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Investigation of Inter Carrier Interference (ICI) in 3G

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Abstract*— *Orthogonal Frequency division multiplexing(OFDM) is promising technique for broadband wireless communication system in which inter carrier interference (ICI) occurs which must be removed. we investigate the Channel estimation techniques for OFDM. In this paper we investigate that DFT based channel estimation has been derived to improve the performance of LS or MMSE channel estimation by eliminating the effect of noise outside the maximum channel delay

Keywords*— *Orthogonal frequency divison multiplexing (OFDM) Inter carrier interference(ICI), The least-square (LS) and minimum-mean-square-error (MMSE), Discrete forier Transform(DFT)-Based Channel Estimation.

I. Introduction

In an OFDM system, the transmitter modulates the message bit sequence into PSK/QAM symbols, performs IFFT on the symbols to convert them into time-domain signals, and sends them out through a (wireless) channel. The received signal is usually distorted by the channel characteristics. In order to recover the transmitted bits, the channel effect must be estimated and compensated in the receiver. Each subcarrier can be regarded as an independent channel, as long as no ICI (Inter-Carrier Interference) occurs, and thus preserving the orthogonality among subcarriers. The orthogonality allows each subcarrier component of the received signal to be expressed as the product of the transmitted signal and channel frequency response at the subcarrier. Thus, the transmitted signal can be recovered by estimating the channel response just at each subcarrier. In general, the channel can be estimated by using a preamble or pilot symbols known to both transmitter and receiver, which employ various interpolation techniques to estimate the channel response of the subcarriers between pilot tones. In general, data signal as well as training signal, or both, can be used for channel estimation. In order to choose the channel estimation technique for the OFDM system under consideration, many different aspects of implementations, including the required performance, computational complexity and time-variation of the channel must be taken into account. Depending on the arrangement of pilots, three different types of pilot structures are considered: block type, comb type, and lattice type . A block type of pilot arrangement is depicted in Figure 1.1. In this type, OFDM symbols with pilots at all subcarriers (referred to as pilot symbols herein) are transmitted periodically for channel estimation. Using these pilots, a time-domain interpolation is performed to estimate

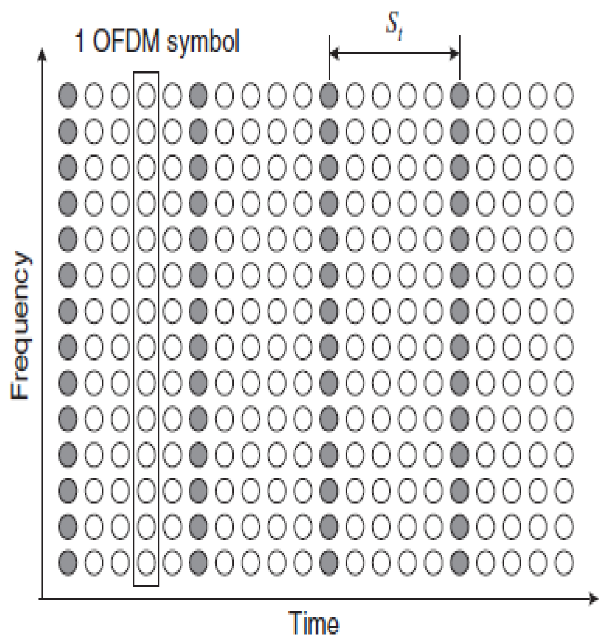

Figure 1.1 Block-type pilot arrangements.

the channel along the time axis. Let St denote the period of pilot symbols in time. In order to keep track of the time-varying channel characteristics, the pilot symbols must be placed as frequently as the coherence time is. As the coherence time is given in an inverse form of the Doppler frequency Doppler in the channel, the pilot symbol period must satisfy the following in equality:

$$s_f \leq \frac{1}{\sigma_{Doppler}} \qquad (1.1)$$

Since pilot tones are inserted into all subcarriers of pilot symbols with a period in time, the block-type pilot arrangement is suitable for frequency-selective channels. For the fast-fading channels, however, it might incur too much overhead to track the channel variation by reducing the pilot symbol period. Comb-type pilot arrangement is depicted in Figure 1.2. In this type, every OFDM symbol has pilot tones at the periodically-located subcarriers, which are used for a frequency-domain interpolation to estimate the channel along the frequency axis. Let Sf be the period of pilot tones in frequency. In order to keep track of the frequency-selective channel characteristics, the pilot symbols must be placed as frequently as coherent bandwidth is. As the coherence bandwidth is determined by an inverse of the maximum delay spread, symbol period must satisfy the following inequality:

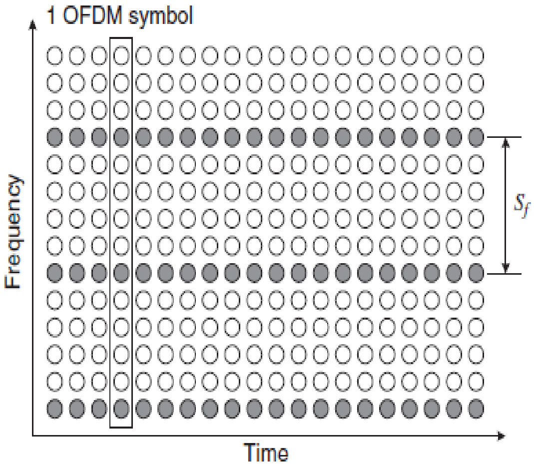

Figure 1.2 Comb-type pilot arrangement

$$s_f \leq \frac{1}{\sigma_{max}} \qquad (1.2)$$

As opposed to the block-type pilot arrangement, the comb-type pilot arrangement is suitable for fast-fading channels, but not for frequency-selective channels.

Lattice-type pilot arrangement is depicted in Figure 1.3. In this type, pilot tones are inserted along both the time and frequency axes with given periods. The pilot tones scattered in both time and frequency axes facilitate time/frequency-domain interpolations for channel estimation. Let S_t and S_f denote the periods of pilot symbols in time and frequency, respectively. In order to keep track of the time-varying and frequency-selective channel characteristics, the pilot symbol arrangement must satisfy both Equations (1.1) and (1.2), such that

$$s_f \leq \frac{1}{\sigma_{Doppler}} \text{ and } s_f \leq \frac{1}{\sigma_{max}}$$

where $f_{Doppler}$ and s_{max} denote the Doppler spreading and maximum delay spread, respectively.

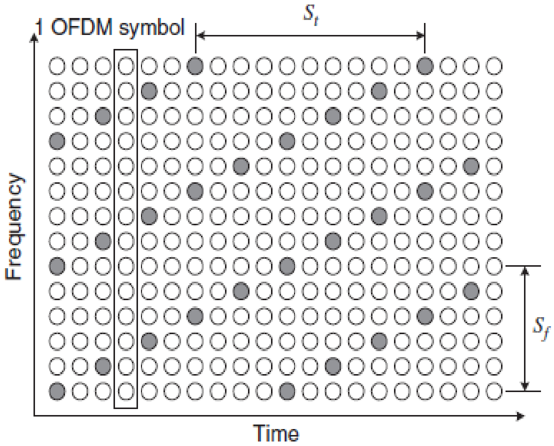

Figure1.3 Lattice-type pilot arrangement

II Training Symbol-Based Channel Estimation

Training symbols can be used for channel estimation, usually providing a good performance. However, their transmission efficiencies are reduced due to the required overhead of training symbols such as preamble or pilot tones that are transmitted in addition to data symbols. The least-square (LS) and minimum-mean-square-error (MMSE) techniques are widely used for channel estimation when training symbols are available .

III DFT-Based Channel Estimation

The DFT-based channel estimation technique has been derived to improve the performance of LS or MMSE channel estimation by eliminating the effect of noise outside the maximum channel delay. Let $\hat{H}[k]$ denote the estimate of channel gain at the kth subcarrier, obtained by either LS or MMSE channel estimation method. Taking the IDFT of the channel estimate $\left\{\hat{H}[k]\right\}_{k=0}^{N-1}$

$$IDFT\left\{\hat{H}[k]\right\} = h[n] + z[n] \square \hat{h}[n], \qquad \mathrm{n} = 0,1,....,\mathrm{N}-1 \tag{2.1}$$

where z½n_ denotes the noise component in the time domain. Ignoring the coefficients $\hat{H}[k]$ that contain the noise only, define the coefficients for the maximum channel delay L as

$$\hat{h}_{DFT}[n] = \begin{cases} h[n] + \mathrm{z[n]}, \mathrm{n} = 0,1,2,\cdots,\mathrm{L}-1 \\ 0 \qquad\qquad otherwise \end{cases} \tag{2.2}$$

and transform the remaining L elements back to the frequency domain as follows .

$$\hat{H}_{DFT}[k] = DFT\left\{\hat{h}_{DFT}(n)\right\} \tag{2.3}$$

Figure 2.1 shows a block diagram of DFT-based channel estimation, given the LS channel estimation. Note that the maximum channel delay L must be known in advance. Figures 2.2(a) and (b) show the received signal constellation before and after channel compensation for the OFDM system with 16-QAM, illustrating the effect of channel estimation and compensation.

Meanwhile, Figure 2.3 illustrates the channel estimates obtained by using the various types of channel estimation methods with and without DFT technique discussed in the above. Comparing Figures 2.3(a1), (b1), and (c1) with Figures 2.3(a2), (b2), and (c2) reveals that the DFT-based channel estimation method improves the performance of channel estimation.

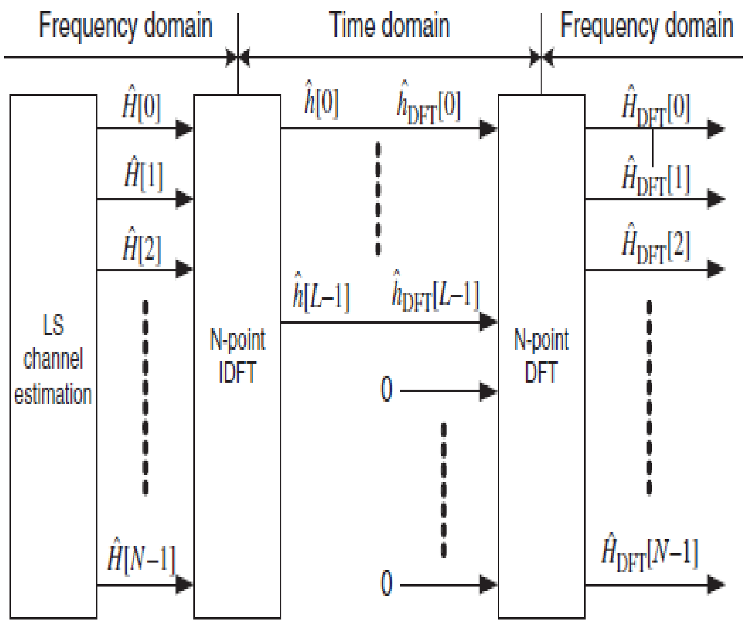

Figure 2.1DFT-based channel estimation.

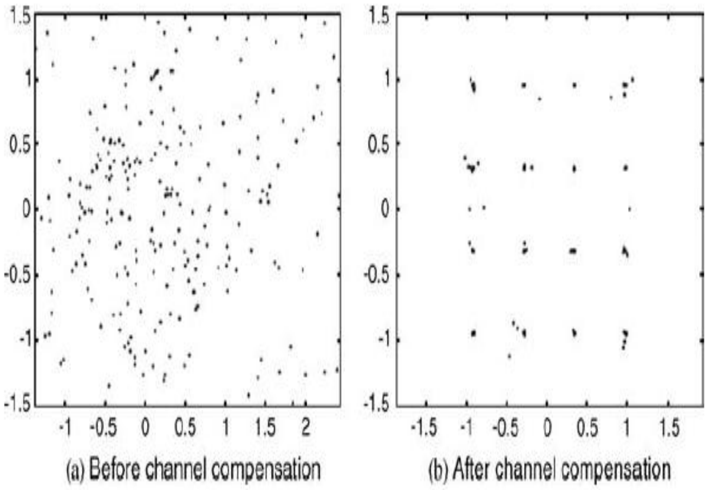

Figure 2.2 Received signal constellation diagrams before and after channel compensation.

Also, comparing Figures 2.3(a1) and (b1) with Figure 2.3(c1), it is clear that the MMSE estimation shows better performance than the LS estimation does at the cost of requiring the additional computation and information on the channel characteristic\

IV. Results of DFT channel estimation

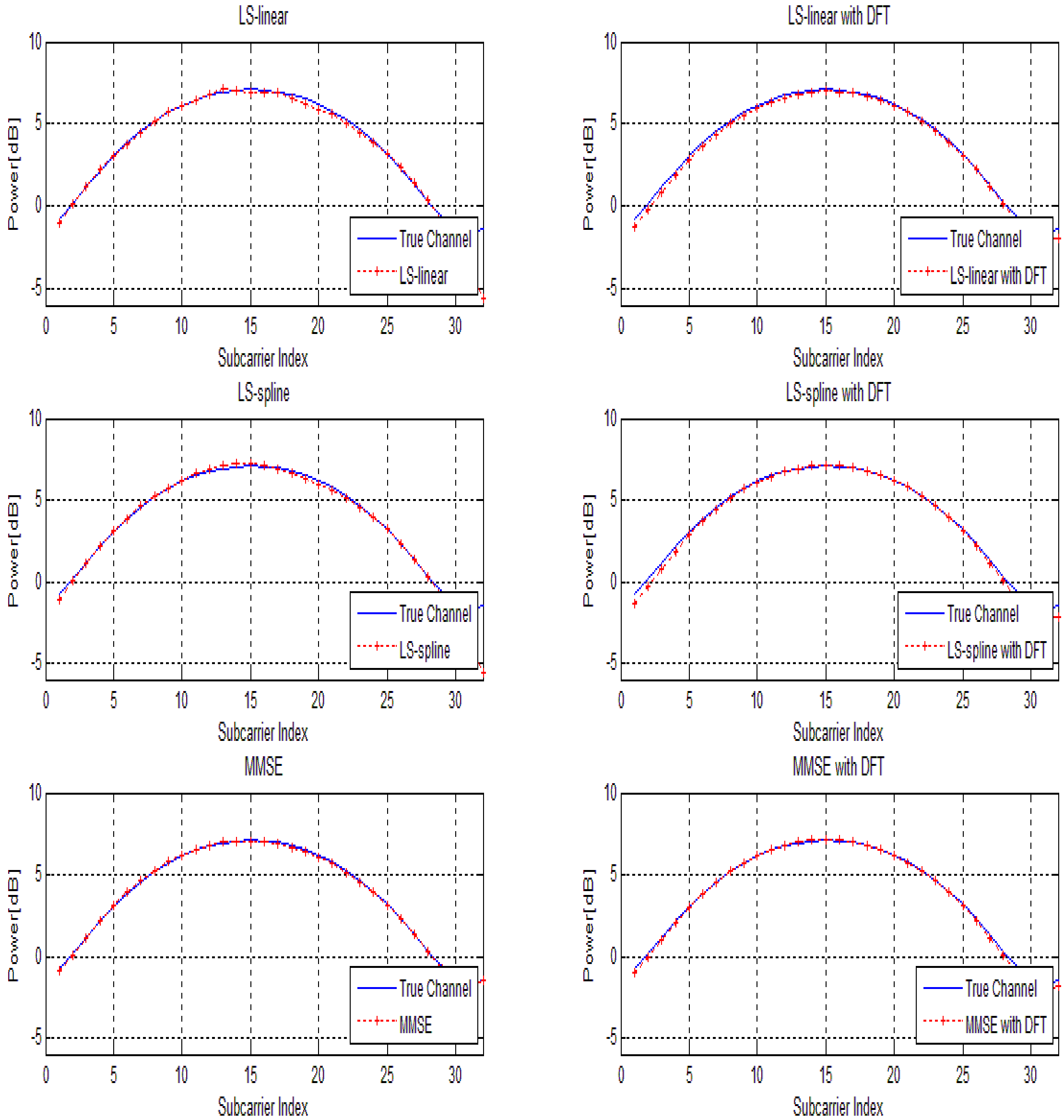

FIGURE 2.3 ILLUSTRATION FOR PERFORMANCE IMPROVEMENT WITH DFT-BASED CHANNEL ESTIMATIONV.

V. Conclusions

In this paper we investigate the ICI in OFDM channel estimation method. The DFT-based channel estimation technique has been derived to improve the performance of LS or MMSE channel estimation by eliminating the effect of noise outside the maximum channel delay. The further work can be done by extending the concept of channel estimation and by performing the simulation to investigate the performance of these ICI cancellation schemes in multipath fading.

References

[1] Weinstein,S.; Ebert, P. "Data Transmission by Frequency Division Multiplexing Using the Discrete Fourier Transform" IEEE Transactions on Communications, vol.19, 1971.

[2] Y.Zhao and S. Häggman, "Inter carrier interference self cancellation scheme for OFDM mobile communication systems," IEEE Transactions on Communications, vol. 49, no. 7, 2001.

[3] Yi-Hao Peng; Ying-Chih Kuo; Gwo-Ruey Lee; Jyh-Horng Wen;"Performance Analysis of a New ICI-Self-Cancellation-Scheme in OFDM Systems", vol.53, pages 1333 - 1338 ,2007.

[4] Hen-Geul Yeh; Yuan-Kwei Chang; Hassibi, B.;"A Scheme for Cancelling Intercarrier Interference using Conjugate Transmission in Multicarrier Communication Systems", vol.6, pages 3-7, 2007.

[5] Niranjane, V.B.Bhoyar, D.B. "Performance Analysis of Different Channel Estimation Techniques" Page: 74 – 78, 2011.

[6] P. H. Moose, "A Technique for Orthogonal Frequency Division Multiplexing Frequency Offset Correction," IEEE Transactions on Communications, vol. 42, no. 10, 1994.

[7] Allam Mousa1, Hala Mahmoud, "Reducing ICI effect in OFDM system using low complexity Kalman filter based on comb-type pilots arrangement", vol.24, page: 53-61, 2010.

[8] Senevirathna, S.B.; Jayawardena, C.; Perera, S.S.; Perera, C.L.; Ranasignhe, D.; Wijerathna, S.R.; Bandara, T.N.,"Carrier Frequency Offset Estimation for OFDM System using Extended Kalman Filter", Page(s): 351 – 354, 2008.

[9] B.Sathish Kumar K.R.Shankar Kumar R.Radhakrishnan "An Efficient Inter Carrier Interference Cancellation Schemes for OFDM Systems", (IJCSIS) International Journal of Computer Science and Information Security, Vol. 6, No. 3, 2009.

[10] V.Jagan Naveen and K.RajaRajeswari,"ICI Reduction using Extended Kalman Filter in OFDM System", vol.17, No.7, 2011.

[11] Colieri, S.; Ergen, M.; Puri, A.; Bahai A., "Study of Channel Estimation in OFDM Systems"Page: 894 – 898, vol.2, 2002.

[12] A. Zerguine (1990) Design of Fractionally Spaced Equalizers. Thesis, King Fahd University of Petroleum & Minerals Dhahran, Saudi Arabia.

[13] J. Proakis and J. H. Miller (July1969) An adaptive receiver for digital signalling through channels with intersymbol interference. IEEE Trans. I Vladimir D. Orlic and Miroslav Lutovac (2009) A solution for efficient reduction of intersymbol interference in digital microwave radio. TELSIKS, 15(2):463-464.

[14] Xuan-Thang Vu, Nguyen Anh Duc and Trinh Anh Vu (2010) 16-QAM Transmitter and Receiver Design Based on FPGA.5th IEEE Symposium on Electronic design, test and application , 95-98 .

[15] Antoinette Beasley and Arlene Cole-Rhodes (2005) Performance of Adaptive Equalizer for QAM signals. IEEE**,** Military Communications Conference, 4: 2373 - 2377.

[16] Kevin Banovi´c, Mohammed A. S. Khalid and Esam Abdel-Raheem (2007) A Configurable Fractionally-Spaced Blind Adaptive Equalizer for QAM Demodulators, Digital Signal Processing, 17(6): 1071-1088.

[17] S. U. H. Qureshi (1985) Adaptive equalization. Proceedings of the IEEE, 73(9):1349-1387.

[18] Mansoor Shafi and David J. Moore (1986) Further Results on Adaptive Equalizer Improvements for 16 QAM and 64 QAM Digital Radio. IEEE Transaction communication, V COM-34 (I):59-66.

[19] Pierre Duhamel, Mohsen Montazeri and Katia hilal (1993) Classical adaptive algorithm (LMS, RLS, CMA, Decision Directed) seen as Recursive Structure. IEEE International Conference on Acoustics, Speech, and Signal Processing, 3:496-499.

[20] Yongxue Zhang and Lixin Yu (2005) Implementation of Adaptive Blind Equalizer with Carrier Recovery for QAM Receiver Chip, 6th International Conference on ASIC, 1:147-152.

[21] Yuang Lou (1990) Adaptive Blind Equalization Criteria and Algorithms for QAM Data Communication Systems. Conference Proceedings, Ninth Annual International Phoenix Conference on Computers and Communications, 222-229.

[22] C. Dick, F. Harris and M. Rice (2000) Synchronization in Software Radios- Carrier and Timing Recovery Using FPGAs. [23]IEEE Symposium on Field-Programmable Custom Computing Mac B. Petersen, D. Falconer (1994) Suppression of adjacent-channel, cochannel and intersymbol interference by equalizers and linear combiners. IEEE Trans on Communication, 42: 3109-3118

