDM System

Y. Bhavani Shankar[1] **J.Chandrasekhar Rao**[2] **B.Anil Babu** [(3)]
[1] M.Tech Student, Department of ECE, KL University, AP, India.
[2]Assistant Professor, Department of ECE, KL University, AP, India.

ABSTRACT: Estimation of signal to noise ratio for the received signal is an important task in communication systems. In this paper, a novel approach for such estimation that uses zero point auto-correlation of received signal per block and auto cross-correlation of decision feedback signal in orthogonal frequency division multiplexing (OFDM) system. The performance of the method is verified qualitatively and they show a stable performance when compared with earlier methods when applied under higher modulation schemes.

Keywords: OFDM, SNR Estimation, Auto correlation, AM

I.INTRODUCTION

Knowledge of the signal-to-noise ratio (SNR) is a requirement in many communication systems in order to perform efficient signal detection and/or link adaptation. A number of non-data-aided (NDA) SNR estimators, have been proposed for constant modulus (CM) constellations. Most of them, however, cannot be applied to non-CM constellations. Decision directed (DD) can be used by substituting the true transmitted symbols by the outputs of the decoder. Maximum likelihood estimator is one of DA estimator, and squared signal-to-noise variance (SNV), Although ML estimators provide good statistical performance, and they tend to be computationally intensive. Under a different classification, I/Q-based estimators make use of both the in-phase and quadrature components of the received signal, and thus require coherent detection; in contrast, envelope based (EVB) estimators only make use of the received signal magnitude, and thus can be applied even if the carrier phase has not been completely acquired. The more signal has high modulation level, therefore, the more SNR estimation is difficult when we compare simple modulation signal such as binary phase shift keying Type II SNR estimation method estimates SNR using zero point correlation relation of received signal based on fourth moment with square of zero point auto-/cross-correlation of transmit and receive signal. Zero point auto-/cross correlation are given as

$$r_x^2(0) = E[x(n)x(n)^*]^2=S^2 \qquad (9)$$

(BPSK) with M-ary amplitude and phase shift keying quadrature amplitude modulation (QAM) modulation signal. Even if SNR estimation algorithm could apply efficiently to BPSK signal, there is much difficulty just as it is about high dimensional signal. There for a new estimator is required, for this a novel method is proposed in this paper

II.CORRELATION BASED SNR ESTIMATION

Let the received signal be

$$y(n)=x(n)+w(n) \qquad (1)$$

Where ***x(n)*** is the original transmitted and w(n) be the Gaussian noise with zero mean and uncorrelated with the signal. The auto correlation of the measured data is given as

$$r_y(k,l)=r_x(k,l)+r_w(k,l) \qquad (2)$$

let m=k-l then the above equation can be transformed as $r_y(m)=r_x(m)+r_w(m)$ (3)

Since the white Gaussian noise is a zeros mean which is un correlated resulting to

$$r_w(m)=\sigma^2\zeta(m) \qquad (4)$$

Where σ^2 is the variance of the noise then the SNR of the received signal can be defined as

$$\rho=\frac{E[|x(n)|2]}{\sigma^2} \qquad (5)$$

Let us consider that we transmitted symbols like {-a ,a} with equal probability in to random/fading channel auto correlation value of transmitted and received signals are as follows

$$r_x(0)=E[x(n)x(n)^*]=2a^2=S \qquad (6)$$

$$r_y(0)=E[y(n)y(n)^*]=2a^2+2\sigma^2=S+N \qquad (7)$$

There for SNR based on auto correlation is given as

$$\hat{\rho}=\frac{S}{N}=\frac{r_x(0)}{r_{y(0)}-r_{x(0)}} \qquad (8)$$

This method is mentioned as Type 1 throughout this paper and under Rayleigh flat fading channel it is termed as Extended Type-1

$$r_y^2(0) = E[y(n)y(n)^*]^2=(S+N)^2 \qquad (10)$$

$$r_{xy}^2(0) = E[x(n)y(n)^*]^2=S(S+N) \qquad (11)$$

SNR based on fourth moment can calculate as auto-cross correlation relation of transmit and receive signal, and is derived as follows.

$$\hat{\rho} = \frac{S}{N} = \sqrt{\frac{r_x^2(0)}{r_y^2(0) - 2r_{xy}^2(0) + r_x^2(0)}} \qquad (12)$$

III SNR ESTIMATION IN OFDM SYSTEMS

The, transmit signal of general OFDM (orthogonal frequency division multiplexing) is given by

$$x(t) = \sum_{k=0}^{k-1} X_k e^{2\pi f k t} \qquad (13)$$

Where K is total sub-carrier number, Ts is symbol duration, frequency of sub-carrier is fk=k/KTs, and t *is n·Ts (n=0,…, K-1). Also, Xk is data symbol at k-th sub-carrier.*

To simplify analysis of system, communication channel assume to AWGN

$$r(n) = x(n) \otimes h(n) + w(n) \qquad (14)$$

Considering AWGN channel to analyze mathematically, channel response $h(n)$ equals to 1 and phase synchronization supposes to be perfect. After removing cyclic prefix, after FFT, the recovered output for the k-th sub-carrier is as follows

$$Y_k = \frac{1}{\sqrt{K}} \sum_{n \in K} r[n].e^{j\frac{2\pi}{K}kn} = X_k + N_k \qquad (15)$$

SNR estimation method of this paper requires zero point auto-correlation of transmitted and received signal in OFDM system. In this paper, we can calculate autocorrelation value of transmit signal using decision feedback signal

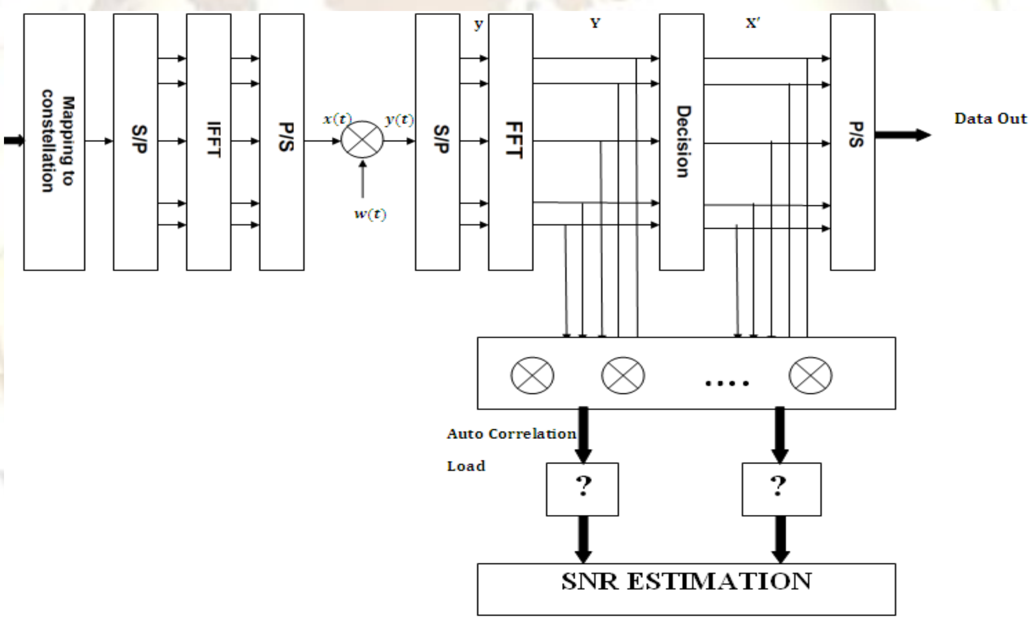

Figure 1: SNR Estimation Approach in OFDM systems

IV.SIMULATION RESULTS

The results are obtained using Matlab 2010a ® under 16-QAM modulation for 8 sub carrier each of carrying 128 symbols. The performance is analyzed between mean square error and SNR estimated.

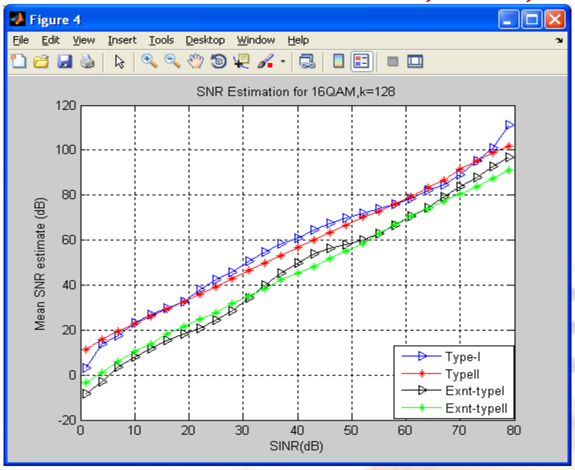

Figure 2: Performance analysis for the proposed approach

Since our estimation scheme in OFDM system uses auto-/cross- correlation of decision feedback signal, it shows stable performance than previous SNR estimation schemes. It can be adapted to high level modulation as well since it is simple and practicable to implement.

The proposed estimation scheme had same performance with CRLB for QAM and QPSK And had NMSE .005 in for wide range of SNR from 0dB to 80dB. The type-I had the estimation error around 2dB. The type 2 scheme has NSER like performance under .005 for more than 20dB.The above figure shows the performance of the proposed scheme under different situations or types of channels (AWGN, Relay fading) with 16 QAM and K=128.

V.REFERENCES

[1] R. López-Valcarce and C. Mosquera, “Sixth-order statisticsbased nondata-aided SNR estimation,” IEEE Commun. Letters. vol. 11, no. 4, pp. 351–353, Apr. 2007.

[2] Seon Ae Kim, Dong Geon An, Heung-Gyoon Ryu,” Efficient SNR Estimation in OFDM”, Radio and Wireless Symposium (RWS), 2011 IEEE.

[3] David R. Pauluzzi and Norman C. Beaulieu, “Comparison of Four SNR Estimators for QPSK Modulations,” IEEE Communication Letters, vol. 4, no. 2, pp. 43.45, Feb. 2000.

[4] M. K. Simon and A. Mileant, “SNR estimation for the baseband assembly,” Jet Propulsion Lab., Pasadena, CA, Telecommunications and Data Acquisition Prog. Rep. 42-85, May 15, 1986.

[5] D. R. Pauluzzi, “Signal-to-Noise Ratio and Signal-to-Impairment Ratio Estimation in AWGN and Wireless Channels,” M. Sc. (Eng.) thesis, Queen’s Univ., Kingston, ON, Canada, 1997.

[6] C. M. Thomas, “Maximum Likelihood Estimation of Signal-to-Noise Ratio,” Ph.D. dissertation, Univ. of Southern California, Los Angeles, 1967

[7] D.R. Pauluzzi and N.C. Beaulieu, “A Comparison of SNR Estimation Techniques for the AWGN Channel,” IEEE Trans. on Comm., vol. 48, no. 10, pp. 1680-1691, Oct. 2000.

[8] M. Álvarez-Díaz, R. López-Valcarce & C. Mosquera, "SNR Estimation for Multilevel Constellations Using Higher- Order Moments," IEEE Transactions on Signal Processing, vol. 58, no. 3 Part 2, March 2010, pp. 1515-1526.

[9] A. Stephenne, F. Bellili, S. Affes, “Moment-based SNR estimation over linearly-modulated wireless SIMO channels,” Wireless Communications, IEEE Transactions on, vol. 9, no. 2, pp. 714 – 722, Feb. 2010.

[10] R. Matzner and F. Engleberger, “An SNR estimation algorithm using fourth-order moments,” in *Proc. IEEE Int. Symp. Information Theory*, Trondheim, Norway, June 1994, p. 119

AUTHORS PROFILE

Mr Y.Bhavani Sankar was born in 1988 at Guntur District,Andhra Pradesh state, India. He Graduated in Electronics and Communication Engineering from Bapatla Engineering College, ANU,Guntur. Presently he is pursuing his M.Tech in Communication and Radar systems in Koneru Lakshmaiah University, vaddeswaram.

Mr J. Chandrasekhar Rao was born in India,1985. He received his B-tech, M-tech degree in Electronics and Communication Engineering. He is currently working as Assistant Professor in ECE department of Koneru Lakshmaiah University, vaddeswaram.. He has three national, one international conference paper and three international journal papers. His research interests include image processing, wireless communication