A Review on Mimo Systems with Antenna Selection

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***Abstract*— Communication system is gaining more importance in modern wireless communication, to improve the performance of the communication system the MIMO systems are employed, there are also different configurations of MIMO and also formats like spatial diversity and spatial multiplexing. These formats are used to increase channel capacity and to increase the performance of the wireless communication system, since MIMO systems are gaining importance, now a days they have become essential part of the wireless communication system, they have also many disadvantages one of them is complexity, the antenna selection is one of the solution for complexity in design process. Various methods and algorithms have been proposed till now for both Transmit and Receive antenna selection, one of them is FFOAS (Fire Fly Optimal Algorithm and Scheduling) which has proposed in recent days of research of wireless communication. It employs LTE scheduling for selected antenna at receiver side and also uses Q-OSTBC encoding method to encode the message which has to be transmitted. These two techniques will essentially increase the performance of the system by decreasing the Bit Error Rate(BER) of communication system**.

Keywords*— *MIMO, wireless, communication, antenna selection, FFOAS, LTE, Q-OSTBC.

I. INTRODUCTION

MIMO is a communication technology which uses multiple antennas both at transmitter side and receiver side to transfer more data at a time. Main advantage of MIMO is the transmitted wave will reach the receiver antenna multiple times at different time because of multipath transmission where transmitted wave bounces of walls, ceilings and other objects and this is called Radio-Wave phenomenon. MIMO allows multiple antennas to send and receive multiple spatial streams at same time. MIMO technology leverages multipath behavior by using multiple "smart" transmitters and receivers. MIMO combines the data streams arriving from different paths and at slightly different time to effectively increase the receiver's signal capturing power, hence this makes the antenna to work smarter.

Since MIMO uses multiple antennas, wireless technology is able to considerably increase the capacity of a given channel, the throughput of the channel is increased in increasing the receive and transmit antennas. This make MIMO as an important technology in upcoming wireless communication system, we know that special band width is more valuable commodity for radio communication system hence the communication techniques are needed to use the available bandwidth more efficiently. MIMO wireless technology is one of these techniques.

II. TYPES OF SMART ANTENNA TECHNOLOGY

There are 4 types of smart antenna technology

1) SISO- Single Input Single Output
2) SIMO- Single Input Multiple Output
3) MISO- Multiple Input Single Output
4) MIMO- Multiple Input Multiple Output

A. SISO

The simplest form of radio communication link in MIMO is termed as SISO- Single Input and Single Output. It is a standard radio channel. Is uses only one antenna at the transmitter side as well as the receiver side. No diversity is applied and hence no additional processing is required, the disadvantage is the SISO channel is limited in its performance as interference and fading is present

B. SIMO

Single Input Multiple Output is a version of MIMO occurs when there is single antenna at the transmitter side and multiple antennas at the receiver side. This is also known as receiver diversity. It is mostly used where the receiver used to receive multiple signals from independent sources to avoid the effects of fading and also interference. The advantage of SIMO is, it is easy to implement, and the disadvantage is processing is required at the receiver

C. MISO

Multiple Input Single Output is also known as transmit diversity, in this case the same data is transmitted redundantly from the transmitter multiple antennas then receiver will receive the optimum signal and then uses it extract the received data. The advantage of using MISO is that the multiple antennas and redundancy coding processing moved from the receiver to the transmitter, this has a positive impact on size, cost and battery life of communication system.

D. MIMO

MIMO is an efficient radio antenna technology as it uses multiple antennas at the transmitter (fig1) and receiver to enable a variety of signal paths to carry the data choosing separate paths for each antenna to enable multiple signal path to be used. MIMO wireless systems can be viewed as an extension towards antennas that have been used for many years to improve wireless communication .The core idea behind MIMO wireless system is space-time signal processing in which time is complemented with the spatial dimension inherent in the use of Multiple spatially distributed antennas.

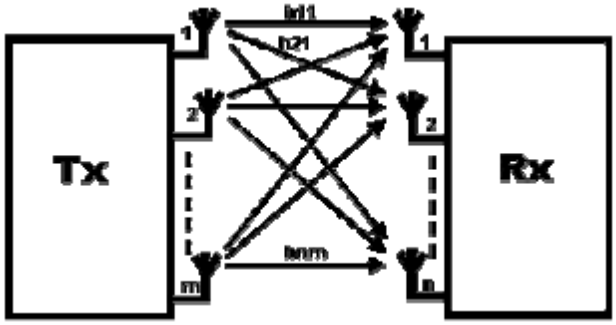

Fig.1 MIMO - Multiple Input Multiple Output

E. Two main formats of MIMO

1) Spatial diversity: spatial diversity will refers to transmit and receive diversity. These two diversity methods will improve SNR and by doing so they also improve the reliability of the system by avoiding the various forms of fading.
2) Spatial multiplexing: this is another form of MIMO which is used to provide additional data capacity by utilizing the different paths to carry additional traffic hence it also increases the data throughput capability

III. ADVANTAGES AND DISADVANTAGES OF MIMO SYSTEMS

The MIMO systems has following benefits and also problems in it are as follows

A. Advantages of MIMO systems

- It provides the better spectral efficiency at low cost than the alternative antenna technology.
- The MIMO system capacity grows linearly with number of antennas.2x2 MIMO doubles the capacity.
- Supports both TDD and FDD techniques so can be used with earlier versions 802.11x to increase the data rate.
- MIMO provides the high speed wireless communication link to support wide range of application without increasing bandwidth or transmitted power.

B. Disadvantages of MIMO systems

- The disadvantages of MIMO system is mostly the need for multiple antenna the cost of the equipment compared to existing equipment available and limited open driver support.
- The main disadvantage is that its more complex
- Requires more hardware

IV. ANTENNA SELECTION FOR MIMO SYSTEMS

Antenna selection for MIMO system MIMO systems without utilizing broadcast power and bandwidth will gain a huge potential to raise system capacity. MIMO systems are widely using in recent commercial long term Evolution Wireless communication hence for this reason they are essentially using in next generation wireless communication models. Antenna arrays are used in both at two ends of communication link. The Multiple RF chains are linked with multiple antennas at the transmitter and receiver. Which are costly in power and size[1].

Antenna selection is a low cost alternative to minimize the complexity of MIMO systems. The antenna selection algorithms are of two types

1) Optimum algorithm
2) Suboptimum algorithm

Antenna selection methods can be classified as

1) Transmitting antenna selection
2) Receiving antenna selection
3) Transmitting and receiving antenna selection

The first section of paper discussed the basics of MIMO and the advantages and disadvantages, the second section will start with methods of antenna selection and an algorithm will be discussed in last section with its contributions and conclusions.

A. Receive antenna selection

The receiving antenna selection as shown in a fig2, here only one antenna is selected among all the receiving antennas. In order to select only one antenna the SNR of all the antennas should be known. The problem here is only one RF chain is there, how can be determine the SNR of all the antennas at a time? There are solutions to address this problem one of those is by using training signal In a preamble to transmitting data, during this preamble period the receiver scans the all the antennas finds the antenna with highest gain this is the method applied when there is one RF chains? Here the subset of antennas need to be selected using the same procedure here the signals of the antennas are combined. This is known as generalized selection and the resulting gains as generalized selection and it is also known as hybrid selection or Maximal ratio combining.[1]

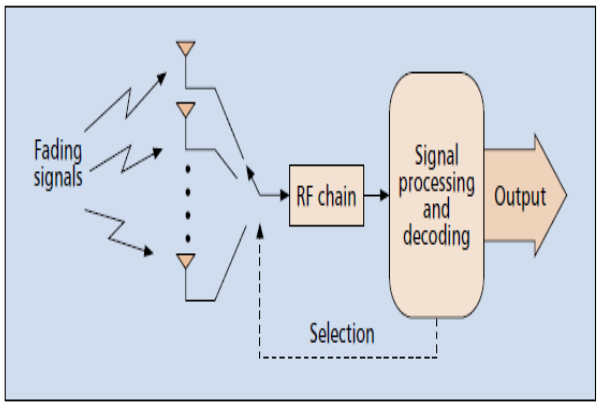

Fig.3Receive antenna selection

B.Transmit antenna selection

Transmit antenna selection is not like receive antenna selection. It needs feedback from the receiver as shown in the figure. To understand the selection concept let us assume that there are 'N' RF Chains and M antennas(M>N) at the transmitter and a single antenna at receiver. Then we need to select most suitable M antennas for N RF chains. In order to achieve this, the phase and amplitude of transmit signals must be in such a way that their superposition at receive results in maximal receive SNR. In this case one should choose the M transmit antenna with highest gain. This is known as hybridMaximal ratio combining.

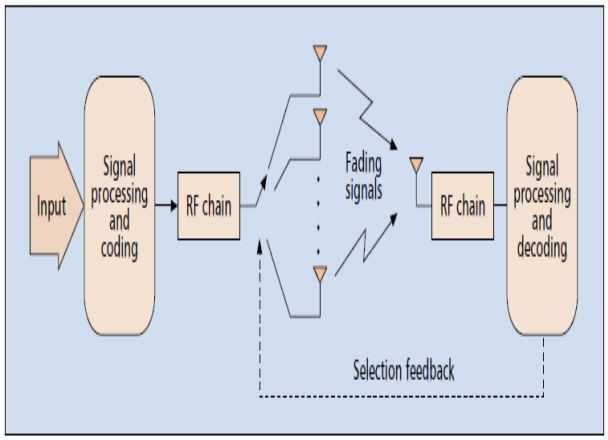

Fig.3 Transmit antenna selection

Hybrid maximal ratio transmission need the transmitter to know not only the N most suitable transmit antennas, but also the complex valued channel gain from each transmit antenna to the receiver in orderTo do so the transmitter needs more feedback than a single selection diversity.[1]

C. Transmit/Receive selection

Next is Transmit and Receive joint antenna selection i.e. to apply selection diversity simultaneously to both transmitter and receiver. In this case there are Mt and Mr Transmit and receive antennas respectively as well as there are Nt and Nr RF chains respectively. Hence it is possible to transmit Nt parallel data streams in order to do it a time-space code is used to provide diversity. Denote that Mt×Mr channel matrix by H. Joint antenna selection strategy need to choose subset of rows and columns from H so that those selected values must maximize the sum of square magnitudes of transmit-receive channel gains. There is still researches is going on in this scenario and various methods are also proposed to achieve the joint antenna selection

There are the 3 methods to implement antenna selection as mentioned before, there also algorithms to select the antennas one of the efficient algorithm is FFOA algorithm which will discussed in the next section

V. ANTENNA SELECTION FOR MIMO WIRELESS COMMUNICATION SYSTEM USING FFOA

In this section the overall flow of FFOA (Fire Flay Optimum Algorithm) methodology as shown in below figure. In this system the 4x4 MIMO is used to implement the FFOA to improve the performance level.[2]

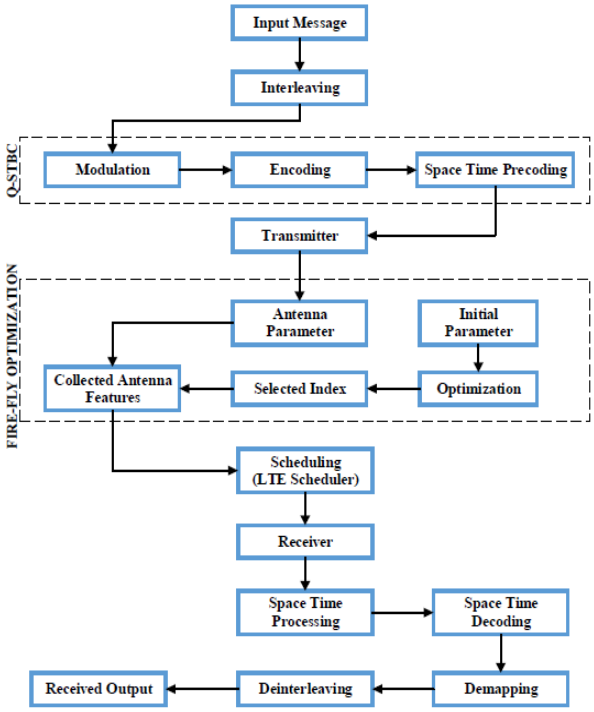

Fig.4 FFOA algorithm flow diagram

As we all know that wireless communication occurs through air. There are more transmission methods to increase the through put and reduce BER(Bit Error Rate).Hence the antenna selection plays an important role to increase throughput and to reduce BER. When we consider the mobile communication the mixing up of signals is main problem, the proposed algorithm avoids mixing of signals and hence throughput is improvised and also BER is reduced.[1]

The overall FFOA algorithm flowAntenna selection is as follows[2]

Step1: Initialization and band width allocation.
Step2:The channel bandwidth is allocated to receiving antenna.

Step3:Message that has to be transmitted is encoded. Q-STBC encoding method.
Step4:Signal duplexing is done at receiver side of antenna area.
Step5:Firefly algorithm is implemented to select an antenna and the antenna is selected.
Step6:The received bit from selected antenna is subjected to LTE schedule.

A. LTE Scheduling

Scheduling plays an important role in Enhancing the performance in multiuser MIMO. User scheduling scheme chooses the best group of users at each time slot in order time increase the run rate capacity of multiuser MIMO wireless communication models. Long Time Evolution Scheduling has the following benefits.[2]

- Minimizes the bandwidth losses
- Decreases the time delay by scheduler
- Lower BER results
- As time delay reduced, the energy and throughput will also get better results.

B. Contributions of FFOA algorithm

- To provide high flexibility for transmission system using the Q-OSTBC approach.
- To enhance the performance level in the MIMO wireless communication system using FFO technique for antenna selection.
- The LTE-based scheduling is implemented to increase throughput parameter by allocating time to communicate over source and destination

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- Throughput is increased by using LTE scheduling
- Delay of the communication system is reduced by using LTE scheduling
- Antenna selection and Scheduling is performed simultaneously hence it improves the performance of the communication system

CONCLUSION

The overall survey article starts with MIMO and its formats with advantages and disadvantages, To get over some disadvantages of MIMO the antenna selection is done and some traditional antenna selection methods are discussed.

There are also algorithms which minimizes the antenna selection complexity one of them is FFOAS it is discussed using 4X4 MIMO system this FFOA technique is compared with some traditional methods and it is concluded that complexity and BER in FFOA is reduced when compared to other traditional technique and also the proposed method can be further used in OFDM based communication.

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