A Novel Channel Estimation Technique in MIMO-OFDM Mobile Communication Systems

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Abstract

4G Wireless communication systems have the inherent capability to foster the multimedia services in terms of bandwidth and data rate. These systems have very high integrity compared to the conventional wireless communication systems. It can fully support extended multimedia services with High Definition quality, audio and video files. Wireless internet and other broad band services provided superior quality signal transmission and reception. The degree of freedom enjoyed by the technology in terms of scalability and reliability is highly commendable. Any basic wireless transmitter sends information by varying the phase of the signal. In the receiver end, the desired signal can be decoded by appropriate decoding algorithm. The degradation occurs at the conventional receivers due to lack of Channel State Information. The efficiency of 4G system purely relies on the performance of receiver and is purely dependent on the synchronization of estimated instantaneous channel. In any wireless terminal, channel state information provides the in and around status of the channel. It provides the following parameters of the propagating signal (ie) Scattering, Fading and Attenuation. The dynamic estimation of channel state information can be obtained through Enhanced Least Squares channel estimation algorithm. It is based on Multi Carrier Filter Bank Transmission system. This kind of dynamic estimation can be done with a set of well-known sequence of coded unique bits .For a transmitter the information propagation is initiated in the form of frame bursts. It enhances the throughput of the system to the required level.

Keywords: Multiple Access interference, Multi User Detection

I. Introduction

It is greatly incontrovertible that quantum of information sent over any type of communication system is rapidly multiplying to cater the end user needs in the current era. The architecture proposed for this kind of service handing not only demands increased file transmission rate, but also needs to ascertain timely and reliable delivery in a synchronous manner. As the process requires enormous bandwidth, the system modelling should govern the effective usage of communication parameters that focus on giant capacities. The exploitation of Spatial dimension plays a vital role in utilization of periodicity of channels. If correctly interpreted, the system enhances its capability to run in a multipath scattering environment with full efficiency. To handle parallel streams of information, Multiple Input Multiple Output (MIMO) technology can guarantee increased Signal to Noise Ratio (SNR) and reduced Inter Symbol Interference (ISI). By exploiting the contrasting knowledge streams on divergent transmitting antennas capability of MIMO, the objective for error free communication can be guaranteed that enhances the desired performance of the proposed architecture. The current generation decoders man oeuvre spectrally economic transmission technologies like Orthogonal Frequency Division Multiplexing.

II. Existing techniques

To achieve high spectral efficiency, Filter Bank based Multi carrier system (FBMC) is proposed. It provides high flexibility compared to conventional OFDM systems. FBMC makes use of Trans-multiplexer structure that consists of Analysis and synthesis filters respectively. A series of parallel transmit filters constitute synthesis filter bank and series of matched filter helps in building analysis filter banks. Typically, modulated filter banks are used as a computationally efficient solution, whenever filter banks are needed. Its unique feature includes less propagation delay that reduces BER to the maximum extent. This interesting feature helps in performance improvement of Maximum Likelihood Decoding technique in MC CDMA systems as presented in [1].

To clearly illustrate the advantages of MC CDMA system, a low complexity closed solution is proposed to obtain energy efficient link adaptation in frequency-selective channels is evaluated in Miao et al (2012). In this paper a closed form expression is derived to obtain energy-efficient schedulers. The results provide satisfactory performance compared to globally optimized solutions for energy efficient schedulers in OFDM system, a multiuser parallel scheduling scheme is proposed to combat MAI and increase the spectral efficiency of the system. The clear intent of the article is to increase the capacity and performance of multiuser systems where every scheduled user is interfering with every other scheduled user. The amount of interference is significantly substantial to the number of scheduled users. The users served starts increasing linearly. There arises a trade-off between system throughput and number of scheduled users. The analytical results will motivate the system designer to appropriately choose the required number of scheduled users. It maximizes the overall throughput and as well as it maintains the desired quality of service under appropriate channel conditions as explained in [2].

A set of equalizers and precoders in a MIMO interference channel play a vital role in mitigating interference. Precoder provides accurate Channel state Information (CSI). It will certainly enable the proposed MC CDMA system to evaluate the impact of interference in a channel environment. Multiple antenna pre-coding technique incorporated will effectively mitigate the interference in any wireless communication model. This work focus on the issue of finite-rate CSI feedback from receivers. Also, it takes care of interfering transmitters in the two-user multiple-input-multiple-output (MIMO) interference channel, termed as cooperative feedback. The mathematical formulation aims in constructing a co-operative precoder that clearly identifies residual interference is presented in [3].

Consider a minimal branch two-branch transmit diversity scheme to enable synchronization between the transmitter and the desired receiver. The scheme makes use of maximal-ratio receiver combining that incorporates a single transmitting antenna and two receiving antennas to achieve transmit diversity and explain the phenomena of multipath propagation. This new technique offers uniqueness in terms of nil bandwidth expansion and feedback from receiver that enhances the performance of the proposed MIMO OFDM system.[4] With the intent to enhance the performance of diversity schemes, a parallel data transmission system with large number of overlapping channels is proposed. The transmission rate of the data rate of the diversity receiver is governed Nyquist rate that guarantees interference free transmission. A precise synchronized phasing technology is employed by the demodulator to decode the carriers based on sampling time. In order to keep propagation delay and amplitude distortions at certain level precise phasing is necessary. In presence of intra symbol interference and inter symbol interference, better results are obtained with the proposed diversity scheme. Spatial data multiplexing is an interesting alternative to reduce guard interval. This technique along with Offset QAM helps in improving the spectral efficiency of Multi carrier systems as carried out. This paper makes a thorough investigation on radio channels associated to non-iterative and iterative receivers that determine the effectiveness of the system. [5]

The importance of channel estimation in analyzing the performance of multi carrier systems, Optimal preamble-based analysis for Least Squares channel estimation in Cyclic Prefix-Orthogonal Frequency Division Multiplexing and OFDM will provide a complete solution to mitigate interference, for both full and sparse preambles. An Equipowered and equispaced pilot tone takes care of reducing the bandwidth expansion thereby offering optimal spectral efficiency required to the system for providing satisfactory performance in noisy environment. The performance of estimation relies in the choice of sparse preamble and channel taps. This optimal preamble when compared with conventional system yields enhanced reliability of the channel characteristics and the channel itself, provided the whole pulse is transmitted in the training phase itself. A standard suitable channel model and the system parameters will reduce synchronization error.[6] Spatial data multiplexing is an interesting alternative to reduce guard interval. This technique along with Offset QAM helps in improving the spectral efficiency of Multi carrier systems as carried out. This paper makes a thorough investigation on radio channels associated to non-iterative and iterative receivers that determine the effectiveness of the system. [7]

Alamouti presents a novel 1+1 diversity branch scheme-based architecture for a noisy environment. The model makes use of maximal-ratio receiver combining that incorporates a single transmitting antenna and two receiving antennas to achieve transmit diversity and explain the phenomena of multipath propagation. This new technique offers uniqueness in terms of nil bandwidth expansion and feedback from receiver that enhances the performance of a MC CDMA system.[8] A key component of MIMO OFDM system is interference cancellation, which is realized through use of proper interference cancellation algorithm. Interference cancellation algorithms play a vital role in enhancing the performance of OFDM systems. The graded diversity-based pilot single-carrier and OFDM systems has been explored and balanced with Nakagami-fading channel. The underlying statistical parameter of multiple synchronous states in the graded region of the PN code is found in [9].

III. Proposed Methodology

Analysis on the evaluation of Multiuser Detection technique that improves performance of MC CDMA is discussed. Multiuser detection (MUD) for CDMA systems can be employed to estimate error using robust detectors. In the proposed Multiuser Detection, analysis of robust channel estimation and MUD techniques for MC CDMA is proposed. The proposed technique makes use of optimized set of linear detectors that perform well in worst case scenario .Considering the case with two types of estimation errors due to prior channel estimation and covariance matrix ,it is observed that calculation of bounded probability provides a best solution to yield optimization set for worst case performance of robust detectors. Hence MC CDMA employing MUD provides best results at the cost of high computational complexity.[10] The emulsion proposed for fully suppressing the MAI for a given set of uplink frequency involves construction and modelling of a quasi synchronous MC CDMA network .Multipath distortions and carrier frequency offsets are considered as significant parameters in statistical modelling. A set of exponential orthogonal codes with selecting a suitable spreading code enhances the synchronization. It does not need any channel state information at the transmitter side. In the work, the MAI suppression is achieved by following a effective transmission scheme and use of suitable orthogonal codes.

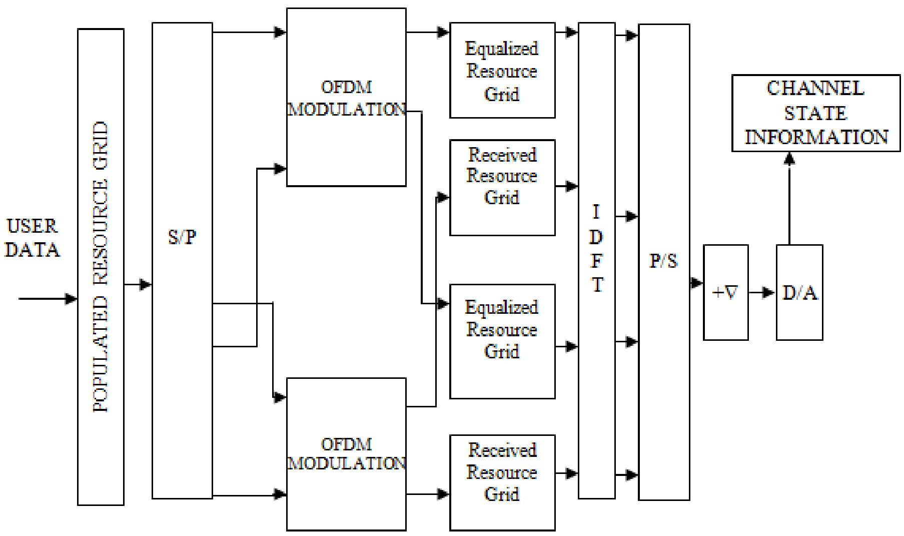

Fig 1: Channel Estimator for Enhanced Least Squares

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With the objective to enhance the error performance of the receiver, channel estimation plays a vital role in an OFDM system. It is used for capacity multiplying of the conventional systems and thereby allowing autonomous synchronization between the transmitter, channel and the receiver. To acquire the channel characteristics, MIMO uses pilot symbols as reference symbols. It is inserted in both time and frequency. Each sub frame in a populated grid provides localization of the channel estimate at given time interval in a specific uplink frequency band. A dynamic channel estimation in terms of sub-frames are coveted by the filter banks. Thereference symbols in the diversity receivers are assigned positions within a sub-frame. Depending on the cell identification number and height of the transmit antenna interpolation scenario based on populated grid exists shown in the following figure.

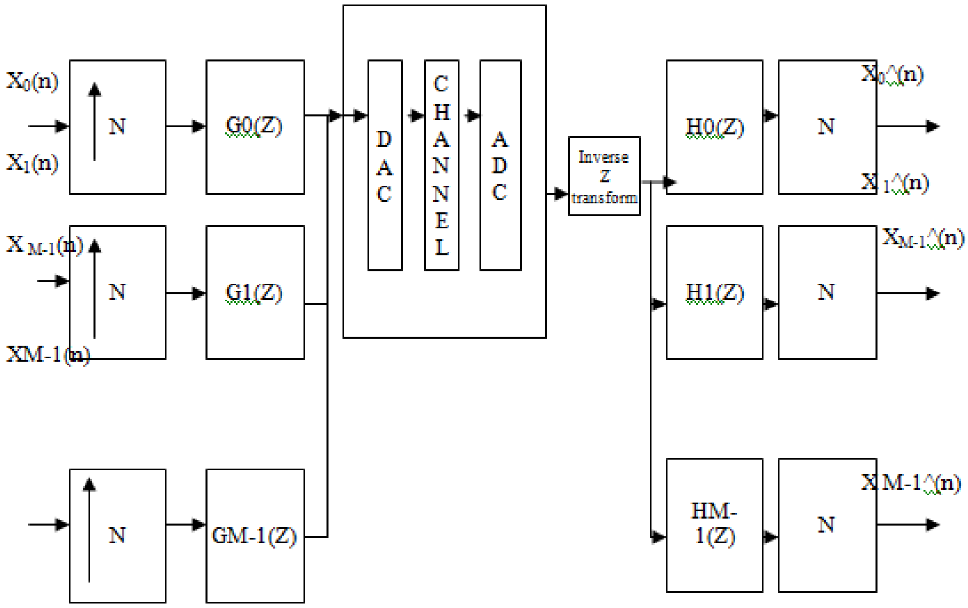

Fig 2: Proposed linear channel estimator

Consider a system with K transmitters, each transmitting N subcarriers. Each subcarrier is allocated a different value of chip interval T_C.

(i) Initially set the modulation scheme as 64-QAM to all the subcarriers.

(ii) Determine E_i
Ei=E M, i / log 2 (Mi)
Where i=1,2,….N, given the subcarrier SNR values
Set E_T as threshold probability of Error.

(iii) Compute Ē which is the mean probability of error.

(iv) Compare Ē with E_T. If E is less than E_T. If Ē is less than E_T, then current configuration is kept and algorithm ends.

(v) Search for the subcarrier with worst E_i and reduce the constellation size to 16-QAM and null the subcarrier.

(vi) Repeat the same procedure to compute E_i for all the subcarriers with changed allocation and comeback to step(v).

(vii) Formulate the convergence point E_c, SNR roundabout with interference cancellation frequency.

a) Calculate the convergence BER E*=Q (SNR/N_0) (8)

b) Leti=1.Fix intersection path set to contain significant path E_m{(1)}and equivalent metricsetm ={iinfinite}.

c) i =i+1. For each state value 'n' extend E'$_m$-1 ending in state n' defined along transition n' n, acquiring the new path E_m in $E_{m,n}$ and up date the metric in $E_{m,n}$ using$_m$=i$_{inf}$(').

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d) The current optimal path is selected based in redundant ‘n’ paths.

e) Define a set of metrics for paths that have reached the target BER, the convergence point for receiver iterations.

For all the iterations of the receiver, derive the CSI periodically to achieve target SNR requirements. The refining process based on adaptive BER determination provides an optimal solution in terms of reduced Bit Error Probability thereby reducing the interference power.

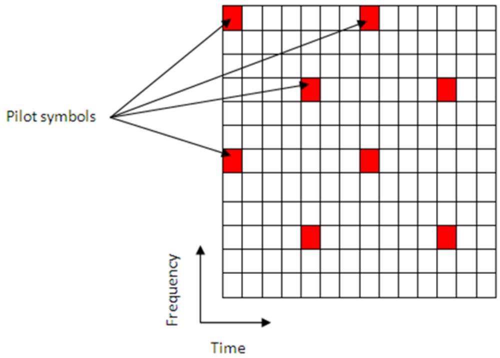

Fig 3: Proposed Populated Grid Scenario

IV. Simulation Results

The Simulation results are shown above. the System Throughput performance of proposed MIMO OFDM system versus Number of users for system throughput 480 bits/block. Again, because of synchronous transmission and reception, desired performance in terms of number of users is easily achieved for worst case SNR values.By proper channel selection, BER of the system can be minimized to maintain the original signal strength at the receiver which is supposed to be the best signal at receiver.

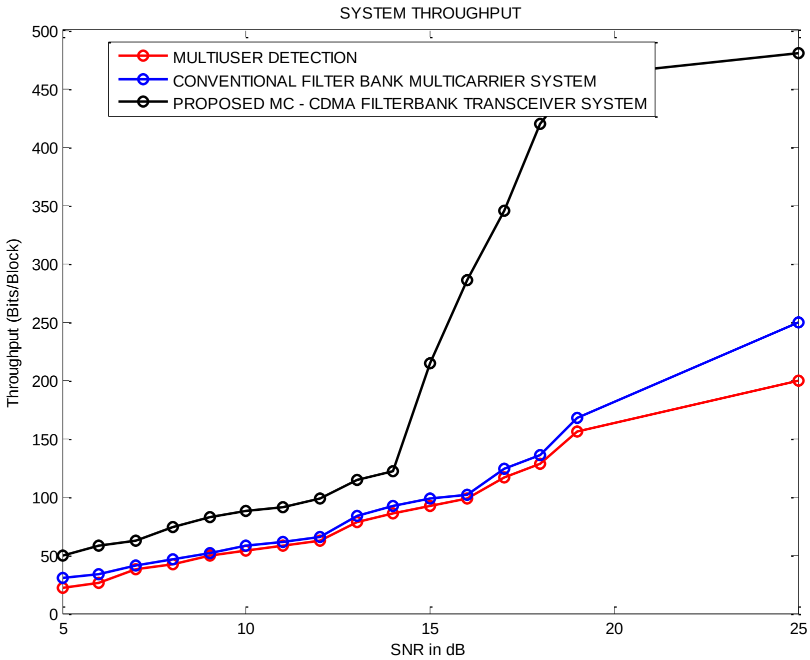

Fig 4: Over all System Throughput of MIMO OFDM System using LS Channel Estimator

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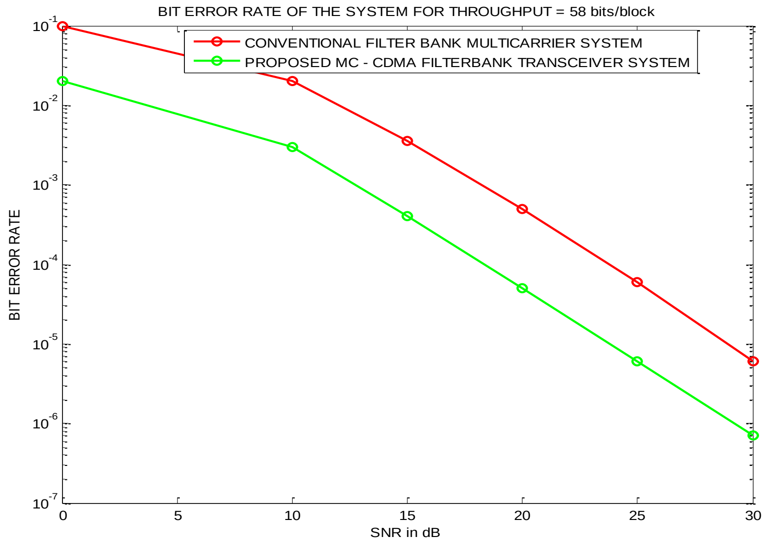

Fig 5: SNR vs BER performance of MIMO OFDM System using LS Channel Estimator

Table 1: Comparison of parameters

S.No.	Parameters	MIMO systems	LS Channel	MIMO-OFDM
1	SNR	20	2.4	48
2.	Channel Capacity	22	5.6	52
3	Noise index	21	4.2	64
4	Noise Figure	18	5.3	85
5	Aspect ratio	17	6.2	53

V. Conclusion

In the proposed work, MIMO OFDM channel estimation technique holds a key, promising next generation wireless technology.It achieves variable data rates in a multi cell and femto cell environment. In addition, various data sets in real time traffic can be obtained by changing the size of the code sequence set, with the same total bandwidth, both analytical and simulation.The MIMO OFDM receiver with proposed Enhanced LS Algorithm helps to obtain better signal strength and mitigate interferences which tend to degrade the signal strength at the receiver section. Simulation results prove the efficiency of the proposed algorithm.

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