OFDM Based Power Line Communication Intensification Using RSC Coding with Adaptive Noise Compensator

Anusuya.C(Student)

Jothimani.M,(Assistant professor),

R.Kalaivani,(Associate professor),

Dept of ECE, Erode Sengunthar Engineering College,Perundurai,Erode-57

***Abstract-* In this paper ,we propose a Recursive systematic convolutional coding combined with adaptive noise compensation to minimize the interference and path effects with better performance than the turbo codes at very low bit error rate and high coding rate. RSC encoder, decoder, mapper, DE mapper are inserting in this system and pilot insertion block for enhance the preliminary estimation of Orthogonal Frequency Division Multiplexing modulation. Compensator is based on impulse bursts estimation using a new clipping and blanking function, estimation of Signal to noise ratio and Peak to average power ratio. Compare to the existing system, The proposed system gives better performance at high coding rate with less latency.**

Index terms-OFDM modulation, RSC convolutional code, adaptive impulsive noise compensator, Power line communication.

I.INTRODUCTION

Present days, the PLC systems are more interest because they can be used for transmitting data over the industrial area or residential area. PLC offers high speed data, video, image and voice services to the customers. Low cost implementation is the main advantage of PLC technology with several challenges. PLC also receive much attenuation due to the connectivity over wider area and availability of power lines. To overcome noisy environment the compensator is used. PLC system requires robust, efficient modulation and coding schemes. Two impairments to the PLC system are i)multipath propagation which is characterized by slow fading or Ricean fading scenarios and ii)impulsive noise which is characterized by asynchronous scenarios. OFDM is widely used modulation scheme in PLC channels against noise and multipath effects. Number of channel models found in literature with the number of topologies, network locations, frequency bands, etc.

Yassine Himeur proposed turbo coding combined with adaptive noise compensator to reduce the burst errors &multipath effects. Turbo encoder/decoder is used for coding in this system"[1]" .Zimmermann's top-down (0.5kHz-20MHz) model is used which is based on physical signal propagation effects in PLC networks with impedance mismatching and different branches"[13]". Wada hosny investigates the BER performance of 16-QAM constellation with OFDM with the presence of impulsive noise and background noise over multipath PLC channel. Impulsive noise modeled as Middleton class A, background noise modeled as AWGN"[3]". Jing Lin proposed impulsive noise as a sparse vector in the time domain with no assumptions and applied sparse Bayesian learning method for the estimation and mitigation with no training"[14]". Mario Bogdanovie proposed least square estimation algorithm to increase the error correction on the receiver side and decrease the data transmission errors issued by amplitude and phase distortions. Algorithm is based on the synergy of block and comb type pilot arrangement in LS channel estimation. P.Amirshahi's system overcome multipath fading and frequency selectivity along with manmade noise and investigates indoor power line channel with burst impulsive noise. Wu Dan's system reduces the loss due to effects in the channel. OFDM multicarrier transmissions technique decreases

ISI and Selective fading"[15]". M.Nandakumar proposed a scheme that "Calculates the BER and computational complexity for OFDM using modulation schemes" to decrease the computational complexity versions of low cost OFDM system for the implementation of clustered OFDM system for the data transmission in pass band frequency"[7]". Raju Hormis's system is PAM based coded modulation scheme that combines LDPC and maximum distance with different block codes to obtain high spectral efficiency, low decoding complexity and better the performance in the presence of ISI. rest of this paper is about RSC coding, PLC channel characteristics, Impulsive noise model and OFDM transmission technique.

1. *Abbreviations and Acronyms:*

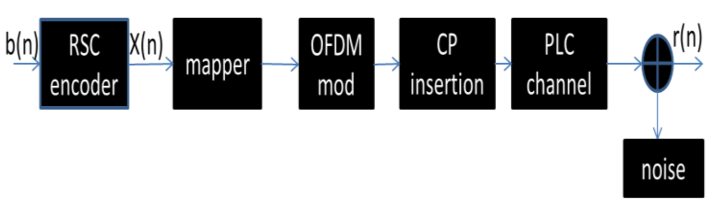
OFDM-Orthogonal frequency division multiplexing, PLC-Power line communication, RSC-Recursive systematic convolutional code, LDPC-Low density parity check codes, BER-Bit Error Rate, PAM-Pulse amplitude modulation, QAM-Quadrature amplitude modulation, DFT-Discrete Fourier Transform, ISI-Inter Symbol Interference, AINC-Adaptive impulsive Noise Compensator.

II.SYSTEM DESCRIPTION

A. RSC encoder

RSC encoder constructed from the standard convolutional encoder by feeding back one of the outputs. It consists channel encoder and interleaver. interleaver randomizing the code maintaining enough structure to permit decoding. Encoder produces codes with low weights with fairly low probability but same input may still cause low weight output. RSC codes have an infinite impulsive response. If a data sequence is consisting of a 1 that is followed by series of 0's enters the RSC encoder, code sequence will be generated containing both ones and zeros for long as the subsequent data bits remain zero, that is RSC encoders will tend to generate high weight code sequences for groups f data bits spread far apart in the input sequence.

Fig1:RSC encoder



B. Channel model of PLC

This PLC channel is based on the top-down model and it considers black box and set of measurements are gathered by exciting the channel with reference signal in either Time domain or Frequency domain. PLC channel has bandwidth of 500kHz to 20 MHz and frequency response expressed in terms of transmission.

$H(f)=\sum_{i=1}^{N} gi.\ \exp(-(a_0+a_1f^k)d_i)\ .\ \exp(-2\pi fd_i/v_p)$

g_i=weighting factor, a_0,a_1=attenuation factor, k=exponent, $v_p=c_0/2$.

C. Transmission model:

Binary data stream block with length $N_C/2$.$b(n)=[b_0(n),b_1(n)\ldots b_{N/2-1}(n)]^T$.

Coded data stream $C(n)=[c_0(n),c_1(n),\ldots c_{NC-1}(n)]^T$ is permuted by random interleaver and mapped by QAM or BPSK mapper. CP insertion block is for reducing ISI and maintaining the orthogonal of OFDM –PLC in multipath PLC. Obtained signal is passed via the noisy PLC channel with frequency response H(f).

D. OFDM modulation:

OFDM with N_c sub carriers partitioned into $N_{P,}$ N_d and null tones. received signal is described as $R_K(n)=H_k(n)S_k(n)+W_k(n)$ after DFT in the OFDM modulation. R(n) is frequency domain output vector, H(n) is frequency domain channel vector, W(n) is frequency domain noise vector, $S_K(n)=P$ for all pilot tones.$S_K(n)=0$ for all null tones, $S_K(n)=X_K(n)$ for all data tones. W(n)=frequency domain of AWGN Z(n)+frequency domain of impulsive noise I(n).

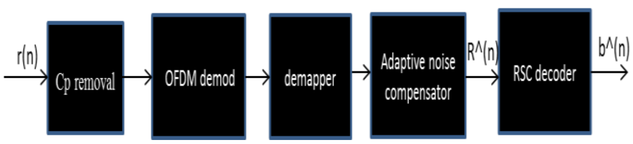
E. Reception model:

Proposed receiver model can be considered as an iterative decoder structure that combines adaptive impulsive noise compensator algorithm and RSC decoding algorithm at every iteration, extrinsic information is fed to the channel estimation. Received signal has obtained after removal of the CP and demodulates the N_C samples of every OFDM block and DE mapping data tones to the nearest place in constellation plot then received signal is passed through the compensator and gives result in estimate signal. Parity bits and aperiori signal that is produced by Soft input soft output decoders which are using in equalized symbol sequence.

F. RSC decoding:

Decoder should be Soft Input Soft Output and it calculates LLR for received signal. The decoder section consists de interleaver, channel estimator, MAP decoder and interleaver. MAP decoding includes the formation of a posteriori probabilities of each information bit followed by selecting the data bit value related to MAP chances for that data bit MAP algorithm is an optimal decoding than the ML algorithm. While decoding the decoder receives as input a SOFT value of the signal. Decoder provides the estimation of the same set of data bits but in a different order due to the presence of interleaver.

Fig2:RSC decoder



G. PLC noise model:

Interference is generating by the impulsive noise at the PLC receiver which has modeled by Middleton class A distribution is described by two factors i)impulsive index, ii)Gaussian to impulse noise power ratio $P_A(k)=\sum e^{-A}(A^m/m!)(1/\sqrt{2\pi\sigma m}).\exp(-x^2/2\sigma^2 m)$ or Poisson noise model $P(t)=P_K(T=t)=(\lambda t)^k/k!\ \exp(-\lambda^t)$, k=0,1,..

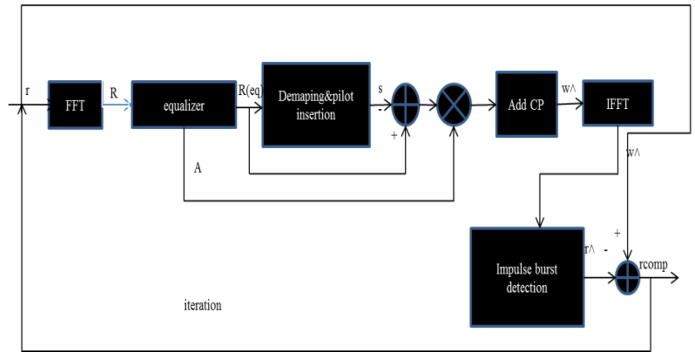
III.ALGORITHM FOR ADAPTIVE IMPULSIVE NOISE COMPENSATOR

STEP 1: H^(n)≡H(n) where H^(n) is the calculated value of the frequency domain channel vector of the OFDM symbol H(n).

STEP 2: Estimate the variance of total noise.$\sigma\wedge^2=1/N\sum_{k=0}^{N-1}|Wk\wedge(n)|2|$

STEP 3: Estimate the impulsive noise samples by using a new clipping and blanking function.

Fig 3:Adaptive impulsive noise compensator



STEP 4: Time domain response of the estimated received signal has derived by subtracting the estimate impulsive noise from the time domain response of received signal.

STEP 5: Previous steps are repeating to get the best performance in terms of BER and MSE.

TABLE 1 Parameters of the simulated OFDM system

Parameters	Simulation
FFT length	2048
Modulation	OFDM
# of Tones	2048
# of Data tones	1845
# of Null tones	32
# of Pilot tones	171
Error correction code	RSC code (rate-1/2)

i. *Receiver signal model design*

The proposed RSC code receiver method considered as an iterative decoder structure which combines both AINC algorithm and RSC decoding algorithm. In each iteration, the noise compensator result gives extrinsic information which is going back to the channel estimator and channel estimator is fed into the RSC decoder, By this method the BER is reducing with that the reduction of impulsive noise peak power as well. The received signal is obtained after removal of the CP, demodulating the *Nc* samples of OFDM block and demapping the data tones to the nearest places in constellation graph. Then, the obtained signal transmitted through the compensator block and it gives an estimated signal ˆ**R***(n)*. In the RSC decoder, ˆ**R***(n)*,parity bits and apriori signal produced by SISO. Decoders are using in the decoding procedure and gives an equalized symbol sequence **D***(n)*. Then, **D***(n)* is transmitted via channel deinterleaver, which gives a deinterleaved equalized symbol sequence **Z***(n)*. at last, **Z***(n)* is going to the MAP decoder to estimate the LLR of the posteriori chances.

ii. Performance of RSC-ANIC receiver

In this coded system, the BER performance of the proposed RSC coded with impulsive noise compensator receiver in the PLC system. The RSC code has code bite length ≈60,000 and code rate ½.The SISO decoding as the final process with these iterations. The proposed RSC-AINC receiver results in further gains. The improvement becomes more requirement in moderate and increased level of E_b/N_0 regimes. On the other hand, comparison of AINC and RSC-AINC to other state of the approaches ,That are using sparsity of the noise in time-domain.

IV.CONCLUSION

In this paper, we proposed a RSC-AINC receiver for an OFDM broadband PLC system. Proposed adaptive noise mitigation algorithm performs an iterative calculation and minimization of the impulsive noise generated over the PLC channel by the help of this recursive systematic convolutional code the system gives better performance at high coding rate with less latency and complexity.

V.REFERENCES

[1] Yassine Himeur, Abdelkrim boukabou(2015)"OFDM based power line communication enhancement using turbo coding with adaptive impulsive noise compensator" Telecommun Syst DOI 10.1007/s11235-015-0087-5.

[8] Saad D. Bennani ,Modeling "Transfer Function of Electrical Power Lines for Broadband Power Line Communication", Int. J. Communications, Network and System Sciences, 2012, 5, 37-42.

[9] Geethu.S.S,S.Narayanan "Performance improvement in power line channel using turbo code" International journal of scientific&engineering research,volume 6,issue 4,April 2015,ISSN 2229-5518.

[10]Sumit kumar, Hemant Dalal "performance of comparison of turbo codes and modified turbo codes with different rate" International journal of science, engineering and technology research,volume 3,issue 5,may 2014.

[11] Pu chuan Hsian, Pu chuan chin "Evaluation of variance mismatch for serial turbo codes with talwar penalty function under interference of impulsive noise"Journal of Engineering science and technology, volume 5,no 3(2010)350-360.

[12] Dhirj.G.Agrawal, Roma K.Paliwal, Priti Subramanium "Effect of turbo coding on OFDM transmission to improve BER" International journal of computer technology and electronics engineering volume 2,issue 1,ISSN 2249-6343.

[13] Zimmermann, M.,&Dostert, K. (2002). A multipath model for the Power line channel. IEEE Transactions on Communications, *50*(4), 553–559.

[2] Cristina Cano1, Alberto Pittolo2, David Malone3, Lutz Lampe4 Andrea M. Tonello5, Anand Dabak6"State-of-the-art in Power Line Communications: from the Applications to the Medium" arXiv:1602.09019v1 [cs.NI] 29 Feb 2016.

[3] Wada Hosny, Ali Hosseinur Najarkolaei "Bit Error Rate Performance in Power Line Communication Channels with Impulsive Noise" 2015 17th UKSIM-AMSS International Conference on Modelling and Simulation.

[4] Jiří Mišurec 1, Petr Mrákava1, Daniel Adamko2"Interference in power lines and data communication over narrow-band PLC" Elektro revue: ISSN 1213-1539.

[5] Nagaraj Shet, Shreesha C, "Data transmission through power line" IJECET, Volume 6, Issue 2, February (2015), pp. 25-34.

[6] Zaveri Himani "Structural Analysis of Efficient Error Control Scheme in PLC Environment. Communications on Applied Electronics "(CAE) – ISSN : 2394-4714.

[7] M.NandaKumar, K.Manjunath, K.Yogaprasad "Estimate BER and Computational Complexity for OFDM Modulation Schemes by using different Modulation Techniques" ISSN: 2278 – 1323 International Journal of Advanced Research in Computer Engineering & Technology Volume 1, Issue 3, May 2012.

[14] Jing Lin, Marcel Nassar, and Brian L. Evans, "Impulsive Noise Mitigation in Power line Communications Using Sparse Bayesian Learning" arXiv:1303.1217v1 [stat.ML] 5 Mar 2013.

[15] P. Amirshahi,S.M. Navidpour and M. Kavehrad "Performance Analysis of OFDM Broadband Communications System Over Low Voltage Power line with Impulsive Noise" 1-4244-0355-3/06/$20.00 (c) 2006 IEEE