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Performance Analysis on the Basis of Efficiency Sensitivity and Error Percentage of Detection of Single Carrier FDMA

Navdeep Singh and Rinkesh Mittal

Department of ECE, Chandigarh Group of Colleges, College of Engineering, Landran, Mohali, India
nssmkk@gmail.com

ABSTRACT

In this research paper, we had studied the effect of different parameters to analyze the performance of detection of Single Carrier Frequency Division Multiple Access (SC-FDMA). We had analyzed the effects of various parameters like throughput, efficiency and error percentage while using linear receivers. Our goal was to find the simplest setting for Detection of SC-FDMA in which we had distilled out various effects. This paper identified the sensitivity of the results to various parameters involved. In the area of performance of interleaved and localized, SC-FDMA has been analyzed and it is found to be fairly non-trivial.

Key words: SC-FDMA, OFDM, DFT, ISI, PAPR

INTRODUCTION

Single Carrier Frequency Division Multiple Access (SC-FDMA) is a decent technique for high data rate up link and has been adopted by (3GPP) for the next generation cellular systems, called Long-Term Evolution (LTE). SC-FDMA is an amended type of Orthogonal Frequency Division Multiplexing (OFDM) with analogous complexity and throughput performance. The two effective methods for dealing with the inter-symbol interference (ISI) problem in frequency selective fading channels are: - (i) The Frequency domain equalization (FDE) for single-carrier transmission [1] and (ii) Multi-carrier systems constructed on OFDM [2]. Both the methods can be applied to multiuser communications that yield SC-FDMA [3] and Orthogonal Frequency Division Multiple Access (OFDMA) [4], respectively. In OFDMA all accessible subcarriers are grouped into dissimilar sub channels that are assigned to different users. User or separation parting at the receiver side is direct due to the orthogonally of the sub channels [5].

SC-FDMA can be regarded as a system of OFDMA in which Discrete Fourier Transform (DFT) and Inverse DFT (IDFT) are added at both the ends i.e. transmitter and receiver, respectively. DFT pre-coder covers all the symbols across the entire frequency band forming a structure of virtual single carrier. The benefit of FDMA matched to OFDMA is its lesser peak-to-average power ratio (PAPR). Though, the optimal multi-user detection in SC-FDMA in the existence of frequency selective channel results in prohibitive high computational complication. A linear minimum mean squared error (LMMSE) detector delivers an efficient low complexity scheme for the detection of FDMA signal in the manifestation of ISI and multiuser interference (MUI) using the circulate structure of channel matrices [5].

The technique of SC-FDMA is an efficient method for greater data rate uplink communication and has been implemented by 3GPP for its generation cellular system, called Long-Term Evolution (LTE). SC-FDMA is an enhanced form of OFDM with analogous throughput performance and complexity. This is many times observed as DFT-coded OFDM in which domain time data symbols are converted to domain frequency by a DFT and then goes over the typical OFDM modulation. Therefore, SC-FDMA gets all the advantages of OFDM over other renowned methods such as Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA) [6].

The key problem in covering Global System for Mobile Communication (GSM) TDMA and CDMA wideband to broadband schemes is the rise in complication with the multipath signal reception. The main benefit of OFDM is its robustness contrary to multipath signal propagation, which makes it appropriate for broadband systems. SC-FDMA gets further advantage of PAPR as compared to OFDM creating it applicable for uplink broadcast by user-terminals [7].

TECHNIQUE AND METHODS

Detection of Received Signal

We first consider the detection of the SC-FDMA symbol sent over a block fading frequency selective channel in which the channel stays constant over the period of a whole symbol and there isn't phase noise. We suppose that perfect frame synchronization, including carrier frequency recovery continues to be established in the training stage. We had implemented the current channel conditions which are estimated in the training phase. We have predicted that the channel state details are offered at the receiver. The model established in this way is essential in understanding the outcome of phase noise on a conventional LMMSE receiver for SC-FDMA [9]. An applied SC-FDMA detector generally includes a single tap FDE then the solicitation of the inverse DFT. The Frequency domain minimum mean square error (MMSE) is most frequently engaged though other linear detectors, such as zero forcing (ZF), are also promising. Yet, linear detectors are suboptimal in unadorned multi-path environment for scattered SC-FDMA and localized SC-FDMA. Non-linear detection of SC-FDMA has involved considerable responsiveness.

More progressive SC-FDMA detection systems, whose performance lie among those of MMSE and MLD, are being used. Turbo equalization (TEQ) and frequency domain TEQ (FD-TEQ) were projected as natural applicants for SC-FDMA detection in the cases where channel coding is used. When the method of TEQ is executed, the equalizer and the channel decoder are instigated as soft input - soft output blocks, divided by proper bit adds. Information formed by one of these blocks is deliberated as a-prior information for the other, subsequent with an iterative receiver structure. The receiver implements the group interference suppression (GIS) technique in which assemblies of symbols, consistent to highly correlated columns are compared. Each assembly undergoes joint detection which trails a linear pre-filtering process aiming at repressing the interference from all the supplementary symbols [8]. Unlike the standard OFDM in which each data symbol is carried by each subcarrier, the SC-FDMA transmitter contains data symbols over a group of subcarriers that are transmitted concurrently. In other words, the group of subcarriers that hold each data symbol can be seen as one frequency band carrying data in succession in a standard FDMA. SC-FDMA offers comparable performance and complexity as OFDM. However, the key advantage of SC-FDMA is the low peak-average-power ratio of the transmitted signal [10]. As we know that peak-average-power ratio is defined as the proportion of peak power to the average power of the transmitted signal. As PAPR is major key concern at the user terminals, due to low PAPR the SC-FDMA is the preferred technology for the uplink transmission.

Detection in the Presence of Phase Noise

PAPR in SC-FDMA also tells the power amplifier efficiency at the transmitter side, and the highest power efficiency is achieved when the amplifier is operating at the saturation point. Lower PAPR allows processing of the power amplifier all-around saturation resulting in higher efficiency [11]. With higher PAPR, the power amplifier operating point needs to be backed away and off to decrease the signal distortion, and thereby lowering amplifier efficiency. SC-FDMA modulated signal can be seen as a single carrier signal, thus, a pulse shaping filter can be used to transmit signal to further improve PAPR. As the overall significance of SC-FDMA is increasing day by day so in this thesis, we should do a performance analysis of this transmitter for considering the viability a variety of forms of applications [12]. An analysis at this stage isn't going to reveal the role played by sub-carrier allocation. Due to the circular symmetry of the matrices used for simulation, all the sub-carriers are similarly affected by phase noise irrespective of the allocation scheme used. The difference arises after the channel equalization step [6].

RESULTS AND DISCUSSION

In this paper, we discussed the various architecture techniques of FDMA. Suppressed carrier frequency modulation is an efficient technique of signal transmission and reception. This technique is robust and the phase noise interference is very less that makes it better than other modulation techniques. During the implementation of the parameter optimization, we had provided an overview of nonlinear frequency domain equalization techniques for SCM transmissions. The main advantage of the frequency domain approach is a reduced complexity with respect to time domain implementations, due to its efficient implementation by means of FFTs. On the other hand, nonlinear equalization can be implemented fully in the frequency domain only by iterative techniques and with the burden of reduced bandwidth efficiency due to the use of PN extension. Still, when compared to OFDM which has the same spectral efficiency, SCM systems with frequency domain equalization have the advantage of a lower peak to average power ratio while still retaining good performance and the convenience of resource allocation by DFT pre-coded OFDM or single carrier frequency domain multiple access.

Frequency domain nonlinear equalization techniques can be extended to multi-antenna systems, as shown in this paper, with a wide range of configurations for a flexible use of space, time and frequency dimensions. The importance of SCM transmissions with FD equalization is confirmed by being under consideration in various standards, the most recent being 3GPP-LTE and LTE-Advanced.

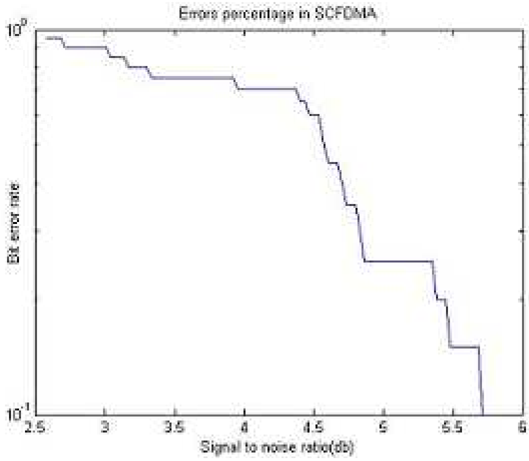

Fig.1 Checking the error percentage of the SCFDMA signal

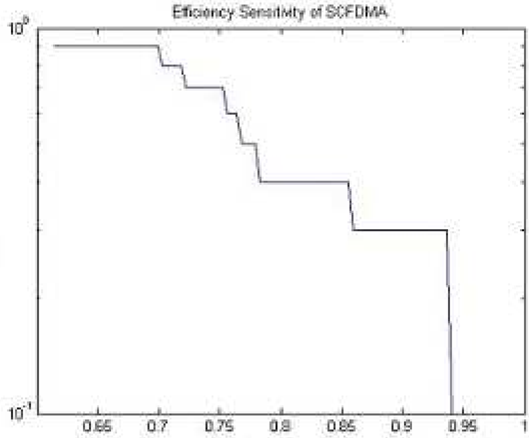

Fig. 2 Efficiency sensitivity of SCFDMA

The research work used MATLAB and its network and communication tool box for implementation and calculating the association of considerable phase noise components with terms that contribute to multiuser interference. I have understood that this is the fundamental cause for the performance gap between interleaved and localized SC-FDMA. Fig.1 shows the empirical and theoretical estimates of analysis of localized SC-FDMA. We can clearly see that at high SNR, the total interference in this case of localized SC-FDMA is higher than interference seen in the case of restricted SC-FDMA by a factor of 4, which clarify the difference in the SINRs of different types of SCFDMA.

CONCLUSION

OFDM has been broadly accepted as a viable solution for such high-speed broadband applications. In this thesis, we attempted to present a complete overview of a promising substitute solution, SC-FDE, which has been in the past shadowed by OFDM. Although the basic idea of SC-FDE can be traced back to adaptive equalizers, the recent increase of interest in SC-FDE was subsequent to the work. SC-FDE enjoys a similar complexity to OFDM due to the similar transceiver architecture which is based on efficient FFT/IFFT operations. A number of aspects in the practical implementation of SC-FDE have been further studied in the recent years including FD channel estimators, non-linear equalizers, training sequence design, interference rejection etc. These recent studies can be successfully integrated SC-FDE in signaling system.

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