

Performance Analysis of Iterative IDMA Scheme in Power Line Communication Using Random Interleaver

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Abstract

Power line distribution networks are mainly used for electrical power supply. The ever-increasing demand of low cost telecommunication, broadband and access to internet services has applied a driven force leading to further research in the field of power-line communication. Different multiplexing techniques, OFDM, CDMA, MC-CDMA, has been already used with power line communication. In this paper coded IDMA is being used with power line communication also the simulation and result has been described.

Keywords: *CDMA, IDMA, MC-CDMA, OFDM, Power line communication.*

1. Introduction

With the advent of technology the need of low- cost broadband communication has been increased so many folds, also becomes the driven force leading to further research in the field of power line communication. Power line used for transmission of broadband data has been under extensive studies during last year. Today due to increasing demand of networking in home, offices, buildings, industrial organizations etc, the power lines are considered as a medium for high speed data (>2Mbps) transmission [Esmailian, Lindell]. PLC Broadband technology is capable of transmitting data via the electrical supply network, and therefore can extend an existing local area network or share an existing Internet connection through electric plugs with the installation of specific units. The principle of PLC consists in superimposing a high frequency signal (message signal, 1.6 to 30 MHz) at low energy levels over the 50 Hz electrical signal [Y. H. Ma]. This second signal is transmitted via the power infrastructure and can be received and decoded remotely. Thus the PLC signal is received by any PLC receiver located on the same electrical network. In order to transport the PLC signal on electrical wiring, the line frequency (for example, 110 V/60 Hz) of the electrical circuit is supplemented by a modulated signal of low amplitude around a centre frequency (carrier frequency) [Y. H. Ma].

Various broadband power line communication (PLC) solutions based on OFDM technology are currently exists [Xavier Carcellem]. CDMA (Code Division Multiple Access) modulation is a type of spread spectrum modulation used in some PLC solutions because its successful application of CDMA in various communication areas suggests that it is a good candidate in broadband power line communications as well. There have been some researches done for evaluating the performance of OFDM and CDMA systems in power lines [P. L. So, 5, P.L. Katsis]. The performance analysis of these different models has been developed by close formulas and verified by simulation results [Xavier Carcellem Y. H. Ma, P. L. So, S.M. Navidpour, P.L. Katsis].

In this paper we have simulate the power line channel in order to measure the efficiency of a wired iterative interleave code division multiple access system with rate $\frac{1}{2}$ convolution coding.

2. IDMA System Characteristics

Interleave division multiple access (IDMA), it is recently proposed multiple access scheme in which user-specific interleavers are adopted as the only mechanism for user separation. Since interleaving is the only mechanism for user separation that's why called IDMA. IDMA can be regarded as a particular case of chip interleaved CDMA. This scheme inherits many advantages from CDMA such as dynamic channel sharing, mitigation of cross-cell interferences, asynchronous transmission, and ease of cell planning. It also allows a low complexity multiple user detection techniques applicable to systems with large numbers of users in multipath channels. As so, IDMA inherits many advantages of CDMA. IDMA fulfil all the requirements of advanced 4G wireless communication system that's why it is widely being deployed now days and is going through many researches also being used with wired communication.



The general layout of simulated system is taken from [Li ping]. An IDMA model where BPSK modulation technique has been used, k simultaneous users using a single path channel i.e. power line. At the transmitter side, an input data sequence $d_k = [d_k(1), d_k(2), \dots, d_k(i), \dots, d_k(N)]^T$ having length N, is encoded into $c_k = [c_k(1), \dots, c_k(j), \dots, c_k(J)]^T$ based on low rate code C and J is the length of chip, code used here is convolution code, having rate 1/2 for getting good performance results and interleaver used here is of random type interleaver

3. Channel model

Modelling the power line channel [P.L. Katsis] is a tough task since its nature is unpredictable nature with frequency, time of day, geographic location and rural environment. The main parameters, taken into account are the impedance, attenuation and noise. Absolute impedance of the power distribution system up to 30 MHz has been carefully studied in several countries, showing similar results between European countries and the US. The main problem lies in the enormous fluctuation in the frequency range of interest though this fluctuation is relatively reduced in the range from 1MHz to 30 MHz [Anatory J]. The authors have developed component based simulation technique for signal transmission characteristic of PLC .a component model can be expressed by F matrix shown in equation (1)

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_2 \\ I_2 \end{bmatrix} \dots\dots\dots (1)$$

Where A,B,C,D are the coefficients of the F matrix , V_1, I_1 are the input voltage and input current and V_2, I_2 are the output voltage and output current. All the coefficients can be uniquely defined from an equivalent circuit model and coefficients can be mentioned as the model parameters of the component model [M. Kavehrad] ,by using two port models all the parameters can be calculated by the equations from (Anatory J).

$$A = \cosh(\gamma l) \dots\dots\dots (2)$$

$$B = Z \cdot \sinh(\gamma l) \dots\dots\dots (3)$$

$$C = \frac{\sinh(\gamma l)}{Z} \dots\dots\dots (4)$$

$$D = \cosh(\gamma l) \dots\dots\dots (5)$$

And the transfer function can be given as-

$$H = \frac{R_l}{A \cdot R_l + B + C \cdot R_l \cdot R_s + D \cdot R_s} \dots\dots\dots (6)$$

Where γ is the propagation constant of the power line, R_s, R_l are the source and load resistance of the power line and l is the number of concerning node in the transmission or reception side.

4. Simulation and analytical results

In this paper the performance of coded IDMA system with power line channel has been examined. The main aim here is to minimize the E_b/N_0 to achieve $BER \leq 10^{-4}$ in figure-2 represents the bit error rate performance of power line communication with IDMA scheme. In this case different data length is taken to evaluate the user count taken is 20. from the result it is clear on increasing data length the bit error rate performance improves. In figure-3 BER performance of coded IDMA with BPSK modulation, at different data length has been evaluated , as the data length is being increased ,the BER performance degrades. And coded IDMA has much better results than uncoded IDMA and after $E_b/N_0 = 6\text{dB}$ the bit error rate becomes zero. When modulation scheme is changed to QPSK in the same case except data length is constant to 512, coded IDMA performs better.

4. Conclusions

In powerline communication with IDMA scheme may be a lacerative proposal for voice and and data communication since it does not need additional hardware fabrication except the household electrical wiring. The IDMA scheme is certainly having certain upper edges over conventional CDMA and OFDMA techniques employed for traditional poweline communications.

The powerline communication with IDMA Scheme with random interleaver demonstrates the good results in case of high user count. With increment in data length, the performance of the proposed system is improved. The convolutionally coded IDMA in PLC also shows superior performance to its uncoded counterpart.

References

Esmailian T, Gulak, PG, Kschischang FR.” A discrete multitone power line communications system”. *Proceedings of ICASSP’2000 2000*; 5:pp. 2953–2956.

Han Vinck AJ, Lindell G. "Summary of Contributions at ISPLC 1997–2001". *Proceedings of the 5th International Symposium on Power-Line Communications and Applications, 2001*;pp. 383–413.

Xavier Carcelle,"*Power Line Communications in Practice*" Artech House Telecommunications Library.

Y. H. Ma, P. L. So and E. Gunawan, "Comparison of CDMA and OFDM Systems for Broadband Power Line Communications" *IEEE Trans. Power Del., Vol. 23*, No 4, pp 1876-1885, October 2008.

Y. H. Ma, P. L. So, and E. Gunawan, "Performance analysis of OFDM systems for broadband power line communications under impulsive noise and multipath effects," *IEEE Trans. Power Del., vol. 20, no. 2*, pp. 674–682, Apr. 2005.

S.M.Navidpour, P. Amirshahi, M. Kavehrad (FIEEE)," Performance Analysis of Coded MC-CDMA in Powerline Communication Channel with Impulsive Noise",IEEE, pp 267-271,2006

P.L. Katsis, G.D. Papadopoulos, F.N. Pavlidou,"*Comparison of Coded Orthogonal Frequency Division Multiplexing and Multicarrier Code Division Multiple Access Systems for Power Line Communications*", Department of Telecommunications - Aristotle University of Thessaloniki, Panepistimioupolis, 541 24 Thessaloniki, Greece.

Li ping, Lihai Liu, Keying Wu and W. K. Leung, "Interleave-Division Multiple-Access," *IEEE Trans. Wireless Commun.*, vol. 5, pp. 938-947, April 2006.

Anatory J., Theethayi N., and Mvungi N. H "Power Line Channel Models: Comparisons between different Modeling Adopted in BPLC Systems", Third Workshop On Power Line Communications, October 1-2, 2009, Udine, Italy

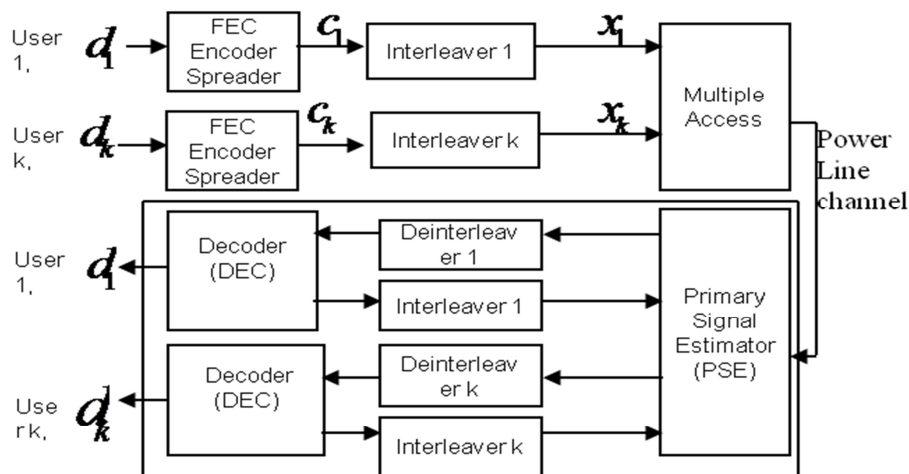


Figure-1.block diagram of IDMA system

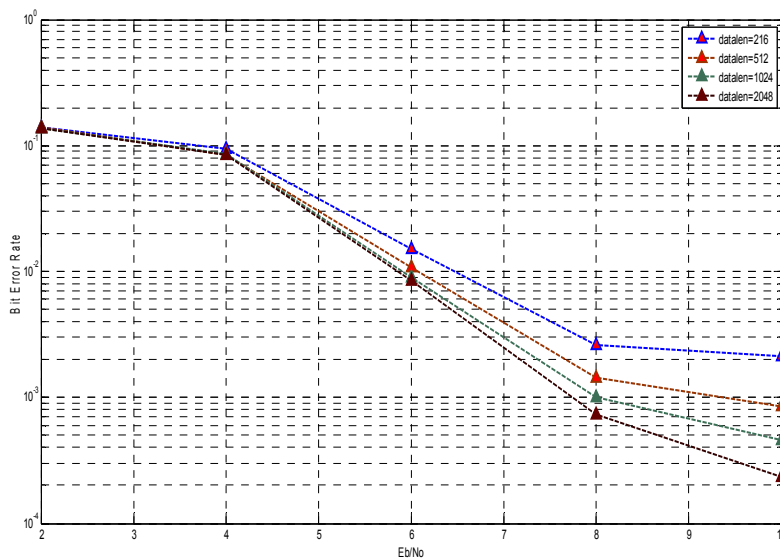


Fig.2-performance of uncoded IDMA systems at no of users=20

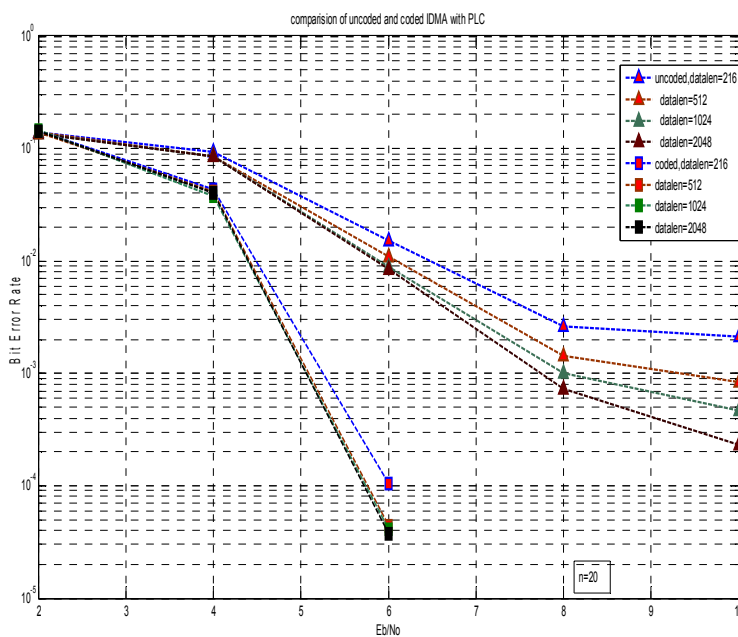


Figure-3.performance of coded IDMA with PLC (with BPSK)

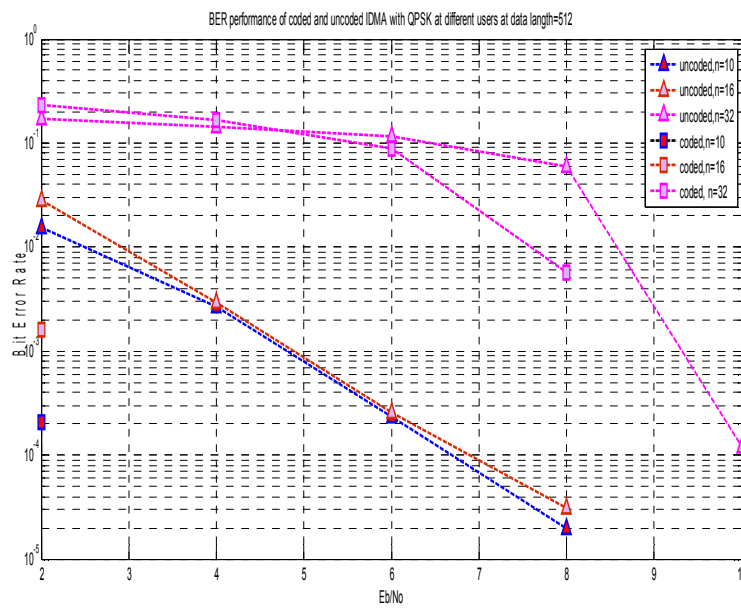


Figure-4. performance of coded IDMA with PLC (with QPSK)