BE PROJECT REPORT

DIGITAL SIGNAL TRANSMISSION OVER MIMO-OFDMSYSTEM

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ABSTRACT

The increased data rates and reliability required to support emerging multimedia applications require new communications technology. We present results regarding two techniques used in high data rate transmission As orthogonal frequency division multiplexing (OFDM) the and multiple-input multiple-output (MIMO) scheme. The aim of this dissertation is to find efficient methods of providing reliable communication links using MIMO-OFDM under fast fading scenarios. Toward this end, both equalization and channel coding techniques are investigated. Despite many advantages of OFDM, OFDM signals are very susceptible to the time-varying channel, which breaks the orthogonality between sub-carriers, resulting in inter-channel interference (ICI). The ICI increases an irreducible error floor in proportion to the normalized Doppler frequency.

INTRODUCTION

As applications for wireless access look to make the transition from voice communication to multimedia data, such as internet data and video data, demand for high-speed wireless communications is increasing. Also, to meet quality of service (QoS) requirements in various situations, reliability become an important issue. Orthogonal frequency division multiplexing (OFDM) is a promising candidate for high-speed transmissions in a frequency selective fading environment. By converting a wideband signal into an array of properly-spaced narrowband signals for parallel transmission, each narrowband OFDM signal suffers from frequency flat fading and, thus, needs only a single-tap equalizer to compensate for the corresponding multiplicative channel distortion. One disadvantage of using OFDM systems is interchannel interference (ICI) in fast fading environments. In OFDM systems, the change in the channel from symbol to symbol is more significant than for a single carrier transmission system, due to its longer symbol duration. Time variations of the channel within an OFDM symbol lead to a loss of subchannel orthogonality, resulting in interchannel interference (ICI) and leading to an irreducible error floor in conventional OFDM receivers. We study the lots of papers and journals , from that we made analysis and literature survey is made on following references.

Multiple Input Multiple Output(MIMO) technique

Multiple Input Multiple Output (MIMO) is a cutting edge antenna technology transmitting multiple data streams on multiple transmitters to multiple receivers. Multiple antennas are used especially when the link has Non Line of Sight. MIMO increases the range and data rates both. Now the capacity of different antenna systems will be studied in order to see the dramatic increases in capacity obtained by using MIMO systems. The expressions are approximate, but they give an intuition for the derived benefits in terms of channel capacity when using multiple antennas

Types of smart antenna technology

Single Input, Single Output

Assume that for a given channel, whose bandwidth is B, and a given transmitter power of P the signal at the receiver has an average signal to noise ratio of SNR.
C = B*log2(1 + SNR)

Single Input, Multiple Output

For the SIMO system, we have NR antennas at the receiver. If the signals received on these antennas have on average the same amplitude, then they can be added coherently to produce an NR2 increase in the signal power. Hence, there is an overall increase in the SNR,
Thus, the channel capacity for this channel is approximately equal to
C = NR*B*log2(1 + SNR)

Multiple Input, Single Output

In the MISO system, we have NT transmitting antennas. The total transmitted power is divided up into the NT transmitter branches. If the signals add coherently at the receiving antenna we get approximately an NT fold increase in the SNR as compared to the SISO case. Thus, the overall increase in SNR is approximately,
Channel capacity for this channel is approximately equal to:
C = NT*B*log2(1 +SNR)

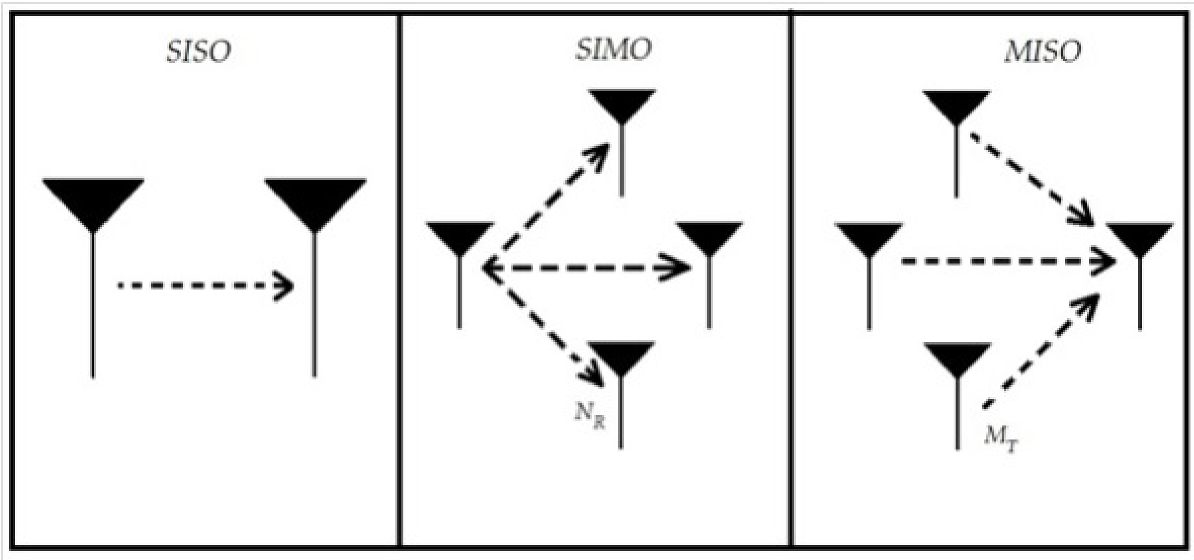

Figure 1: SISO, SIMO and MISO system.

Multiple-Input, Multiple-Output

Different signal transmitted by each antenna, in MIMO using the same bandwidth and still be able to decode correctly at the receiver. The capacity of each one of these channels is roughly equal to:

C = min(NT,NR)*B*log2(1 +SNR)

Thus, as we can see from , we get a linear increase in capacity with respect to the number of transmitting antennas. So, the key principle at work here, is that it is more beneficial to transmit data using many different low-powered channels than using one single, high-powered channel.

MIMO System Model

Let us consider single user MIMO communication system with 2 antennas at the transmitter and 2 antennas at the receiver. Consider that we have a transmission sequence is x1; x2;.......... xn. In normal trans- mission, we send x1 in the first time slot, x2 in the second time slot and xn in the nth time slot. Now we have two transmit antennas, we may groups the symbols into groups of two. In the first time slot, send x1 and x2 from the first and second antenna. In the second time slot, send x3 and x4 from the first and second antenna and in next time slot x5 and x6 and so on. Let us consider for 2x2 MIMO. The signal received on the first antenna is

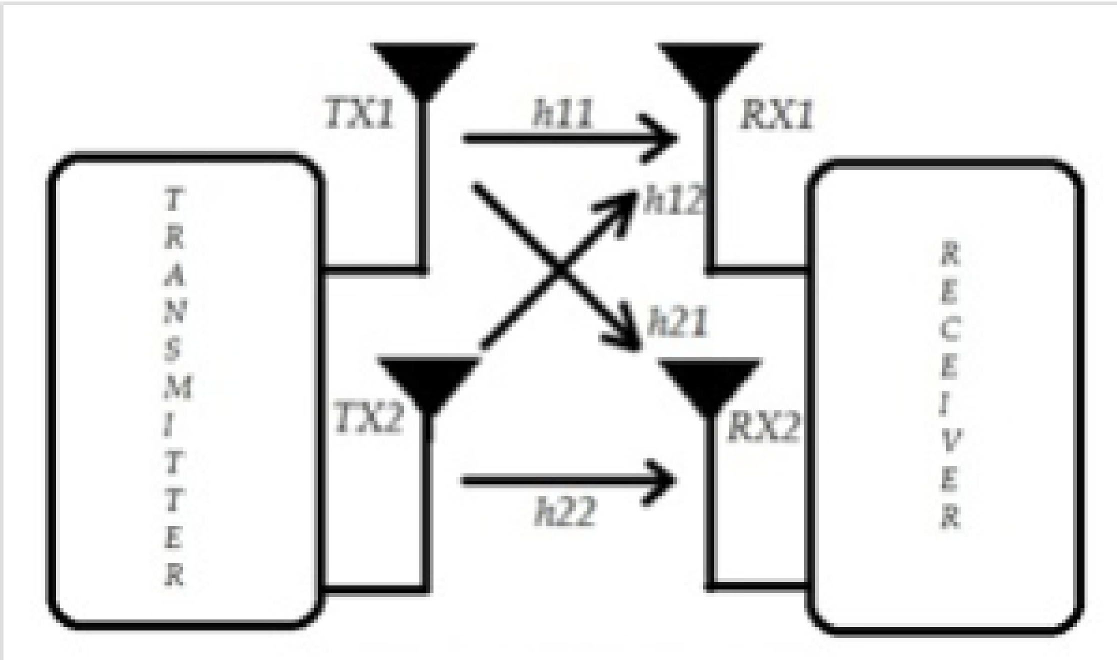

Figure 2: MIMO SYSTEM MODEL .

given by:

r1 = h11s1 + h12s2 + n1

The signal received on the second antenna is given by:

r2 = h21s1 + h22s2 + n2

where, y1 and y2 are the received symbol on the first and second antenna respectively,h11 is the channel from 1st transmit antenna to 1st receive antenna,h12 is the channel from 2nd transmit antenna to 2nd receive antenna,h21 is the channel from 1st transmit antenna to 2nd receive antenna, h22 is the channel from 2nd transmit antenna to 2nd receive antenna, s1 and s2 are the transmitted symbols and n1 and n2 is the noise on 1st and 2nd receive antennas respectively

MIMO Advantages

The advantages of MIMO based wireless networks are increased range, throughput and robustness of the data link. This advantage is achieved by firstly high throughput i.e ability to provide high data rate compared to range and secondly by using 40MHz channels to increase the available bandwidth for high data rate.

1. Better Spectral Efficiency at Low Cost

MIMO drives greater bandwidth, reach and spectral efficiency at a lower cost than the alternative antenna technology.

2. Linear Capacity Growth.

The MIMO Systems capacity grows linearly with the number of antennas. 2x2 MIMO doubles the capacity and 4x4 MIMO quadruples capacity.

3. Backwards compatible.

Supports both TDD and FDD techniques so can be used with earlier versions of 802.11x to increase the data rate.

Intel defining the MIMO benefits states MIMO uses multiple transmitter and receiver antennas to allow for increased data throughput through spatial multiplexing and increased range by exploiting spatial diversity and this helps in making products that will have Extended battery life , Expanded wireless connectivity and Immersive entertainment.

MIMO Disadvantages

MIMO has very few disadvantages associated with it.
The disadvantages of the MIMO system is mostly the need for multiple Antennas the cost of the equipment compared to existing equipment available and limited open source driver support.
Computational complexity.
Cost for added antennas.

ALAMOUTI SPACE-TIME BLOCK CODING

Alamouti STBC is a complex space-time diversity technique that can be used in 2x1 MISO mode or in a 2x2 MIMO mode. It is the only STBC that can achieve its full diversity gain without needing to sacrifice its data rate. this property usually gives Alamouti's code a significant advantage over the higher-order STBCs even though they achieve a better error-rate performance

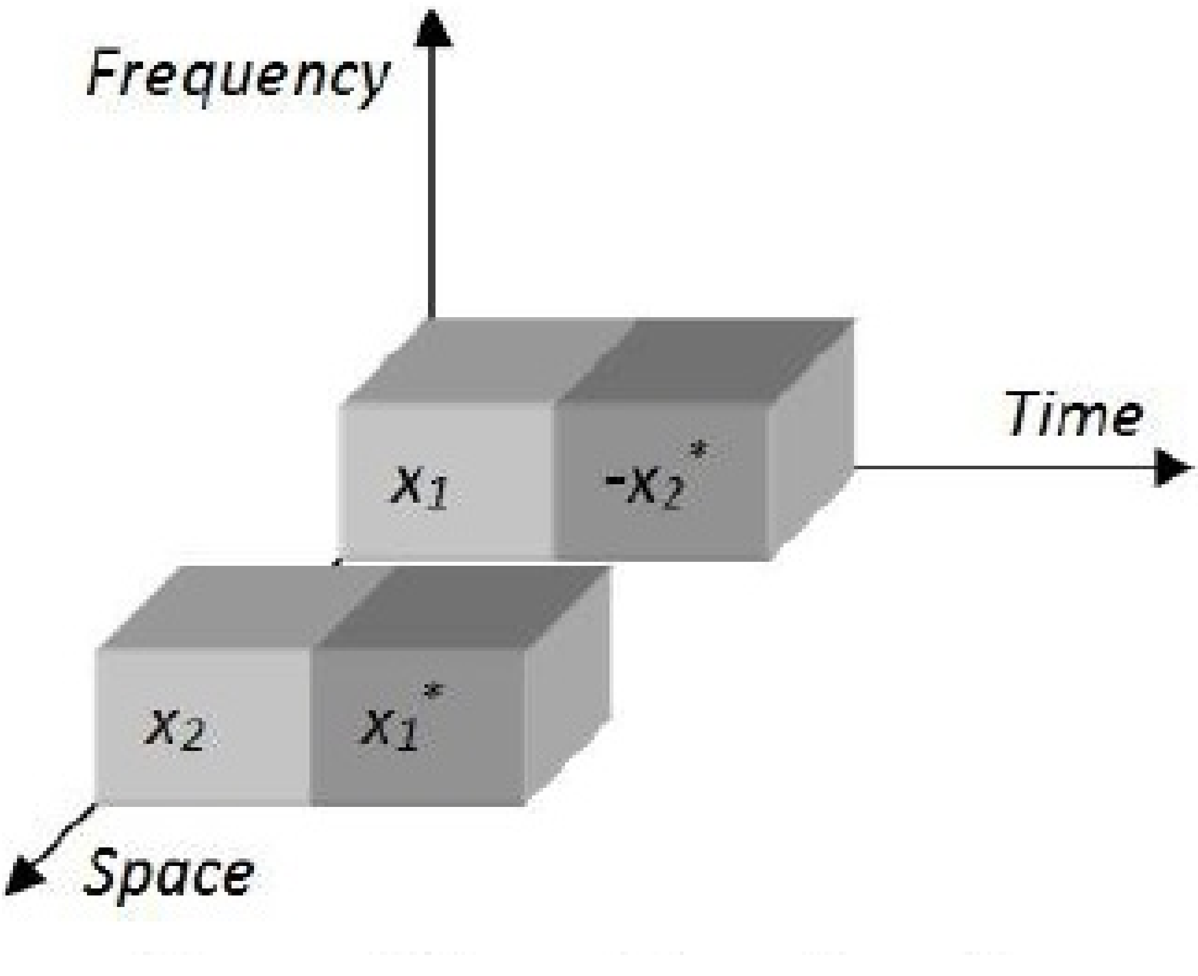

Figure 3: Alamouti Space Time Diversity .

Figure shows that two symbols and their conjugate are sent, in two time slots, which brings a diversity gain without having to compromise on the data rate. Over the air, the transmitted symbols will suffer from channel fading and noise at the receiver, their sum will be received. Working principles of 2x1 and 2x2 Alamouti STBC is indicated Figure respectively.

1) 2x1 Alamouti STBC

The 2x1 Alamouti STBC systems consists of two antenna at transmitter and at receiver side contains one antenna as shown the figure At time t and are transmitted by Transmitter 1 and

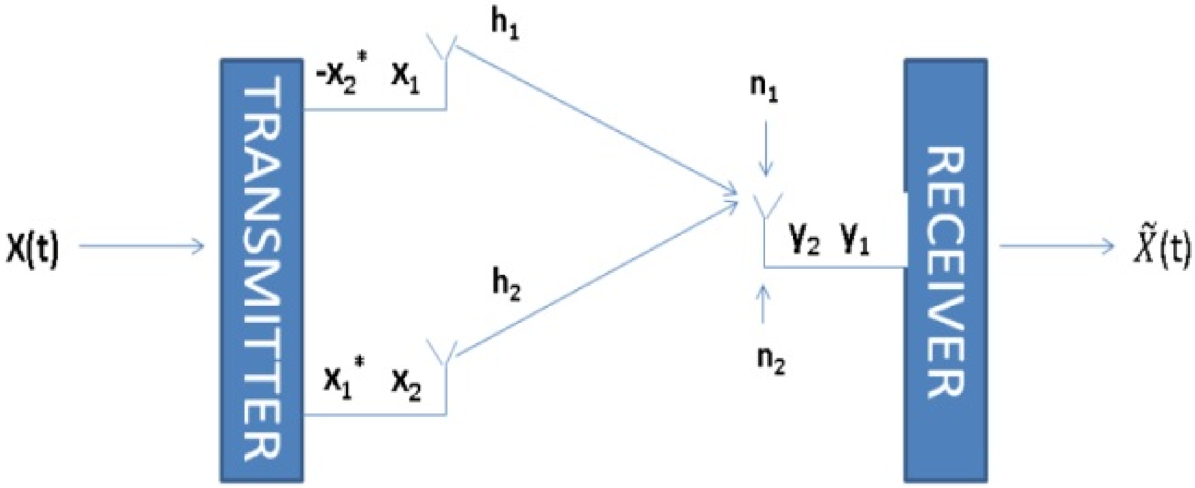

Figure 4: 2X1 Alamouti STBC .

2 and after that at time (t+T) their conjugates are transmitted. From Table 1 and Figure 4 we can write receiving data;

y1 = x1*h1 + x2*h2 + n1 (First time slot)

y2 = -x2*h1 + x1*h2 + n2 (Second time slot)

Where; x1 and x2 transmitted data,

y1 and y2 received data,

h1 and h2 Rayleigh channel,

n1 and n2 AWGN noise,

In order to get rid of conjugates of transmitted data at the receiver, we take conjugate of y2;

y1 = x1*h1 + x2*h2 + n1

y2* = h1*(-x2) + h2*x1 + n2

2) 2x2 Alamouti STBC

The 2x2 Alamouti STBC System is shown in figure 5 which is similar to 2x1 Alamouti but we have one more receiver antenna. This system is consists of 2 Transmitter and 2 Receiver. Working principle is also similar to 2x1 Alamouti. In 2x1 Alamouti we send block codes to just one receiver but in this system we send block codes to 2 receiver

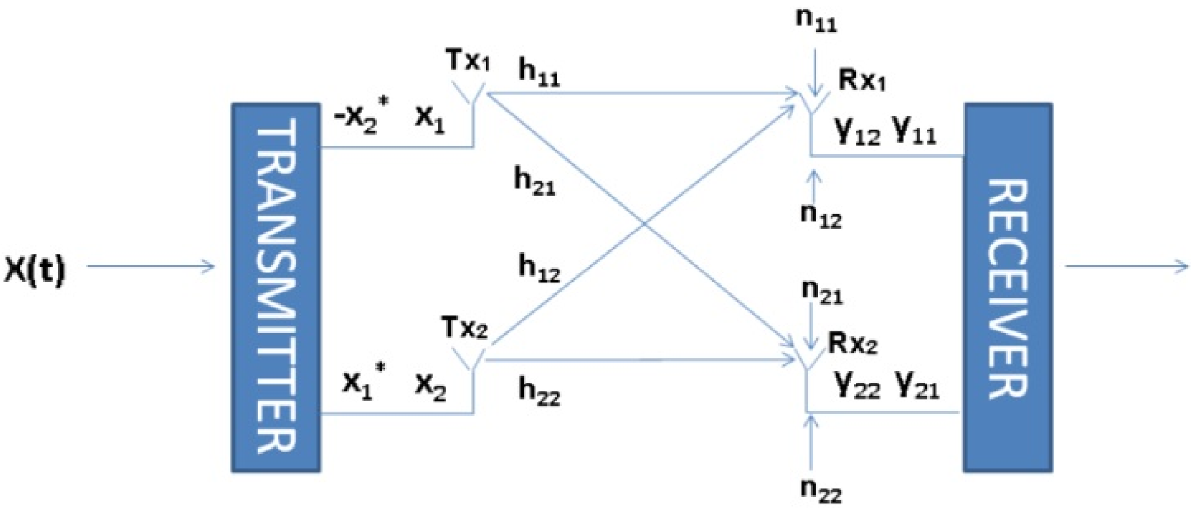

Figure 5: 2X2 Alamouti STBC .

y11 = x1*h11 + x2*h12 + n11 (first timeslot received data in Rx1)

y12 = -x2*h11 + x1*h12 + n12 (Second timeslot received data in Rx1)

y21 = x1*h21 + x2*h21 + n21 (first timeslot received data in Rx2)

y22 = -x2*h21 + x1*h22 + n22 (Second timeslot received data in Rx2)

Where; x1 and x2 transmitted data y11 and y21 are received data (for first time slot)

y12 and y22 are received data in (for second time slot)

h11,h12 ,h21 ,h22 are Rayleigh channel

n11,n12,n21,n22 are AWGN noise

Now we take conjugates of y12 , y22 to get rid of conjugates of transmitted data at the receiver

y12* = -x2h11* + x1h12* + n12*

y22* = -x2h21* + x1h22* + n22*

We write together to all

y11 = x1*h11 + x2*h12 + n11

y12* = -x2h11* + x1h12* + n12*

y21 = x1*h21 + x2*h21 + n21

y22* = -x2h21* + x1h22* + n22*

Problem Statement:-

Now days OFDM is used to transmit audio and video over multiple channels . The aim of this project is to analyse behaviour of Image signals/audio signals over a MIMO channel by analysing parameters such as ICI , BER , PSNR , etc.

Platform :- MATLAB .

Future Plan:-

In our project we will transmit the digital image over OFDM and mimo system, find all the parameters like BER , SNR ,etc. using 16-QAM for modulation.

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