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Peak to Average Power Ratio Reduction Technique using LPC Coding in OFDM System

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Abstract*. The main challenge in orthogonal frequency division multiplexing (OFDM) is to reduce the high peak to average power ratio (PAPR), in which leads to the nonlinearity and distortion for the different application of high power amplifier (HPA). PAPR is defined as the ratio between the maximum instantaneous power and its average power. In this paper, we have presented new PAPR reduction technique to reduce peak to average power ratio using Linear predicting coding (LPC), Vandermonde-like matrix (VLM) algorithm and selective mapping (SLM) algorithm. These techniques show the significant reduction in PAPR without any harmful degradation in power spectral density (PSD), computational complexity (CC) and performance error of the system. This technique can be applied for any number of subcarrier and independent of modulation scheme under Additive White Gaussian Noise (AWGN) channel.*

Keywords: *PAPR, OFDM, LPC, VLM, SLM, AWGN, PSD, Bit error rate (BER).*

I. INTRODUCTION

OFDM system is a special case of frequency division multiplexing (FDM) worked as PAPR reduction technique where, there are all carrier signals is orthogonal. A multi-carrier modulation technique such as fourth generation (4G) wireless communication system that an attractive candidate for OFDM systems. OFDM system offers immunity to multipath delays these are low inter symbol interference (ISI), high spectral density (HSD), selective fading immunity and global mobile interoperability based on microwave access Wi-MAX mobile [1]. This technique includes encoding and decoding signals. As the signal random in nature there are two schemes are included, where are the first is partial transmission sequence (PTS), and second is selected mapping (SLM).

There are some techniques for reducing the PAPR have been summarized in [2]. Vandermonde-like Matrix (VLM) precoded SLM scheme has been proposed for peak to average power ratio reduction in IEEE 802.11 standards and [3]. VLM is one of the very efficient solutions for the PAPR reduction technique.

In this paper we show a PAPR reduction technique based on LPC coding. The PAPR reduction studied in term of CCDF, BER performances and power spectral density. This paper presents the significant reduction In PAPR. LPC technique in OFDM system presents the better result in comparison to other PAPR reduction technique such as SLM method [4, 5]. The remaining paper organised as: related work is discussed in second section, in third section we have discussed proposed work, simulation results and conclusion are discussed in section fourth and fifth respectively.

A. PAPR Reduction technique for OFDM system in VLM precoded SLM technique.

OFDM system technique Offers high spectral efficiency tolerance to propagation of multipath propagation delay, very high immunity and energy efficiency to selective fading channels [15, 16]. In this technology for the next generation of wireless used in OFDM system is implemented to many type of wireless communication system [17]. It is a multi-carrier transmission system and high-speed data rate in OFDM signal model, serial data is slower speed across the narrow-band subcarrier transmitted in parallel data.

Join modulated data in linear sub carrier can have very large amplitude fluctuation and large PAPR reduction technique. In which the OFDM system well-known as limitation of the system for the high power amplifier (HPA) [18], in the practical distortion application of the model technique that the severe nonlinear system.

B. PAPR problem in OFDM

$$x(n) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_{k} e^{j \frac{2\pi}{N} kn}, 0 \le n \le N-1 \quad (1)$$

Given the large number of PAPR in OFDM signal may be generated where N, number of independently modulated subcarrier, which can be an 'N' number of point inverse fast Fourier transform (IFFT). In the transmitter and considering the N block symbols to the fast Fourier transform (FFT).

$X_N = \{X_k, k = 0, 1, \ldots, N-1\}$, is formed of the system. Where, X_K is the symbol carry by the K_{th}, sub-carrier model systems. The PAPR system is defined as:

$$PAPR = \left[\frac{max|X(n)|^2}{E\{|X(n)|^2\}}\right] \quad (2)$$

Where, $E\{|X(n)|^2\}$, denoted as the expectation operation of system. As the number of subcarrier increases, PAPR also increases proportionally.

II. RELATED WORK

VLM preceded SLM technique for PAPR reduction in OFDM system work has been proposed by Md. Mahmudul Hasan in (2013) [3]. Used methodology, VLM precoding based SLM technique performances are evaluated to CCDF and BER performance simulated in term of MATLAB. The main drawback in OFDM system that the composite transmit signal can exhibit, very high peak power then the input sequence are highly correlated. The proposed enhanced precoding method performs in this paper, presented the better than the conventional precoding techniques without increasing the complexity of the system to the BER performances.

PAPR reduction techniques in OFDM signals has been proposed by Jiang, T., & Wu, Y. in (2008) [2]. Used methodology of PAPR reduction technique for multiuser broadband communication system used as high power amplifier (HPA), in OFDM and PAPR reduction technique. In this system one of the serious draw-back is to compose the signals, peak power is high when the input sequences are highly correlated. To discussed some important aspects including the distribution of the PAPR reduction technique as well as provided mathematically analysis. The proposed enhanced method perform in the paper presented the reduction technique in PAPR, at the cost of lose in data rate where transmit signal power increases BER performances decrease.

Multicast Broadcasting service support in OFDM based Wi-MAX system work has been proposed by T. Jiang, W. Xiang in (2008) used Methodology multicasting broadcast wireless networking [1].

This is one of the faster and easier deployment and revenue realization, lower operational costs for network maintenance. The main drawback of this existing system a null places in direction of the interferers so that the antenna gain is not maximized, at the direction of the desired user.

Review of selected mapping (SLM) technique in SLM technique [6], [7] and related to the [8] and [9], it has assume that U statistically independent alternative transmit sequence denoted as,$a^{(u)}$, $0 \leq u < U$ and in which to represent the same information are generated by some suitable algorithm. Finally, $a^{(\bar{u})}$ sequence terminal is selected for transmission with lowest peak power.

Channel Estimation in OFDM Systems work has been proposed by Srishtansh Pathak and Himanshu Sharma in (2013) [10]. Used methodology Least Square Error (LSE), and Minimum Mean Square Error (MMSE), channel estimators. In OFDM system the main drawback is that the high PAPR, bit error rate (BER) and high sensitivity to carrier frequency offset (CFO). The proposed enhanced precoding method performs in this paper presented the better than the OFDM lies in processing frequency selective channels as multiple flat-fading sub-channels.

III. PROPOSED WORK

A. *Vandermonde-like Matrix*

These systems are very compatible because the signal in PAPR reduction compounds of OFDM can shows a very high PAPR reduction technique. If using the linear predictive coding in PAPR reduction method, matching sequence of the previous applied the IFFT operation. So the OFDM signal is also reduced in PAPR technique.

There is a close relationship between self-correlation periodic (ACF) functions in vector X and PAPR reduction method [5].

Let ρ(i) to be the ACF of the signal X, given that the

$$(i) = \sum_{k=0}^{N-1-i} X_{k+1} + iX_k^* \qquad (3)$$

For $i = 0,1 \ldots \ldots \ldots \ldots, N-1$

Where * denoted the complex conjugate, $X_{k+1} + iX_k$ denoted the complex conjugate in reduction technique. The PAPR reduction technique to the transformed the signal is limited by the system.

$$PAPR \leq 1 + 2/N \times \delta \qquad (4)$$

Where δ, is defined as in reduction system that is.

$$\delta = \sum_{i=1}^{N-1} |\rho(i)| \qquad (5)$$

Where $|\rho(i)|$ is the absolute a periodic (ACF). Equation (4) and equation (5) denoted as the input vector, with a lower range λ it can produce a signal low PAPR technique in OFDM systems [5].

B. *LPC transceiver analysis and synthesis*

To the basic ideas of linear predictive coading in PAPR reduction technique to attempt de-correlate the signals by the subtracting best possible linear prediction, from the input signal while retaining other aspects of the signal. The prediction is a transmission of the prediction error in place of the original signal [11, 12].

$$\tilde{x}(n) \sum_{k=1}^{M} c(k)\, x(n-k) \qquad (6)$$

The differences between the model system in original sequence and the expected sequences, we can denoted as the prediction error sequence (n) as.

$e(n) = x(n) - \tilde{x}(n)$, Put the value X(n), in terms of M coefficients.

C. VLM Precoded SLM

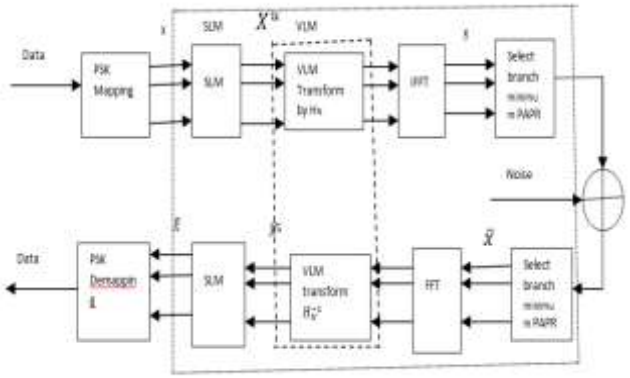

Figure 1. Block diagram of OFDM systems in VLM precoded SLM technique.

In OFDM system VLM precoded SLM technique to pre-encoded transmitting and receiving end is shown in Figure 1. Reduce to VLM transformation can auto-correlation of the input terminal where the SLM technique encodes the OFDM signal to generate alternate the sequences of input symbols. In the transmitting end side to serial data better than the parallel data sequence is divided into multiple blocks shown in figure 1, then assigned to the points to produce of the PSK in X modulated symbols.

D. OFDM system in VLM precoded SLM technique

Denoted as Figure (2), to the implementation of SLM technique required to the number of IFFT, operations denoted as VLM technique inversion is given in [19] to fast algorithm for finally the modulated symbol denoted as $\tilde{X}$, and recovered symbol $\widetilde{Xu}$ using the side information phase index as denoted n.

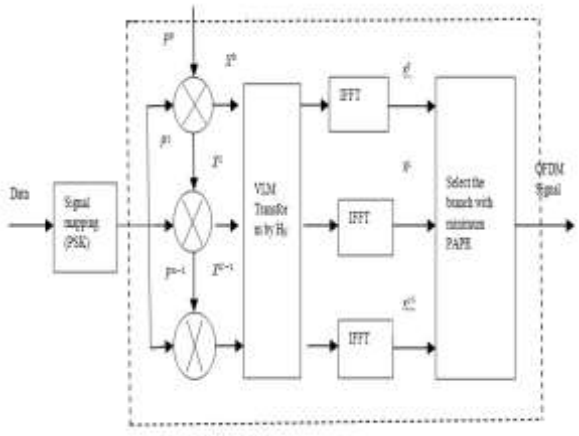

Figure 2. Block diagram of VLM precoded with SLM technique of OFDM transmitter.

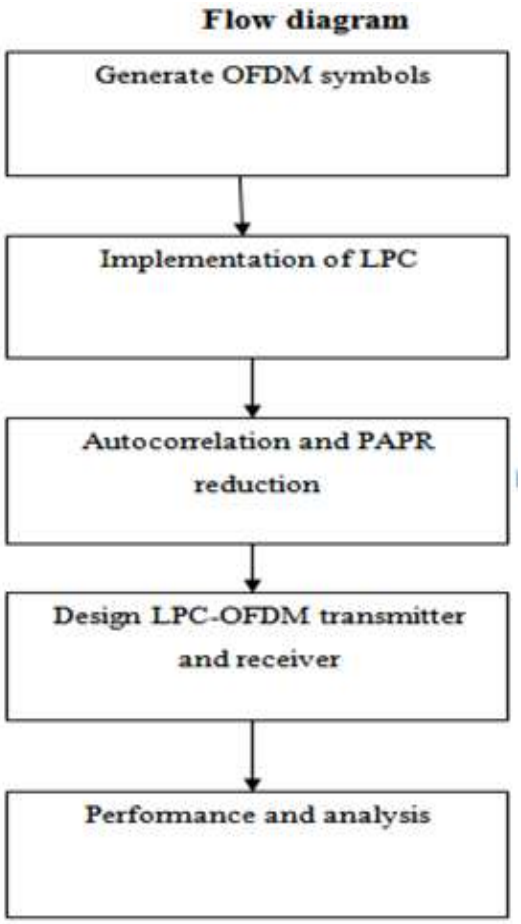

Figure 3. Flow chart

A flow diagram shown in figure 3, presented the sequence of generation of OFDM signals to performances analysis of the system in the paper.

MODULES

- Symbol Generation for OFDM
- Implementation of Linear Predictive Coding
- Reduction of PAPR
- Performance Analysis

E. Performance Analysis:

The ratio of peak-to-average power ratio is defined as the peak amplitude squared, gives as peak power, that the divided by the RMS value squared, giving the average power [3] It's the square of the crest factor.

$$PAPR = \frac{|x|peak^2}{x_{rms^2}} = C^2 \qquad (8)$$

$$PAPR_{db} = 10\log_{10}\frac{|x|peak^2}{x_{rms^2}} = C_{db}^2 \qquad (9)$$

The bit error rate is defined as the number of bit errors, divided by the total number of bits transferred during a time interval studied. BER is a measuring of a performance of unit less system, often expressed as a

percentage. The bit error's probability is the expected value of the bit error rate. The bit error rate can be considered as a rough estimation of the bit error probability. This estimation is accurate for a long time interval and a large number of bit errors.

In the case of QPSK and AWGN, the BER based on Eb / N0, is given by

$$BER = \text{erfc}\left(\sqrt{Eb/N_0}\right) \qquad (13)$$

IV. SIMULATED RESULT

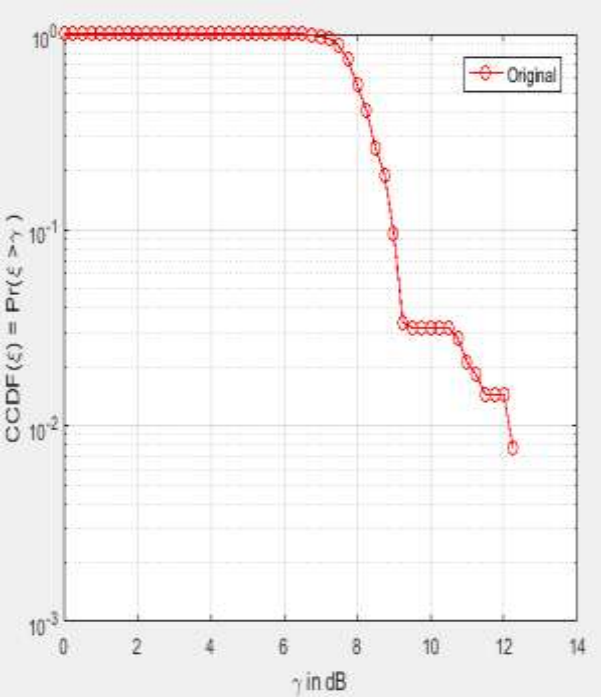

Fig. 4 Base signal for OFDM using LPC system between the CCDF and γ indB

To enhanced the references circuit using LPC coding technique to better performances to reduce the PAPR reduction effect of base signal whitening by the use of LPC coding technique shown as Figure4, It is clear from that the spectral, although of an OFDM signal having varying energy at every shown frequencies such as the λ of an exponential distribution or Poisson distribution and complementary cumulative distribution function (CCDF).

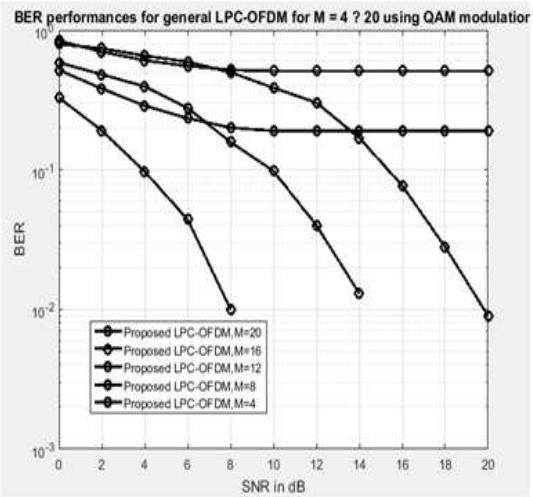

Fig. 5 To the BER performances for general OFDM system using LPC coding technique, For M=4 to 20, using QAM modulator.

In Figure 5, simulated the system model using 64 QAM mapping without power equalization to be better performances is shown as the figure.

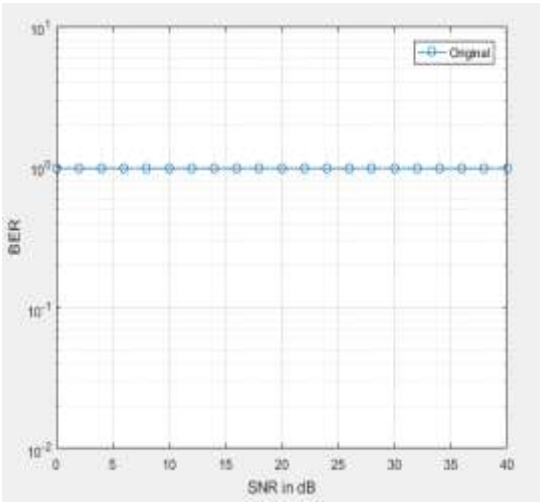

Fig. 6 To the BER performances of general OFDM systems and using LPC coding technique, equation formed for M = 4 → 32, using LPC coding technique.

Figure 6, shown in the simulation of 64-QAM LPC coding technique in OFDM systems make stability of bit error rate performances for high level modulation technique to the enhanced system reduction techniques. It is shown that the SNR value is improved, error will less compare to the reference model by 5–3dB for value of M from 4 to 32 bit. To get optimise the order of the error filter to optimum trade off must be considered between PAPR reduction technique and BER performance.

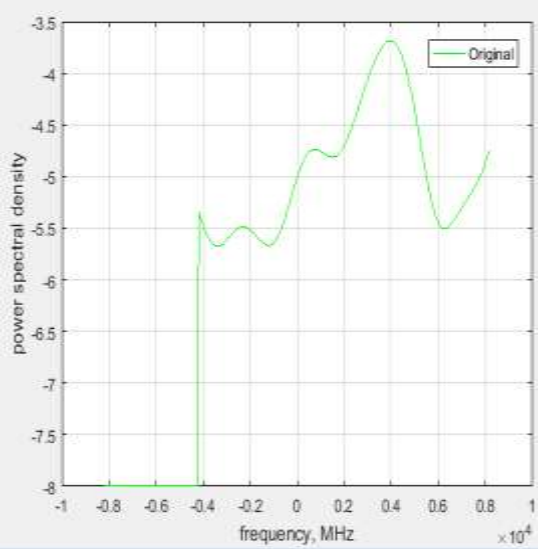

Fig. 7 Improved PSD in general OFDM systems and LPC coding technique with the power equation for M = 4 to 16, by use of LPC coding technique.

Figure 7, gives view of equalized power conditions where in band spectra is demodulated system and another value of M, can have valuable PAPR minimum with diminishing error performance to using LPC coding technique. Due to the impedance out of band spectra power, it will leads to ISI if not addresses properly to make shift of the system to reference paper. If we choose smaller values of M, it will assist in reduction of interference and reduction also. Which is showing that white noise is nearly equal to prediction error.

Figure, 8 shows that, when we are increasing order of the filter capacity of the linear predictor error filter then the signal is increases, for the characteristic shown in power spectral density and frequency in MHZ. M=8, 16 and 32.

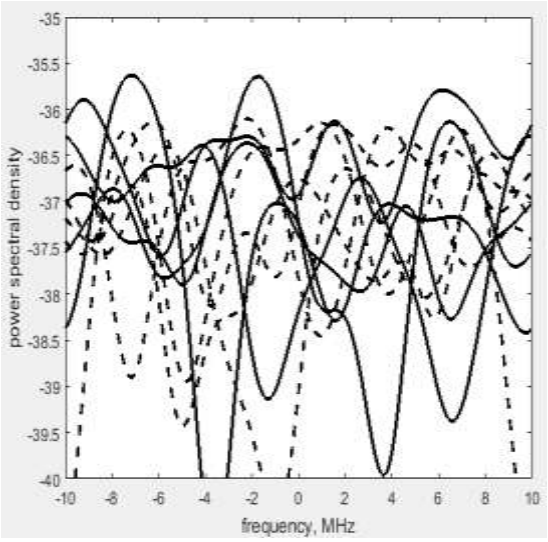

Fig. 8 LPC filtered signals and Base signal showing PSD, for M=16 and 32

Where,

- (_____) Original signal
- (……...) LPC Filtered, M=16
- (- - - -) LPC Filtered, M=32

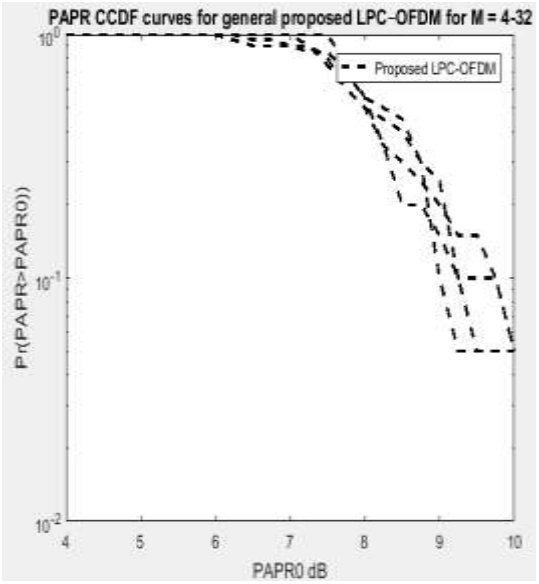

Fig. 9 PAPR reduction technique CCDF curves for general proposed LPC OFDM for M=4 to 32

Figure 9, shows the extension of simulation for using 64-QAM mapping where proposed method shown that the like-wise performances. Hence it is clear that the proposed method does not depend on modulation schemes and applicable to high order modulation technique and low reduction better performances

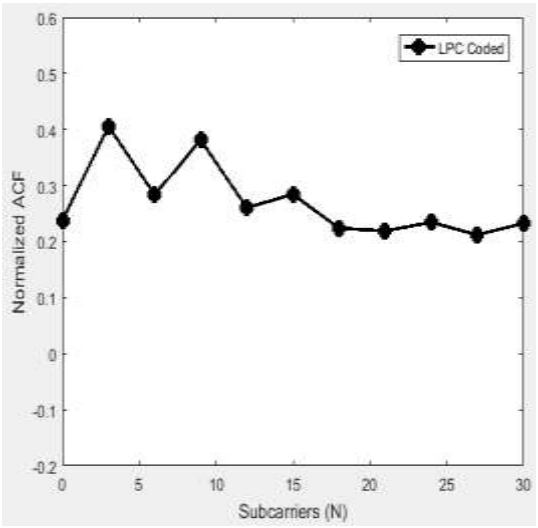

Fig. 10 Shown Normalized autocorrelation of OFDM system and PAPR reduction performance was evaluated using LPC coding technique

In this case the possibility of the OFDM system and the sequences of PAPR reduction method to be used as cross-voltage level, then the PAPR0 and PAPR reduction become minimum. In fact, if side lobs auto-correlate will given higher value then the input sequences are highly correlated.

V. CONCLUSION

In this paper, using the VLM and SLM algorithm used as various methods proposed based on linear predictive coding. In this system used various method, we have reduced PAPR in OFDM system and obtained good BER performances. The proposed system is applicable for any modulation scheme and the work for any number of subcarriers. In this system mathematical concept To the critical, system models and simulation results are given to support the statement.

REFERENCES

[1] Jiang, T., Xiang,W., Chen, H. H., & Ni, Q. (2007). Multicast broadcasting services support in OFDMAbased on WiMAX systems. IEEE Communications Magazine, 45(8), 78–86.

[2] Jiang, T., & Wu, Y. (2008). An overview: Peak-to-average power ratio reduction techniques for OFDM signals. IEEE Transactions on Broadcasting, 54(2), 257–268.

[3] Hasan, M. M. (2013). VLM precoded SLM technique for PAPR reduction in OFDM systems. Wireless Personal Communication, Springer. doi:10.1007/s11277-013-1217-6.

[4] Bauml, R. W., Fischer, R. F. H., & Huber, J. B. (1996). Reducing the peak-to-average power ratio of multicarrier modulation by selected mapping. Electronic Letters, 32, 2056–2057.

[5] Tellambura, C. (2000). Upper bound on peak factor of N-multiple carriers. Electronics Letters, 36(14),1226–1228.

[6] R. Bäuml, R. Fischer, and J. Huber, "Reducing the peak-to-average power ratio of multicarrier modulation by selected mapping," Electron. Lett., vol. 32, no. 22, pp. 2056–2057, Oct. 1996.

[7] S. Müller-Weinfurtner, "OFDM for wireless communications: Nyquist windowing, peak-power reduction, and synchronization," Ph.D. dissertation, Univ. Erlangen Nürnberg, Shaker Verlag, Germany, 2000.

[8] P. Van Eetvelt, G. Wade, and M. Tomlinson, "Peak to average power reduction for OFDM schemes by selective scrambling," Electron. Lett., vol. 32, no. 21, pp. 1963–1964, Oct. 1996.

[9] D. J. G. Mestdagh and P. M. P. Spruyt, "A method to reduce the probability of clipping in DMT-based transceivers," IEEE Trans. Commun., vol. 44, pp. 1234–1238, Oct. 1996.

[10] Srishtansh Pathak and Himanshu Sharma (2013) Channel Estimation in OFDM Systems.

[11] Makhoul, J. (1975). Linear prediction: A tutorial review. Proceedings of the IEEE, 63, 561–580.

[12] Atal, B. S. (2006). The history of linear prediction. IEEE Signal Processing Magazine, 23(2), 154–161.

[13] Vaseghi, Saeed V. (2006). Advanced digital signal processing and noise reduction (3rd ed.). London:Wiley.

[14] Benesty, J., Sondhi,M.M., & Huang, Y. (Eds.). (2007). Springer handbook of speech processing. Berlin: Springer.

[15] Wu, Y. W., & Zou, Y. (1995). Orthogonal frequency division multiplexing: A multi-carrier modulation scheme. IEEE Transactions on Consumer Electronics, 41(3), 392–399.

[16] Zou, W. Y., & Wu, Y. (1995). COFDM: An overview. IEEE Transactions on Broadcasting, 41(1), 1–8.

[17] Jiang, T., Xiang,W., Chen, H. H., & Ni, Q. (2007). Multicast broadcasting services support in OFDMAbased WiMAX systems. IEEE Communications Magazine, 45(8), 78–86.

[18] Han, S. H., & Lee, J. H. (2005). An overview of peak-to-average power ratio reduction techniques for multicarrier transmission. IEEE Personal Communications, 12(2), 56–65.

[19] Zhong, X.,&Zhaoyong,Y. (1998).Afast algorithm for inversion of confluentVandermonde-likematrices involving polynomials that satisfy a three-term recurrence relation. SIAM Journal of Matrix Analysis and Applications, 19(3), 797–806.