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Enhanced MIMO Based Anti-Jamming Technique in Wireless Networks

M. Madhanraj[1], K. Sowmya[2]

[1]M Tech Student, ECE Department, DMI College of Engineering, Chennai,

[2]Assistant professor, ECE Department, DMI College of Engineering, Chennai, India

Abstract*:* ***MIMO-OFDM (Multiple Input Multiple Output - Orthogonal Frequency Division Multiplexing) system has been recognized as one of the most popular and competitive technique in a wireless environment nowadays. The multicarrier modulations is a techniques and It gives Advantages Like, inter carrier interference cancellation and improve packet delivery rate performance in multipath fading. Our simulation output Expose, the Better Bit Error Rate performances using LML (Linear maximum likelihood) equalizer. And also, analyzed in different fading channels for various modulation techniques in the Equalizers. The LML (Linear maximum likelihood) equalizer plays important role in Orthogonal Frequency Division Multiplexing technology. Reactive Jammer is the Most efficient jamming attacks and no other Powerful anti-jamming solutions to secure OFDM (Orthogonal Frequency Division Multiplexing) wireless communications under reactive jamming attack. In this paper, Improve anti-jamming techniques use of MIMO (Multiple Input Multiple Output) technology for jamming resilient OFDM(Orthogonal Frequency Division Multiplexing) communication.MIMO (Multiple Input Multiple Output) based anti-jamming Method that Enhanced interference cancellation and transmit pre-coding capabilities of MIMO (Multiple Input Multiple Output) technology to turn a jammed non-connectivity scenario into an operational network.***

Keywords*:* MIMO-OFDM, Jamming attacks, Bit Error Rate, ISI (inter symbol interference), LML(Linear maximum likelihood) equalizer, Jamming Resilient.

1. Introduction

OFDM is the most popular wide modulation methods. It is used in many areas such as high bandwidth utilization. OFDM systems have the capacity to cope with severe disturbance and noise, they are not perfect for environments where adversaries try to intentionally jam communications. Jamming has been a Major Denial-Of-Service attack to wireless communications and Deliberately Emitting Jamming signals, It can destroy to the OFDM network communications. Reactive jamming is one of the most effective jamming attacks. A reactive jammer continuously listens for the channel activities then emits jamming signals However it find out user activities, otherwise it stays listen when the sender is inactive. Reactive jamming is regarded as one of the most powerful, and energy efficient jamming approach. The recent advance in the highly programmable software defined radio has made such sophisticated but powerful jamming attacks very realistic demonstrated that a reactive jammer is readily implementable and the jamming results devastating. The increasingly severe hostile environments with advanced jamming threats prompt the development of security extensions to the Orthogonal Frequency Division Multiplexing systems. Recent experiments attempt to reduce the Impact of jamming attacks to the OFDM systems. Proposed a jammed Iterative Channel tracking and enhanced rotation Method for OFDM systems to counteract narrow-band jammer that jams the pilot tones and introduced pilot attack method, Which minimizes the received pilot energy to be more destructive, and provided mitigation schemes by randomizing the location and value of pilot tones. They both specifically focus on the adversaries jamming subcarriers pilot tones signals, It required knowing the pilot tone signal frequency locations and also demand very tight synchronization. Their denial mechanisms will fail to recover strong Jamming signals and also produce the low throughput in the receiver side.

a) MIMO System Model

In Figure 1 shows that MIMO system there is a channel/path between each of the transmitters and each of the receiver antennas

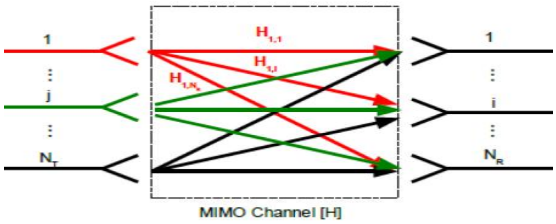

Figure 1: NT transmitter antennas and NR receiver antennas for MIMO system

Multi-Input Multi-Output (MIMO) has emerged as a key technology for wireless networks mostly due to its potential capacity gain. New wireless devices are equipped with a growing array of antennas. It can be utilize to obtain maximum diversity value and spatial multiplexing gains, and lead to an increase in the network capacity. Recent advance in MIMO interference cancellation (IC) technique has greatly enhanced MIMO communication capability under powerful jamming attacks. It utilizes Interference Cancellation technique in MIMO to mitigate jamming attacks targeting Orthogonal Frequency Division Multiplexing systems. MIMO-OFDM based denial mechanisms by utilizing MIMO technology coupled with IC and transmit pre-coding techniques. Our design is able to restore admissible OFDM communication in the present of strong Jammers and Effective techniques have several key challenges. First method Different jammers Emit different types of jamming signals, So the receiver needs to cancel them regardless of their signal structures. Second method for Powerful Defense mechanism should be able to track the jammers purposeful adaptation then the Defence Mechanism should be Robust against sophisticated jammers attempting to disrupt the receiver's cancellation scheme. Propose a novel defence mechanism for jamming resilient OFDM communication based on MIMO IC technique, which tracks the jamming signal's direction in real-time before cancel out. The object of this paper is to support operational OFDM communications under reactive jamming attack. Exploit the MIMO IC and transmit pre coding techniques to counteract reactive jamming attacks for securing OFDM wireless communications. Propose novel mechanisms, LML (linear maximum likelihood) Equalizer to effectively sustain acceptable throughput under Strong jamming attack, In our idea to calculate the performance in terms of packet delivery rate. Our Results show Improve the Packet Delivery Ratio performance Under strong jamming signal.

2. System Model

a) Network Model

The wireless sensor network in our problem consists of N sensor nodes each having the same transmission range for each one base station. Every sensor node is provide with a worldwide accepted significant time and Omni-directional antennas, m radios for in total k channels throughout the network where k>m, for simplicity model the considered network as a connected unit disk graph (UDG) G=(V,E), where V is the set of N nodes and where any node pair i, j is connected if Euclidean distance between two nodes is less than or equal to transmission range. Since each sensor node has same transmission range and only the neighbour nodes within transmission range can receive its message.

b) Jamming Attack Models

Jammer can perform various different attack strategies in order to interfere with other wireless communication. As a phenomenon of their different attack philosophies, these various attack models will have different levels of effectiveness, and may also require different detection strategies.

1) Constant Jammer

Constant jammer continuously sends out random bits to the channel particularly, the constant jammer does not wait for the channel to become idle before transmitting. Whether a channel is idle or not by comparing the signal strength with a fixed threshold value, which is lower signal strength value generated by the constant jammer.

2) Random Jammer

Random Jammer continuously sending out a Jamming signal, It change the action between sleeping and jamming mode. First Mode the Jammer jams for a random period of time, and the Second mode (sleeping Mode) the jammer Turns Its transmitters off for another random period of time. The energy efficiency is determined as the ratio of the length of the jamming period over the length of the sleeping period.

3) Reactive Jammer

Reactive jamming is one of the most effective jamming attacks. A reactive jammer continuously listens for the channel activities, and emits jamming signals whenever it detects user activities, otherwise it stays listen when the sender is inactive. Reactive jamming is regarded as one of the most powerful, and energy efficient jamming approach. The recent advance in the highly programmable software defined radio has made such sophisticated but powerful jamming attacks very realistic demonstrated that a reactive jammer is readily implementable and the jamming results devastating.

3. Defence Mechanisms

3.1 Anti - Jamming Technique on MIMO OFDM Communications

This new wireless communication system makes upon a reconstructed physical layer and based on an orthogonal frequency division multiple, resilient techniques in exacting multipath environments and substantially improves the performance of the wireless channel in terms of bits per second. Two types of (IC) interference cancellation and equalization framework is proposed for interference cancellation in the uplink of multiple-input multiple-output orthogonal frequency division multiplexing systems. The first stage uses time domain cancellation techniques to suppress co-channel interference, mitigate a synchronism, and shorten the post-equalization channel response to be no longer than the length of the Cyclic Prefix Estimation Value. The Second Method use for Low Complexity equalization and detection in the frequency domain and also In this techniques developed framework using spatial multiplexing and is applied to multiuser MIMO-OFDM systems with a synchronism between users as well as to single-user MIMO OFDM systems and Interference from jamming due to inter-carrier-interference. In common, there are two class of equalization schemes to handle ICI . First one is the frequency domain equalization, for this, method cannot completely cancel the ICI introduced by the a synchronicity unless the number of antennas is greater than the number of time taps in the channel and scheme of frequency domain equalization. Shows that Figure 2 the frequency domain equalization at the receiver is done using the Linear Maximum Likelihood. The Linear channel estimation for multiple-input multiple-output orthogonal frequency division multiplexing (MIMO-OFDM) systems is analysis. Our idea is an Linear Maximum Likelihood channel estimation, which can fully exploit the channel correlations over time, space and frequency domains, to estimate the channel response value using Effective Linear Maximum Likelihood channel estimation algorithm. It does not need to spatial time correlations and has a complexity only linear in the number of subcarrier orthogonality. This LML equalizer is the frequency domain equalizer which is applied in the receiver of the OFDM communication technologies. This powerful novel equalizer is used for anti-jamming OFDM communication.

3.2 Linear Maximum Likelihood Estimation

A LML estimator is a method in which it minimizes the mean square error (MSE), which is a universal measure of estimator quality. The Most Efficient characteristic of Linear equalizer is that it does usually eliminate ISI completely and also instead of minimizes the total power of the noise and ISI components in the output. Let assume that X to be an random constant variable and R be a known random constant variable value,

$R = HX + n$.

An estimator x (R) is any function of the measurement (Y), and its mean value is given by

Mean square value = $\{(X - X)^2\}$

where the LML always performs better than the ZF equalizer and the proposed of LML decoder in the system is to get the performance with low complexity and Simulation Results shows that Fig 2 LML which perform maximum diversity combiner technique with best performance of BER compare to other techniques in the system and same complications of implementation.

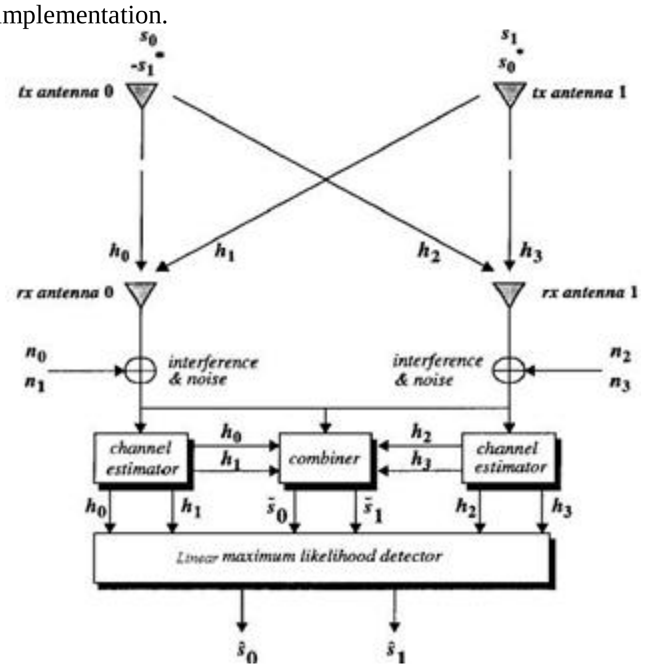

Figure 2:.Two-branch transmit diversity scheme with two receivers and two transmitter

With combining the space time value and space frequency value in the system, it will enable to achieve of high Eb/No with low decoding complexity and maximum diversity order in MIMO-OFDM system.

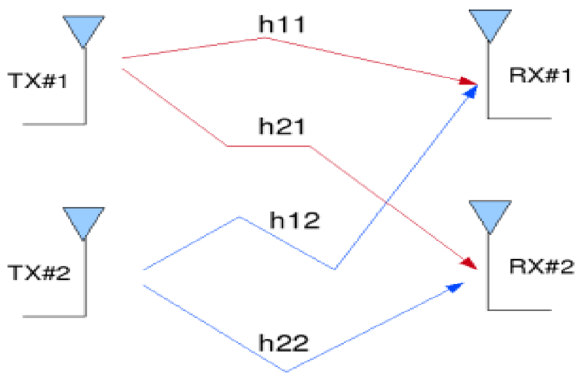

Figure 3: Transmit 2 Receive (2×2) MIMO channel

From Fig 3, the received signal in the first time slot is,

$$\begin{bmatrix} y_1^1 \\ y_2^1 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} n_1^1 \\ n_2^1 \end{bmatrix}$$

The second time slot, the received signal is in the second time slot is,

$$\begin{bmatrix} y_1^2 \\ y_2^2 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \begin{bmatrix} -x_2^* \\ x_1^* \end{bmatrix} + \begin{bmatrix} n_1^2 \\ n_2^2 \end{bmatrix}$$

Combining the equation at time slot 1 and 2,

$$\begin{bmatrix} y_1^1 \\ y_2^1 \\ y_1^{2*} \\ y_2^{2*} \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \\ h_{12}^* & -h_{11}^* \\ h_{22}^* & -h_{21}^* \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} n_1^1 \\ n_2^1 \\ n_1^{2*} \\ n_2^{2*} \end{bmatrix}$$

Also,

$$\boldsymbol{H} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \\ h_{12}^* & -h_{11}^* \\ h_{22}^* & -h_{21}^* \end{bmatrix}$$

We know, for a general m x n matrix, the pseudo inverse is defined as,. The calculate of the transmitted symbols

$$\widehat{\begin{bmatrix} x_1 \\ x_2^* \end{bmatrix}} = (H^H H)^{-1} H^H \begin{bmatrix} y_1^1 \\ y_2^1 \\ y_1^{2*} \\ y_2^{2*} \end{bmatrix}$$

Inter-carrier Interference Issue. Another practical issue with the wideband jamming signal is that it suffers from multipath effects, which leads to inter-carrier interference (ICI). Proposal system results derived from channel coherence time to mitigate the negative effects of ICI on channel estimation. This additional noise would reduce the SNR of the intended signal, hence affects, the throughput. Interference issue, We must directly investigate the time-domain signal, since ICI is inherently a time-domain phenomenon. To cancel out the ICI and jamming signal simultaneously. The signal of interest can then be decoded using a standard decoder.

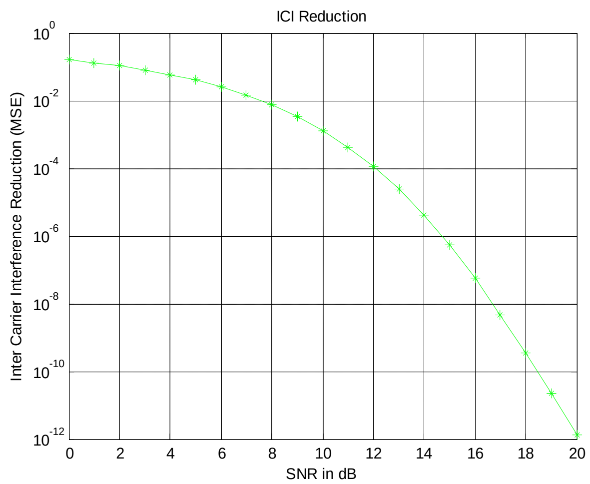

Figure 3: Shows the inter-carrier interference cancellation. The main disadvantages of MIMO OFDM is its sensitivity against carrier frequency offset which causes inter carrier interference (ICI).The undesired ICI degrades the signal heavily and hence degrades the performance of the system. We show that Fig 3 investigates an ICI self cancellation scheme for combating the impact of ICI on OFDM systems for different frequency offset values.

CFO Estimation And Reduction Carrier frequency offset (CFO) in orthogonal frequency-division multiplexing systems, which can produce the loss of orthogonality between subcarriers and result in significant performance value decreased. Novel techniques improve orthogonality between different subcarrier. Improve Packet delivery value in the receiver side.

4. Evaluation

A. Packet delivery rate performance

Two clients synchronized by a MIMO system combine with, a two antenna receiver value. Two sender transmit different stream signal to the receiver. The receiver applies interference cancellation technique to decode one of the streams by regarding the other stream as interference from the jammer. Change the locations of the clients and receiver to measure and Show that Figure 4 the packet delivery ratio performance with different angles between two sustain signals. Fix the distance between the clients and receiver,

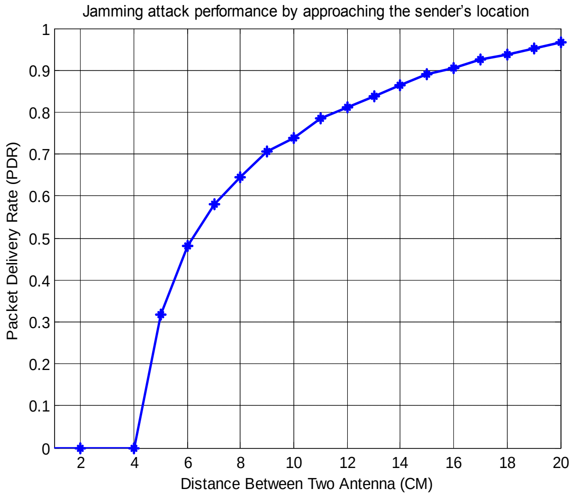

Figure 4: Packet delivery rate performance with different angles

so that the implementation variation between different cases and different angles rather than different path losses.

B Auto correlation function

The receiver uses these known OFDM symbols to estimate the channel coefficients, and examines how long the channel from the sender to the receiver remains correlated. Every channel coefficient is a complex number with phase and amplitude values with multiple subcarriers signal.

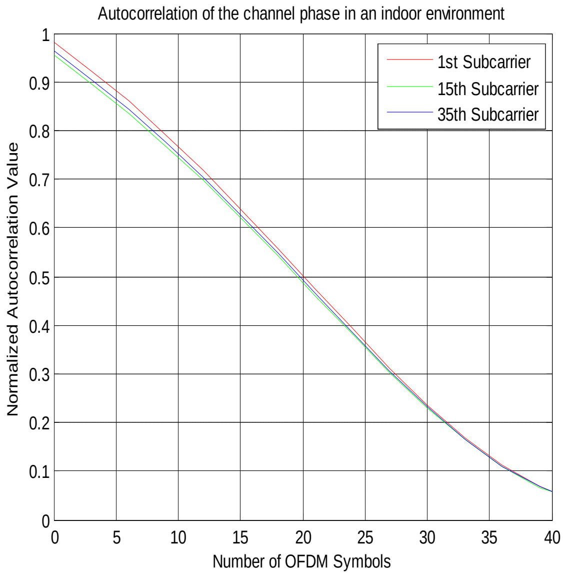

Figure 5: Autocorrelation of the channel phase in an indoor environment.

The Fig 5 shows that the autocorrelation of channel phase over different Subcarriers and the channel phase correlates over multiple OFDM symbols, before it becomes uncorrelated autocorrelation value becomes zero. The number of correlated OFDM symbols varies with subcarriers, with the average number of 40 symbols. The channel amplitude stays more stable over multiple OFDM symbols. Autocorrelation value shows Correlation Over 500 Orthogonal Frequency Division Multiplexing symbols. and the channel experimental coherence time is nearly 33 OFDM symbols.

5. Related Work

Research efforts in the interference management area have developed novel interference cancellation techniques to improve the network throughput, medium access protocol and robustness of MIMO communication. It enables MIMO-OFDM communications under high power cross technology interference, so Our work exhibit several significant differences 1) Consider smart jammers, who can adapt their attack strategy to be more destructive, while interferers are unintentional 2)Channel estimation technique need to average over multiple OFDM symbols, It is not applicable for tracking jammers channel because jammer is fast conversion, So our techniques place pilots into known locations to mutually track the sender and jammer's channel instantaneously.

6. Conclusion

In MIMO-OFDM, the Inter carrier interference is the major problem. Novel techniques provides the solution for inter carrier interference cancellation. In this paper has presented channel estimation technique that can be used in MIMO OFDM system that designed with anti jamming techniques and also increased Packet delivery Ratio performance due to reduction of jamming noise. Our proposed method provides good anti-jamming solutions to secure OFDM communications. Finally, Exploited MIMO technologies to protect against effective jamming attacks. To analysis such a attacks can seriously disrupt to MIMO-OFDM communications through controlling the jamming signal vectors in the antenna-spatial domain and proposed defence mechanisms based on interference carrier cancellation and transmit pre-coding techniques to maintain OFDM communications under strong jamming.

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