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An Improved Slot Based Filteration Approach to Reduce the ICI Cancellation using kalman filter

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Abstract*— Orthogonal Frequency Division multiplexing (OFDM) is a multicarrier modulation scheme that provides high spectral efficiency as well as high data rate transmission over the network. A well known problem with OFDM is that its sensitivity to the frequency offset between the transmitted and received carrier frequencies. This frequency offset introduced inter carrier interference in the OFDM symbol. This interference degrades the performance of OFDM system. So we focus on the problem of inter carrier interference (ICI) cancellation by using extended kalman filter (EKF). This paper also shows the simulation result under specific parameter and analyse the performance in reducing ICI.

Keywords*— OFDM, ICI, Extended kalman filter (EKF).

I. INTRODUCTION

The ever increasing demand for very high rate wireless data transmission calls for technologies which make use of the available electromagnetic resource in the most intelligent way. Key objectives are spectrum efficiency (bits per second per Hertz), robustness against multipath propagation, range, power consumption and implementation complexity. These objectives are often conflicting, so techniques and implementations are sought which offer the best possible trade off between them. The Internet revolution has created the need for wireless technologies that can deliver data at high speeds in a spectrally efficient manner. However, supporting such high data rates with sufficient robustness to radio channel impairments requires careful selection of modulation techniques. Currently, the most suitable choice appears to be OFDM (Orthogonal Frequency Division Multiplexing). One of the main reasons to use OFDM is to increase the robustness against frequency selective fading or narrowband interference. In a single carrier system, a single fade or interferer can cause the entire link to fail, but in a multicarrier system, only a small percentage of the subcarriers will be affected. Error correction coding can then be used to correct for the few erroneous subcarriers. The concept of using parallel data transmission and frequency division multiplexing was published in the mid-1960s [1, 2].

II. ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING

OFDM is multicarrier modulation techniques which divide the bandwidth into many carriers; each one is modulated by low rate data stream. Weinstein and Ebert [3], proposed a modified OFDM system in which the discrete Fourier Transform (DFT) was applied to generate the orthogonal subcarriers waveforms instead of the banks of sinusoidal Generator and reduced the implementation complexity significantly, by making use of the inverse DFT (IDFT) modules and the digital-to-analog converters. In their proposed model, baseband signals were modulated by the IDFT in the transmitter and then demodulated by DFT in the receiver. Therefore, all the subcarriers were overlapped with others in the frequency domain, while the DFT modulation still assures their Orthogonality. Cyclic prefix (CP) or cyclic extension was first introduced by Peled and Ruiz [4], in 1980 for OFDM systems. In their scheme, conventional null guard interval is substituted by cyclic extension for fully-loaded OFDM modulation. As a result, the Orthogonality among the subcarriers was guaranteed. With the trade-off of the transmitting energy efficiency, this new scheme can result in a phenomenal ISI (Inter Symbol Interference) reduction. Hence it has been adopted by the current IEEE standards.

Hirosaki [5], introduced an equalization algorithm to suppress both inter symbol interference (ISI) and ICI which may have resulted from a channel distortion, synchronization error, or phase error. In the meantime, Hirosaki also applied QAM modulation, pilot tone, and trellis coding techniques in his high-speed OFDM system, which operated in voice-band spectrum. Cimini [6] introduced a pilot-based method to reduce the interference emanating from the multipath and co-channels. In the 1990s, OFDM systems have been exploited for high data rate communications. In the IEEE 802.11 standard, the carrier frequency can go up as high as 2.4 GHz or 5 GHz. Researchers tend to pursue OFDM operating at even much higher frequencies nowadays. For example, the IEEE 802.16 standard proposes yet higher carrier frequencies ranging from 10 GHz to 60 GHz.

III. THEORY

Different possible way to minimize ICI, some of them can be named as:

1. Pulse shaping
2. Frequency domain equalization

3. Time domain equalization
4. ICI self cancellation
5. Extended kalman filtering (EKF)

Out of above one of important method is being taken into consideration for further exploration. This method is ICI reduction via extended kalman filtering (EKF).

EXTENDED KALMAN FILTER ICI CANCELLATION APPROACH

As it is well known that in OFDM systems ICI generally occur due to the small differences of carrier frequencies at transmitter and receiver. These differences of frequencies are commonly termed as frequency offset. Kalman filter are common in the field of engineering especially termed in communication & signal processing techniques. Kalman filter is outstandingly versatile and potent recursive approximation algorithm that has enormous application in communication such as adaptive antenna arrays, adaptive equalization of fading dispersive channel and adaptive equalization of telephone channel.

As a recursive filter, it is particularly applicable to non stationary process such as signal transmitted in time variant radio channel. In approximating non-stationary process, kalman filter computes and approximates its own performance as a part of the recursion and use this information to update the approximate at each step. Therefore approximation process is adjusted to the time variant statistical characteristics of random process.

A state space model of discrete kalman filter is defined as

Z(n)= a(n).d(n) + v(n)

In this model observation z(n) has a linear relationship with desired value d(n). By using discrete kalman filter, d(n) can be recursively estimated based on the observation of z(n) and updated estimation in each recursion is optimum in the minimum mean square sense.

$$y(n) = x(n)e^{j\frac{2\pi n'\varepsilon(n)}{N}} + w(n)$$

It can also be written as:

$$y(n) = f(\varepsilon(n)) + w(n)$$

Where

$$f(\varepsilon(n)) = x(n)e^{j\frac{2\pi n'\varepsilon(n)}{N}}$$

From talyor series expansion

$$y(n) \approx f(\hat{\varepsilon}(n-1)) + f'(\hat{\varepsilon}(n-1))\left[\varepsilon(n) - \hat{\varepsilon}(n-1)\right] + w(n)$$

Where $\mathcal{E}$(n-1) is the estimation of $\mathcal{E}$(n-1)

Define

$$z(n) = y(n) - f(\hat{\varepsilon}(n-1))$$

$$d(n) = \varepsilon(n) - \hat{\varepsilon}(n-1)$$

and following relationship

$$z(n) = f'(\varepsilon(n-1))d(n) + w(n)$$

This shows that z(n) are linearly related.

Now consider the certain assumption [7], the state equation to approximate the offset can be as

$$\varepsilon(n) = \varepsilon(n-1)$$

The pseudo (code for EKF) of computation can be give be given with state error

$$P(n) = \left[1 - K(n)H(n)\right]P(n-1)$$

And update approximate

$$\hat{\varepsilon}(n) = \hat{\varepsilon}(n-1) + \mathrm{Re}\left\{K(n)\left[y(n) - x(n)e^{j\frac{2\pi n'\hat{\varepsilon}(n-1)}{N}}\right]\right\}$$

On applying offset correction scheme [8]

$$\hat{x}(n) = FFT\left\{ y(n) e^{-j\frac{2\pi n'\hat{\varepsilon}}{N}} \right\}$$

IV. RESULT AND DISCUSSION

The Mat lab simulation results of EKF ICI cancellation approach under the following parameter are shown given below

Parameter	Specification
Number of symbol	1000
Sub-carrier size	512
Frequency offset	0.05, 0.15, 0.3
Signal Constellation	BPSK, QPSK
Data duration	3.2 micro sec

Extended Kalman filter (EKF) method for approximation and cancellation of the frequency offset for OFDM system result shows that this method does not reduce the bandwidth efficiency.

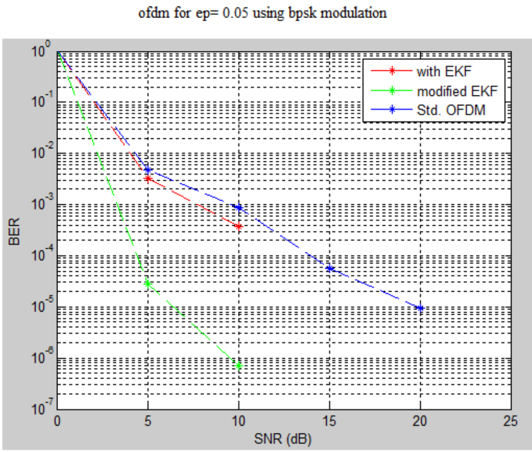

Fig. 1 BER performance of ICI cancellation with EKF, $\mathcal{E}$=0.05

In order to compare the existing Extended kalman filter with modified Extended kalman filter, BER curve were used to evaluate the performance of these techniques. Modulation schemes of BPSK and QPSK were chosen as they are used in many standards as 802.11a. Here the above plot shows between BER and SNR for BPSK modulation scheme, shows that modified Extended kalman filter perform well than existing kalman filter.

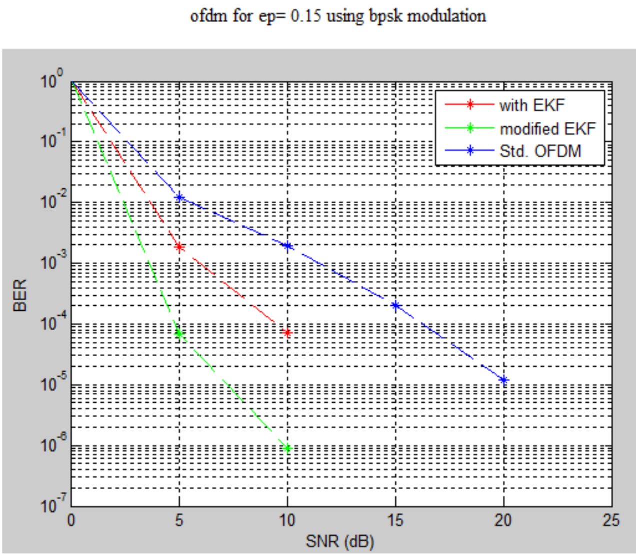

Fig. 2 BER performance of ICI cancellation with EKF, $\mathcal{E}$=0.15

Above diagram indicates that modified EKF reduced the ICI much more than the standard OFDM .

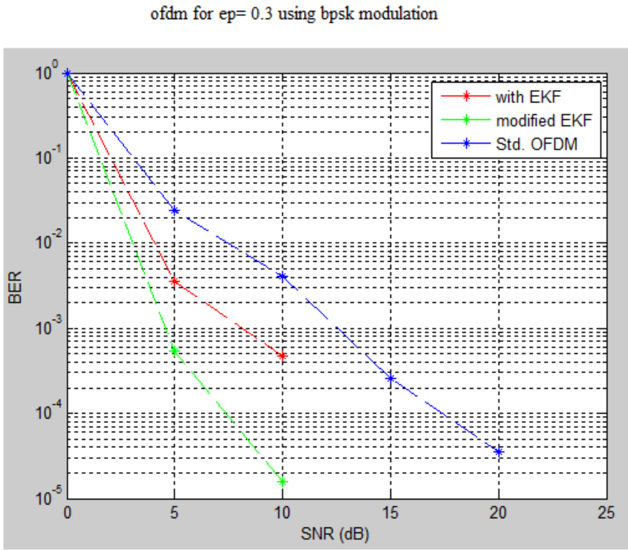

Fig. 3 BER performance of ICI cancellation with EKF, $\mathcal{E}$=0.3

From above diagram investigate that reduction in ICI much more in case of modified EKF as compare to existing EKF and standard OFDM. Below plot indicates that modified Extended kalman filter and existing kalman filter work well to reduce the ICI as compare to standard OFDM.

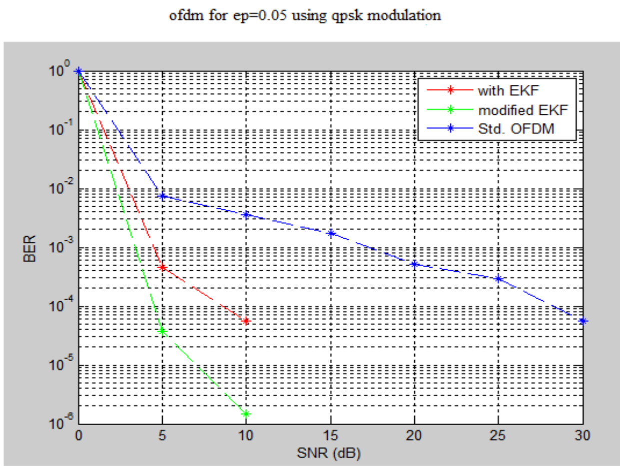

Fig. 4 BER performance of ICI cancellation with EKF, $\mathcal{E}$=0.05

Below diagram shows that modified filter perform better than existing EKF and Standard OFDM.

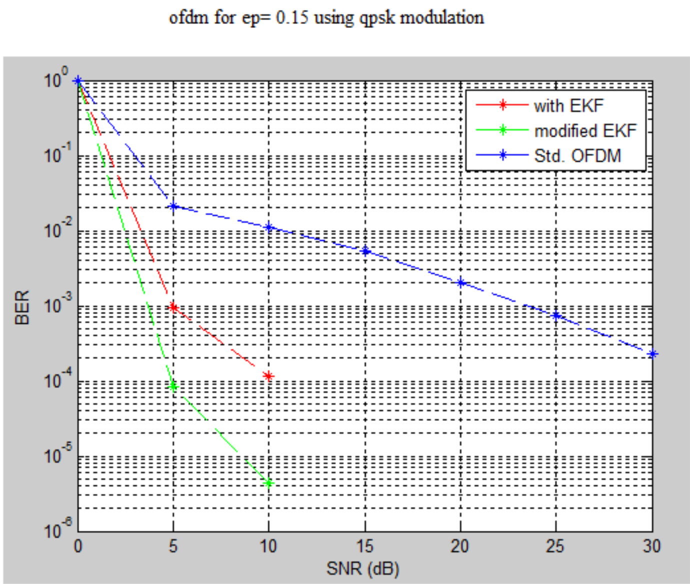

Fig. 5 BER performance of ICI cancellation with EKF, $\mathcal{E}$=0.15

Below diagram indicates that modified EKF perform well than the existing EKF and standard OFDM.

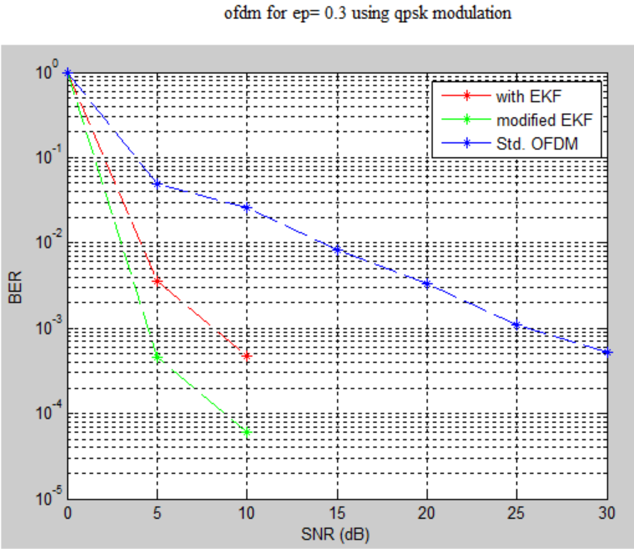

Fig. 6 BER performnace of ICI cancellation with EKF, $\mathcal{E}$=0.3

Required SNR and improvement for BER of 10^{-2} for BPSK

Method	ε= 0.05	Gain	ε= 0.15	Gain	ε= 0.3	Gain
Std. OFDM	**8**		**10**		**12.6**	
EKF	**6**	**2dB**	**5**	**5 dB**	**7**	**5.6dB**
Modified EKF	**3**	**5dB**	**3.6**	**6.6dB**	**4.5**	**8.1dB**

Required SNR and improvement for BER of 10^{-2} for QPSK

Method	ε= 0.05	Gain	ε= 0.15	Gain	ε= 0.3	Gain
Std. OFDM	**15**		**20**		**22.8**	
EKF	**4**	**11dB**	**4.8**	**15.2dB**	**7**	**15.8dB**
Modified EKF	**3**	**12dB**	**3**	**17dB**	**4.7**	**18.1dB**

V. Conclusion

Various methods have studied to reduce the ICI in OFDM. Modified Extended kalman filter (EKF) perform well for both BPSK and QPSK modulation scheme. Significant gain in performance can be achieved using modified EKF method for frequency offset value. This is attributed to fact that EKF method approximate the frequency offset very accurately and cancel the offset using approximated value.

References

[1] Chang R.W, synthesis of band limited orthogonal signal for multichannel data transmission, Bell syst. Tech., Vol. 45, pp.1775-1796, Dec. 1996.

[2] Salzberg, B.R, performance of an efficient parallel data transmission system, IEEE trans. Com., Vol. Com-15, pp. 805-813, Dec. 1967.
[3] S. Weinstein and P. Ebert, "Data transmission by frequency division multiplexing using discrete fourier transform", IEEE Trans. Communication, vol. 19, pp. 628-634, Oct. 1971.
[4] Peled and Ruiz, "Frequency domain transmission using computational complexity algorthim" , IEEE ICASSP '80', vol. 5, pp. 964-967, Apr. 1980
[5] Hirosaki, "An analysis of automatic equalizer for orthogonally multiplex QAM system", IEEE Trans. Communication, vol. 28, pp. 73- 83, jan. 1980.
[6] L. J. Cimini, "Analysis and simulation of a digital mobile channel using OFDM" *I.EEE* Trans. Communications, Vol. 33, pp. 665-675, July1985.
[7]http:// en. Wikepedia.org/wiki/kalman filter
[8]. http.//www. Complextoreal.com//chapter/ ofdm2.pdf.

