Review of Joint Estimation of Channel and Frequency in MIMO OFDM System with Different Block Coding Technique

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Abstract—*The wireless channel suffers from attenuation due to destructive multipath in the propagation media. These forms of attenuation result in the inefficient and unreliable transmission of data over many radio channels. Some possible, but non-pragmatic, solutions to combat this degradation are to increase transmission power, antenna size, or antenna height. A practical alternative to these solutions would be to transmit some less-attenuated replica of the signal to the receiver thereby increasing the probability that the receiver will receive a less corrupted signal. This scheme of transmission and reception is called diversity and is one of the most important techniques used to mitigate the effects of fading in wireless communications. Space-Time Trellis Codes (STTCs) were introduced for a high data rate, bandwidth and power-efficient method of communication over wireless Rayleigh and Rician fading channels. STTCs can achieve a diversity advantage by placing the diversity burden on the BS, and hence leaving the MS to maintain its mobility and practicality.*

Keywords*: Wireless communication, MIMO, OFDM and Space time coding (STC).*

1. INTRODUCTION

In the past, the communication systems like telephony and telegraphy etc, were all analog and use electrical wires. They are hence the examples of wired communication system. With further development, the focus shifted towards digitization of the communication system. A major breakthrough in this field with the advent of the wireless technology due to the invention of radio system. Since then, wireless technology has evolved at a fast pace and hence revolutionized the field of wireless communication system. Initially, wireless communication was used for military and other non commercialized applications but when the wireless communication links are commercialized then it results in the rapid advancement and development of the physical layer design issues for providing high and error free signal transmission, which makes the foundation of second-generation technology (2G) and subsequently the development of third-generation technology (3G). The second generation technology (2G) has been in use mainly for voice, data and slow transmission of the signal. And now with the introduction of GPRS, video signal transmission, high data rates services etc, the base of third generation technology (3G) has been confirmed and the research and development is already aiming for the successful development and deployment of fourth generation technology (4G). The propagation of signal through the wireless channel suffers from multipath fading that prevents the maximum use of available bands of frequency spectrum. This multipath fading mainly occurs due to the reflection, diffraction, scattering, shadowing and from surrounding buildings and structures through which the wireless signal transmission takes place. Out of these, the multipath fading due to shadowing are considered as the long-scale fading while the others mentioned above are small-scale fading. The need for high data rate and high spectral efficiency are the key elements for future wireless communication systems. Adaptive coding and modulation, iterative (turbo) decoding algorithms, space–time coding (STC), multiple antennas and multiple-input–multiple output (MIMO) systems, multicarrier modulation (OFDM), and ultra wideband radio are examples of enabling technologies for next generation wireless communication.

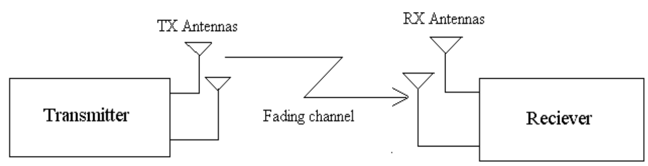

Fig. 1.1: MIMO Systems.

MIMO employ multiple antennas at the transmitter and multiple antennas at the receiver. The three basic link performances that completely describe the quality and usefulness of any wireless links are speed, coverage, reliability, are improved by the use of multiple antennas at both transmitter and receiver, (MIMO) along with multicarrier system (OFDM) without any using additional frequency spectrum. Section II discusses OFDM and modulation of wireless communication. Section III discusses related work.

Section IV discusses Problem formulation. And Section V discusses conclusion of the research work. Finally, future work in section VI.

2. OFDM

There has been an increasing interest in providing high data rate services such as video conference and multimedia over wideband wireless channels. In wideband wireless channels, the symbol period becomes smaller relative to the channel delay spread, and consequently, the transmitted signals experience frequency-selective fading. Therefore, it is desirable to investigate the effect of frequency-selective fading. OFDM is a technique for combating the effects of multi-path propagation in frequency selective fading channels. OFDM technique is a multi-carrier transmission technique, which is being recognized as an excellent method for high-speed bi-directional wireless data communication. The prime idea is that all queuing data in buffer are uniformly allocated on small sub-carriers which are orthogonal to each other. The OFDM converts a frequency-selective fading channel into a parallel collection of frequency flat-fading sub channels, in which the available bandwidth is very efficiently used. OFDM efficiently sque ezes multiple modulated carriers tightly together reducing the required bandwidth but keeping the modulated signals orthogonal so that they do not interfere with each other.

MODULATION

The choice of modulation technique has a direct impact on the capacity of a wireless communication system. It determines the bandwidth efficiency of a single physical channel in terms of the number of bits per second per Hertz (bit/s/Hz) and it is therefore important that this choice is discussed in detail. In selecting a suitable modulation scheme for a wireless communication system consideration must be given to achieving the following,

- High bandwidth efficiency.
- High power efficiency.
- Low carrier-to-co channel interference power ratio (in case of cellular mobile communication system)
- Low out-of-band radiation.
- Low sensitivity to multipath fading.
- Constant or near constant envelope.
- Low cost and ease of implementation.

Many digital modulation techniques are available and are extensively used in the present wireless communication system these includes phase shift keying (PSK/BPSK), multilevel phase shift keying (M-ary PSK), Qadrature phase shift keying (QPSK), Frequency shift keying (FSK/BFSK) and Qadrature amplitude modulation (QAM). But one of the most efficient modulation techniques is trellis coded modulation (TCM).

SPACE TIME CODING

Space time coding has gained much interest due to its capability of achieving better performance using transmits diversity. Transmit diversity can achieve diversity gain by transmitting from multiple spatially separated antennas. A space time code is a method employed to improve the reliability of data transmission in wireless communication system using multiple antennas. The space time codes depends on transmitting multiple, redundant copies of a data stream to the receiver in the hope that at least some of them may survive the physical path between the transmission and reception in a good enough state to allow reliable decoding. A number of space-time coding techniques have been proposed for transmit diversity. Space-time coding techniques were used to achieve lower error rates or higher data rates in narrowband systems. Mainly the family of space time codes includes space time block code (STBC) and space time trellis codes (STTC).

3. RELATED WORK

In this section discuss the related work to communication system. The communication system involves the modulation techniques with MIMO and OFDM etc. system. Here we contain various research papers for communication system and describe with the method and author name with references number and description.

In this paper author introduce a novel iterative joint FO and channel estimation algorithm that uses a preamble affected by an insufficient CP, whose main contributions are explained next. First, our proposal addresses the joint estimation of both parameters, i.e., channel and FO, in the scenarios of concern. Most previous contributions only describe channel estimation and insufficient CP, excluding the effect of FO, and cope with ideal conditions in the preamble symbols, that is, they do not analyze the effect of distortions within the preamble to perform proper joint estimations. In fact, the addressed the joint estimation. Second, in this paper, the joint estimation is based on all the samples of the preamble (N samples), despite the fact that the first half (N/2 samples) conveys ISI–ICI.

In this paper author propose a complete algorithm capable of jointly estimating the CFO and the path CA, by taking into account the fast variation of each path CA in MIMO environment. Generally, it is preferable to directly estimate the physical channel parameters instead of the equivalent discrete-time channel taps. Indeed, as the channel delay spread increases, the number of channel taps also increases and a large number of BEM coefficients have to be estimated. This requires more pilot symbols. Hence, using a parametric channel model rather than an equivalent discrete channel model enables to reduce the signal subspace dimension. Additionally, estimating the physical propagation parameters means estimating path delays and path CA.

In this article author investigates the proposed scheme offers better BER than other reduced guard interval equalization schemes. This work investigates the channel-induced interference problem caused by insufficient CP in OFDM based systems. Insufficient CP scenario may occur when channel delay spread is extremely long, when the transmitter deliberately shortens the guard interval to reduce transmission overhead in order to increase system throughput, or in multiuser environment when the propagation delay differences among different users are significant. A null subcarrier based frequency domain equalizer is proposed to mitigate the adverse effects caused by the shortened guard interval as well as channel noise.

In this paper author consider a general case of antenna and tap correlation under frequency-selective Rayleigh fading channels. They analyze the capacity expression at high and low SNR regimes for arbitrary number of transmit/receive antennas for MISO/SIMO-OFDM respectively, and find the closed form capacity expression for all SNR regions. In deriving the above capacity expression, they utilize the probability density function of a sum of weighted chi-square random variables which was developed. they dealt with carrier frequency offset estimation without any capacity analysis, whereas the current work focuses on the ergodic capacity analysis of a MISO/SIMO-OFDM system with arbitrary correlation. The case of same tap correlations for all antenna pairs which is a common model in existing works is a special case of our model. Due to the general nature of our analysis, all correlation possibilities that can exist in MISO/SIMO frequency selective channels are included in our model.

In this paper author gives details the design of a highly robust and efficient OFDM-MIMO system to support permanent accessibility and higher data rates to users moving at high speeds, such as users travelling on trains. It has high relevance for next generation wireless local area networks (WLANs) and 4G mobile cellular wireless systems. The paper begins with a comprehensive literature review focused on both technologies. This is followed by the modeling of the OFDM-MIMO physical layer based on Simulink/Matlab that takes into consideration high vehicular mobility. Then the entire system is simulated and analyzed under different encoding and channel estimation algorithms. The use of High Altitude Platform system (HAPs) technology is considered and analyzed.

4. PROBLEM FORMULATION

In the process of review we found that some performance affected problem related to the security threats. In this paper we work in the area of wireless communication. MAC layer is a basic building block of wireless communication. In MAC layer we perform modulation-demodulation and noise reduction of information code. This utility layer or coding technique suffers from several problems.

- Due to increased number of transmitter and receiver, STTC suffer from high error rate.
- In traditional STTC coding technique the available frequency spectrum is not efficiently used.
- The large size of information generates moderate corruption of bits.
- The provided OFDM technique does not get the optimal gain of bandwidth.

5. CONCLUSION

- Multiple receive antennas:- As we have considered the MIMO configuration for increasing data rate and to mitigate the fading situations therefore the future work may be directed for using large numbers of antennas at the transmitter and receiver that can reduce the noise from the channel resulting high SNR gain and high data rate.
- Higher order modulation: - We have considered the M-ary PSK modulation for our simulation but the future work may be directed towards the use of different higher order digital modulation techniques including QAM, GMSK etc.
- Different types of fading: - Different fading conditions encountered during signal transmission due to the channel characteristics such that slow fading, flat fading, shadowing etc. The future work may directed towards the proper estimation of these different fading conditions
- Imperfect channel estimation:- The channel state information is a very important parameter to overcome fading, the proper CSI leads to the increase SNR gain. In our simulation we have considered perfect CSI but the future work can be directed towards imperfect CSI to be present at both transmitter and receiver.

6. FUTURE WORK

In future work we tried to introduce a noise interference reduction technique for the improvement of high data rate in traditional space time coding technique (STTC). A new technique of 2-PSK, 4-PSK, 16-PSK Balanced STTC for multiple transmit antennas. These codes generate the points of the constellation with the same probability. Therefore, the systematic search for good codes can be reduced to this class. A method to design the balanced codes has been described here. Finally, the performance of all these 2-state, 4-state and 16-state codes is evaluated by simulation and described by the Symbol Error Rate (SER) over fast Rayleigh fading channels with AWGN floor. Reduced noise based estimation schemes are widely favored as their implementation is relatively simple and most current wireless standards already provide for their use. Training sequences for multiple transmit antennas require properties of zero (or very low) cross correlation between sequences transmitted from different transmit antennas.

REFERENCES

[1] Carlos Prieto del Amo, M. Julia Fernández-Getino “Iterative Joint Estimation Procedure for Channel and Frequency Offset in Multi-Antenna OFDM Systems With an Insufficient Cyclic Prefix” IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, IEEE VOL. 62, 2013. Pp 3653-3662.

[2] Eric Pierre Simon, Laurent Ros, Hussein Hijazi, Jin Fang, Davy Paul Gaillot, Marion Berbineau “Joint Carrier Frequency Offset and Fast Time-varying Channel Estimation for MIMO-OFDM Systems” " Transactions on Vehicular Technology IEEE 2011. Pp 955-965.

[3] Yin-Ray Huang, Carrson C. Fung, Kainam T. Wong “FREQUENCY DOMAIN EQUALIZATION FOR OFDM SYSTEMSWITH INSUFFICIENT GUARD INTERVAL USING NULL SUBCARRIERS” 17th European Signal Processing Conference, 2009. Pp 308-312.

[4] V.K. Varma Gottumukkala, Hlaing Minn “Ergodic Capacity Analysis of MISO/SIMO-OFDM with Arbitrary Antenna and Channel Tap Correlation” IEEE 2013. Pp 1-7.

[5] Yuejie Chi, Ahmad Gomaa, Naofal Al-Dhahir, A. Robert Calder bank “Training Signal Design and Tradeoffs for Spectrally-Efficient Multi-User MIMO-OFDM Systems” IEEE 2011.pp 1-13.

[6] H A Mohammed, M J N Sibley, P J Mather “Investigation of Doppler Effects on high mobility OFDM-MIMO systems with the support of High Altitude Platforms (HAPs)” 25th International Congress on Condition Monitoring and Diagnostic Engineering 2012. Pp 1-13.

[7] Li Wang, Li Li, Chao Xu, Dandan Liang, Soon Xin Ng, SM,Lajos Hanzo “Multiple-Symbol Joint Signal Processing for Differentially Encoded Single- and Multi-Carrier Communications: Principles, Designs and Applications” COMMUNICATIONS SURVEYS & TUTORIALS, IEEE 2013. 1-13.

[8] Jihye Lee, Taehyun Jeon “ Optimization of Gain Control Loops for Packet Based Data Transmissions” International Journal of Control and Automation Vol. 6, 2013. 399-408.

[9] U. Yunus, L. H. Lin, and K. Yamashita, “A novel equalization method for OFDM systems without guard interval,” in Proc. IEEE GLOBECOM, 2010, pp. 1–5.

[10] L. Yang and S. Cheng, “Optimum ISI and ICI cancellation filter for OFDM systems without CP,” IEICE 2007. pp. 364–367.

[11] H. Hijazi and L. Ros “Joint Data QR-Detection and Kalman Estimation for OFDM Time-varying Rayleigh Channel Complex Gains” IEEE Trans. Comm., vol. 58, 2010 Pp. 170–178.

[12] Z. Tang, R. C. Cannizzaro, G. Leus, and P. Banelli “Pilot-assisted time varying channel estimation for OFDM systems” IEEE Trans. Signal Process., vol. 55, 2007 Pp. 2226–2238.

[13] K. Vanbleu, G. Ysebaert, G. Cuypers, M. Moonen, K. Van Acker “Bitrate Maximizing Time-Domain Equalizer Design for DMT-Based Systems,” IEEE Trans. on Communications, vol, 52 2004.Pp. 871-876.

[14] A. Gusmao, P. Torres, R. Dinis and N. Esteves “A Reduced-CP Approach to SC/FDE Block Transmission for Broadband Wireless Communication” IEEE Trans. on Communications, vol. 55, 2007, Pp. 801-809.

[15] C. Toker, S. Lambotharan, J. A. Chambers “Joint Transceiver Design for MIMO Channel Shortening” IEEE Trans. on Signal Processing, vol. 55, 2007, Pp. 3851-3866.