ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 5, Issue 3, March 2018

Analysis of OFDM system Using Cyclic Prefix & Unique Word as guard band

[1] Vidhya Seeman, [2] Kushal Ghadge, [3] Harsha Ghadge
[1][2] Dept.of EXTCL, PVPPCOE
[3] Dept. Of EXTC, Pillai's College of Engineering

Abstract: **- The OFDM plays a very important role in communication. We used channel estimation for fast time varying channels based on BEM model using two dimensional prolate functions. We are using CP and UW for OFDM. Instead of the conventional cyclic prefix (CP), we use a deterministic sequence, which we call unique word (UW), as guard interval. We show how unique words, which are already well investigated for single carrier systems with frequency domain equalization (SC/FDE), can also be introduced in OFDM symbols. Since unique words represent known sequences, they can advantageously be used for synchronization and channel estimation purposes.**

***Index Terms*— OFDM, channel estimation, time-varying channel estimation, high mobility, intercarrier interference (ICI).**

I. INTRODUCTION

OFDM is a modulation scheme that allows digital data to be efficiently and reliably transmitted over a radio channel, even in multipath environments. Signals are orthogonal if they are mutually independent of each other. Orthogonality is a property that allows multiple information signals to be transmitted perfectly over a common channel and detected, without interference. Orthogonal frequency-division multiplexing (OFDM) is a popular multicarrier modulation technique with several desirable features, e.g. robustness against multipath propagation, high spectral efficiency, and easy to adopt in multi user setup. In an OFDM transmission, a large number of closely-spaced orthogonal sub-carriers, specifically, complex exponentials are used to carry data [5]. The data is divided into several parallel data streams, one for each subcarrier. Each subcarrier is modulated with a conventional amplitude modulation scheme at a low symbol rate, maintaining total data rate similar to conventional single carrier modulation schemes in the same bandwidth.

Orthogonal frequency-division multiplexing (OFDM)[3] is robust against frequency selective fading due to the increase of the symbol duration. However, for mobile applications channel time-variations in one OFDM symbol introduce inter carrier-interference (ICI) which degrades the performance. Many communication systems are operating in high frequency environment. For example, in mobile communications, a high vehicle speed causes the carrier frequency to spread out. This so-called Doppler spread yields a Time-Varying (TV) channel, whose channel taps vary with time. This condition provokes inter-carrier interference (ICI) that greatly degrades system performance. Basis Expansion Models (BEMs) can be used to approximate the time-variation within a certain observation. Unique word orthogonal frequency division multiplexing (OFDM)[9] is a promising alternative to cyclic prefix based OFDM (CP-OFDM), which currently denotes the method of choice for many digital communication standards, with applications ranging from audio and video broadcasting, last mile internet access to modern cellular networks. In this signaling concept, the guard interval (GI) is filled with an arbitrary deterministic sequence --- the so-called ``unique word" (UW) --- instead of the random CP. This sequence provides the same advantages as a CP (no intersymbol interference and diagonalization of the channel matrix), but can additionally be designed to optimally meet synchronization and estimation tasks. Furthermore, most important, and different to almost all signaling schemes of the OFDM family, the UW is already part of the discrete Fourier transform (DFT) interval. Ensuring such time domain properties entails the introduction of a certain redundancy in the frequency domain. This redundancy can be exploited beneficially to enhance range, reliability, capacity or battery lifespan. In this sense, UW-OFDM transforms the usually disregarded guard interval into a multipurpose sequence, thus tackling the well-known inefficiency problem of guard intervals in current communication systems. Moreover, adapting the UW and therefore the GI length to different channel conditions will not impact the DFT length and thus keeps relevant processing chain structures untouched. Hence, UW-OFDM allows supporting a wide range of communication scenarios while still ensuring high efficiency.

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 5, Issue 3, March 2018

II. METHODOLOGY

A. Overview on methodology

Orthogonal frequency division multiplexing (OFDM) based systems are strong candidates for an air interface of future fourth-generation mobile wireless systems which provide high data rates and high mobility. In order to achieve the potential advantages of OFDM-based systems, the channel coefficients should be estimated with minimum error. The channel estimation can be improved using more pilot symbols. However, it causes data rate reduction or bandwidth expansion. Therefore, spectrally efficient channel estimation techniques should be considered. We have used CP (or UW) for OFDM. Instead of the conventional cyclic prefix (CP), we use a deterministic sequence, which we call unique word (UW), as guard interval. We show how unique words, which are already well investigated for single carrier systems with frequency domain equalization (SC/FDE), can also be introduced in OFDM symbols. Since unique words represent known sequences, they can advantageously be used for synchronization and channel estimation purposes. In this paper, following objectives are covered. Discussion of OFDM with CP and with unique word Inclusion of a linear minimum mean-squared error (LMMSE) estimator at receiver side of OFDM Providing low complexity channel estimation algorithm using two dimensional prolate Plotting BER graphs and mentioning the less complex products The CP is less useful for other purposes like channel estimation, equalization, or synchronization as long as the content of the CP is not known and varies with every single block. The overhead induced by the CP could be used in a more efficient way if its content would be known before and could be chosen in a proper way.

B. Proposed Method

Instead of the conventional cyclic prefix (CP), we used a deterministic sequence, which we call unique word (UW), as guard interval. Unique words, which are already well investigated for single carrier systems with frequency domain equalization (SC/FDE), can also be introduced in OFDM symbols. Since unique words represent known sequences, they can advantageously be used for synchronization and channel estimation purposes.

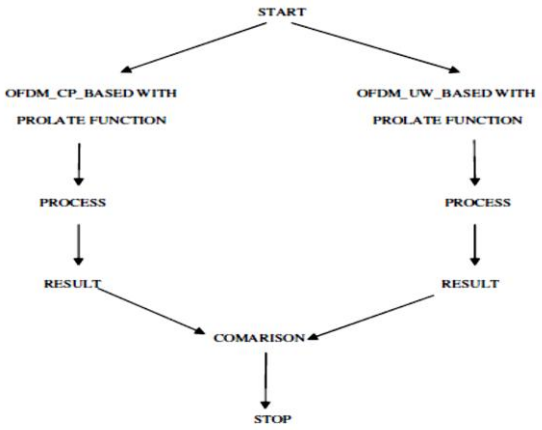

Fig.1.Complete Development Flowchart

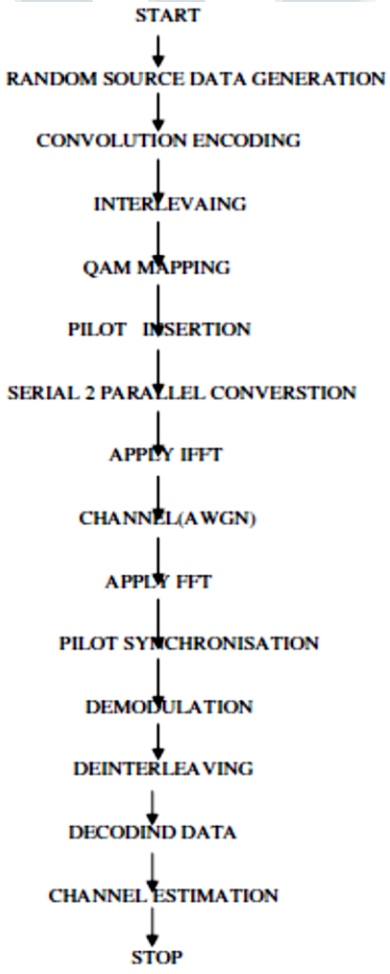

Fig.2.Flowchart for CP based OFDM system

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 5, Issue 3, March 2018

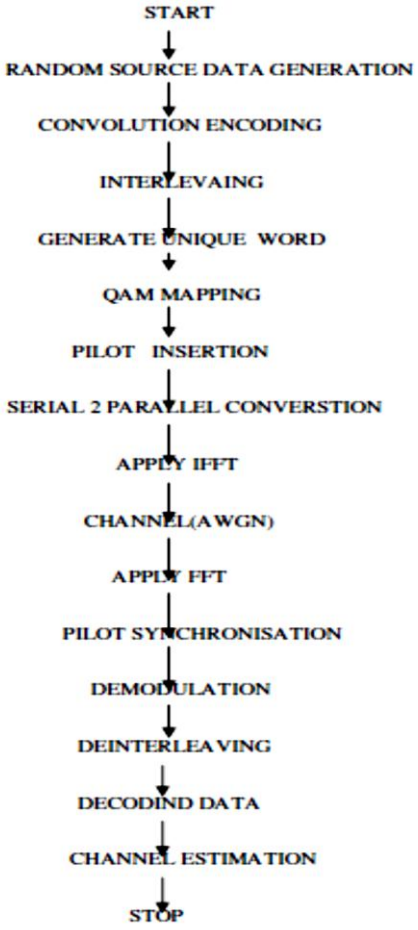

Fig.3.Flow for UW based OFDM system

III. SIMULATION RESULTS

The experiment was simulated using Matlab 7.10(2010a) under Windows 7 system having 3 GB RAM memory

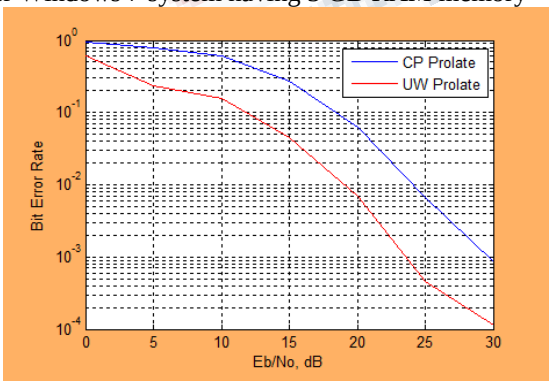

Fig.4.Experiment Graph

SNR \ BER	CP based OFDM	UW based OFDM
0 dB	0.92969	0.61719
5 dB	0.77437	0.23438
10	0.59922	0.15684
15	0.26734	0.045055
20	0.061766	0.0068438
25	0.0066375	0.00045055
30	0.00084813	0.00011406

Table 1. BER and SNR results

IV. CONCLUSION

The CP is a random sequence whereas the UW is deterministic. Hence, the UW can be optimally designed for particular needs like synchronization and channel estimation purposes at the receiver side. These advantages have already been investigated in the context of UW based SC/FDE systems. As UW-OFDM and UW-SC/FDE show the same transmit signaling structure, many of the concepts are likely to be easily transferrable. A second advantage of UW-OFDM over CP-OFDM is the fact that in UW-OFDM the guard interval is part of the DFT interval, whereas this is not the case for CP-OFDM. The generation of the UW within the DFT interval introduces correlations in the frequency domain which can beneficially be exploited by the receiver to improve the bit error ratio (BER) performance.

REFERENCES

[1] A. Molisch, M. Toeltsch, and S. Vermani, "Iterative methods for cancellation of intercarrier interference in OFDM systems," IEEE Trans. Veh. Technol., vol. 56, no. 4, pp. 2158–2167, Jul. 2007.

[2] F. Pe˜na-Campos, Roberto Carrasco-Alvarez, O. Longoria-Gandara, and R. Parra-Michel "Estimation of Fast Time-Varying Channels in OFDM Systems Using Two-Dimensional Prolate", IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS, VOL. 12, NO. 2, FEBRUARY 2013

[3] Farah Zaarour and Eric Pierre Simon," Fast Time-Varying Channel Estimation for OFDM Systems With Narrowband Interference", IEEE WIRELESS COMMUNICATIONS LETTERS, VOL. 4, NO. 4, AUGUST 2015

[4] Ting-Li Liu, Wei-Ho Chung, Member, IEEE, Shih-Yi Yuan, Member, IEEE, and Sy-Yen Kuo, Fellow, IEEE, "ICI Self-Cancellation With Cosine Windowing in OFDM Transmitters Over Fast Time-Varying Channels", IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS, VOL. 14, NO. 7, JULY2015

[5] Oana-Elena Barbu, Carles Navarro Manchón, Christian Rom, Tommaso Balercia, and Bernard H. Fleury, "OFDM Receiver for Fast Time-Varying Channels Using Block-Sparse Bayesian Learning", IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, VOL. 65, NO. 12, DECEMBER 2016

[6] C. Chen and M. Zoltowski, "Bayesian sparse channel estimation and tracking," in Proc. IEEE SSP, 2012, pp. 472–475.

[7] E. Panayirci, H. Senol, and H. Poor, "Joint channel estimation, equalization, and data detection for OFDM systems in the presence of very high mobility," IEEE Trans. Signal Process., vol. 58, no. 8, pp. 4225–4238, Aug. 2010.

[8] R. Prasad, C. Murthy, and B. Rao, "Joint approximately sparse channel estimation and data detection in OFDM systems using sparse Bayesian learning," IEEE Trans. Signal Process., vol. 62, no. 14, pp. 3591–3603, Jul. 2014.

[9] Mario Huemer1, , Christian Hofbauer1, and Johannes B. Huber2 "The Potential of Unique Words in OFDM", http://uwofdm.jku.at/publications