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Performance OF MIMO System Using GENETIC ALGORITHM

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ABSTRACT
Modern radio communication systems have to provide faster data rates. As conventional methods like using more bandwidth or higher order modulation types are limited, new methods of using the transmission channel have to be used. Multiple antenna systems (Multiple Input, Multiple Output – MIMO) gives a significant boost to data rate and channel capacity. It considered as an striking tool for future wireless communication systems, as it the continuing demand for high data rates, spectral efficiency, suppress interference ability and robustness of transmission. MIMO-OFDM is very helpful to transmit high data rate in wireless transmission and provides good maximum system capacity by getting the advantages of both MIMO and OFDM. The main problem in this system is that increase in number of transmit and receive antennas lead to hardware complexity. To tackle this issue, an effective optimal transmit antenna subset selection method is proposed in paper with the aid of Genetic Algorithm (GA). For all the mutation points, the fitness function are evaluated and from that value, best fitness based mutation points are choosen. After the selection of best mutation points, the mutation process is carried out, accordingly. The implementation of proposed work is done in the working platform MATLAB and the performance are evaluated with various selection of transmit antenna subsets. Moreover, Improvement in Channel Capacity and BER with increasing SNR are discussed Hence, using the proposed work, the selection of transmit antenna with the maximum capacity and minimum BER are made and which leads to the reduced hardware complexity and undisturbed data rate in the MIMO system..

Key words: Multi Input Multi Output, Channel Capacity, Genetic Algorithm.

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I.INTRODUCTION

In modern usage, "MIMO" specifically refers to a practical technique for sending and receiving more than one data signal simultaneously over the same radio channel by exploiting multipath propagation. MIMO is fundamentally different from smart antenna techniques developed to enhance the performance of a single data signal, such as beam forming and diversity. MIMO techniques have quite large potential for future wireless communication systems, due to the ever increasing demand for high data rates and spectral efficiency [1].MIMO has become an essential element of wireless communication standards including IEEE 802.11n (Wi-Fi), IEEE 802.11ac (Wi-Fi), HSPA+ (3G), WiMAX (4G), and Long Term Evolution (4G). More recently, MIMO has been applied to power-line communication for 3-wire installations as part of ITU G.hn standard and Home Plug AV2 specification. The Institute of Electrical and Electronics Engineers created a task group in late 2003 to develop a wireless LAN standard delivering at least 100 Mbit/s of user data throughput. Generally, the MIMO system capacity is proportionate to number of transmit and receive antenna[2].But MIMO technique delivers some issues such as increases the hardware cost and complexity of hardware due to increasing number of antennas .The capacity and bit error rate probability [3], [4], throughput or energy efficiency [5], [6], are mutual criteria for antenna selection. However, ESA is not relevant in the case of large scale of MIMO antenna selection because of the enormously increased computational costs with the increasing number of antennas [7]. Antenna subset selection is a potential technique has been proposed to simplify the hardware complexity, i.e., save on RF chains, while providing many heterogeneous advantages [8-9].The throughput/reliability tradeoff can also be increased by antenna selection techniques along with reducing the system cost [11].In this paper, we are optimize the channel capacity and bit error rate of MIMO system using genetic algorithm in the wireless communication system. The rest of paper as described as follows.

Section II describes the general MIMO system model and then antenna selection problem is formulated. In section III, the GA method for MIMO system is described in detail. Results and analysis of channel capacity and bit error rate of MIMO system has been described in section IV. Conclusions are drawn are described in section V.

II. MIMO SYSTEM MODEL

In MIMO systems, a transmitter sends multiple streams by multiple transmit antennas. The transmit streams go through a matrix channel which consists of all N_t,N_r,paths between the N_t transmit antennas at the transmitter and N_r receiver antennas at the receiver. Then, the receiver gets the received signal vectors by the multiple receive antennas and decodes the received signal vectors into the original information.Recently, results of research on multi-user MIMO technology have been emerging. While full multi-user MIMO (or network MIMO) can have a higher potential, practically, the research on (partial) multi-user MIMO (or multi-user and multi-antenna MIMO) technology is more active.Massive MIMO is a technology where the number of terminals is much less than the number of base station (mobile station) antennas.[38] In a rich scattering environment, the full advantages of the massive MIMO system can be exploited using simple beamforming strategies such as maximum ratio transmission (MRT) or zero forcing (ZF). To achieve these benefits of massive MIMO, accurate CSI must be available perfectly. However, in practice, the channel between the transmitter and receiver is estimated from orthogonal pilot sequences which are limited by the coherence time of the channel. Most importantly, in a multicell setup, the reuse of pilot sequences of several co-channel cells will create pilot contamination. When there is pilot contamination, the performance of massive MIMO degrades quite drastically. To alleviate the effect of pilot contamination, the work of proposes a simple pilot assignment and channel estimation method from limited training sequences.Spatial MultiplexingrequiresMIMO antenna configuration. In spatial multiplexing,a high-rate signal is split into multiple lower-rate streams and each stream is transmitted from a different transmit antenna in the same frequency channel. If these signals arrive at the receiver antenna array with sufficiently different spatial signatures and the receiver has accurate CSI, it can separate these streams into (almost) parallel channels. Spatial multiplexing is a very powerful technique for increasing channel capacity at higher signal-to-noise ratios (SNR). The maximum number of spatial streams is limited by the lesser of the number of antennas at the transmitter or receiver. Spatial multiplexing can be used without CSI at the transmitter, but can be combined with precoding if CSI is available. Spatial multiplexing can also be used for simultaneous transmission to multiple receivers, known as space-division multiple access or multi-user MIMO, in which case CSI is required at the transmitter. The scheduling of receivers with different spatial signatures allows good reparability.

A narrowband flat fading MIMO system is modelled as:

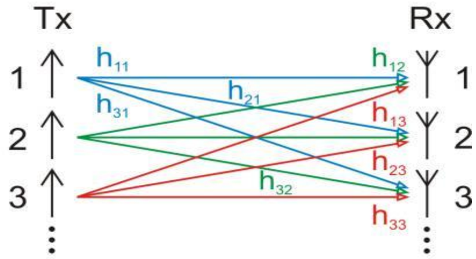

Fig.1: Basic Diagram of MIMO System

$$y = h \times x + n$$

where y and x are the receive and transmit vectors, respectively, and h and n are the channel matrix and the noise vector, respectively.

The fitness function for channel capacity for $N_t \times N_r$ MIMOsystem is described as follows:

$C = log_2\left\{I_{N_t+}\frac{p}{N_t}HH^H\right\}$...(1)

Where

C : Channel capacity of channel

I_{Nt} : N_t×N_r identity matrix

ρ: Signal to noise ratio

H: Rayleigh fading channel matrix

H^H: Conjugate transpose of channel matrix of H

Further H is given by equation (2) as shown below:

H=sqrt(0.5)×(randn(nT,nR))+j×randn((nT,nR)...(2)

WherenT: numbers of subsets of transmit antennas;
nR: Number of subsets of receiving antennas;
randn(): returns an n-by-n matrix of normally distributed random numbers

Since channel capacity is one of the criteria on antenna selection algorithms, we aim at finding the best antenna subset H to maximize the system capacity C.

III. GA FOR MIMO ANTENNA SELECTION

Genetic algorithm is a very useful algorithm for optimizing the capacity of MIMO system. It was developed by John Holland who invented it in the early 1970's. It provides a random search algorithm [4], which is simulated on the law of natural selections and the genetic information recombination with the population.In a genetic algorithm, a population of candidate solutions (called individuals, creatures, or phenotypes) to an optimization problem is evolved toward better solutions. Each candidate solution has a set of properties (its chromosomes or genotype) which can be mutated and altered; traditionally, solutions are represented in binary as strings of 0s and 1s, but other encodings are also possible.

The evolution usually starts from a population of randomly generated individuals, and is an iterative process, with the population in each iteration called a *generation*. In each generation, the fitness of every individual in the population is evaluated; the fitness is usually the value of the objective function in the optimization problem being solved. The more fit individuals are stochastically selected from the current population, and each individual's genome is modified (recombined and possibly randomly mutated) to form a new generation. The new generation of candidate solutions is then used in the next iteration of the algorithm. Commonly, the algorithm terminates when either a maximum number of generations has been produced, or a satisfactory fitness level has been reached for the population.

A typical genetic algorithm requires:
1. a genetic representation of the solution domain,
2. afitness function to evaluate the solution domain.

A standard representation of each candidate solution is as an array of bits. Arrays of other types and structures can be used in essentially the same way. The main property that makes these genetic representations convenient is that their parts are easily aligned due to their fixed size, which facilitates simple crossover operations. Variable length representations may also be used, but crossover implementation is more complex in this case. Tree-like representations are explored in genetic programming and graph-form representations are explored in evolutionary programming; a mix of both linear chromosomes and trees is explored in gene expression programming.
GA suggests the endurance of the fittest between individuals over consecutive generation.It also sustains the population of n chromosomes connected with fitness value. The various steps required for evaluating the efficiency are described below:

A. Initialization

The population size depends on the nature of the problem, but typically contains several hundreds or thousands of possible solutions. Often, the initial population is generated randomly, allowing the entire range of possible solutions (the search space). Occasionally, the solutions may be "seeded" in areas where optimal solutions are likely to be found.

B. Selection: It is used to generate next generation of population by choosing thesolutions from available populations. It is done in order to direct the search to promising areas within the search space. Selection is based on the value of fitness function.

C. Crossover: It is used to generate new child (offspring) by exchanging thegenetic code of obtained solutions. Crossover rate is defined by taking the probability of parent solution being crossed over. Ideally, the range of crossover rate lies between 0.6 and 0.9

D. Mutation: It is used to maintain the total number of genetic characteristics in thegenetic makeup of population. The mutation probability mutates the new offspring of the entire in chromosome. Mutation rates are used to stop best solutions from being effected.

E. Termination

This generational process is repeated until a termination condition has been reached.
Common terminating conditions are:
- A solution is found that satisfies minimum criteria
- Fixed number of generations reached

To find the optimal value of fitness function by GA we have used MATLAB software (R2010a) with VC++ (6.0) compiler, we have chosen the following appropriate parameters to apply genetic algorithm, which are shown in Table 1.

Table 1 : Values of parameters of GA.

Parameters	**Values**
Size Of Population	200
Size Of generation	20
Probability Of Mutation	0.01
Cross-over fraction	0.8

The input and output parameters and output parameters are summarized in the table 2 as shown below:

Table2: Input and Output Parameters

Input Parameters	**Output Parameters**
SNR	Channel Capacity
Bandwidth	-----------------------
Rayleigh Channel Fading model	------------------------

IV. RESULTS AND DISCUSSION

Genetic Algorithm is a very realistic way of evaluating the channel capacity varying with in SNR and generation(iteration). The input parameter p, H,I_{Nt} and N_t can be initialized as per LTE requirements and output parameters channel capacity are obtained by solving the fitness function and reliability function. By using the value of input and output parameters a fitness function is developed. After making a fitness function, We apply Genetic Algorithm for obtaining the optimized value of channel capacity value.

Simulation scenario with (N_t,N_r,nT, nR)=(10,10,8,8) is considered in fig 2.In this figure, thebest and mean fitness value of channel capacity with varying generation at p =20db with population size=200 is evaluated.

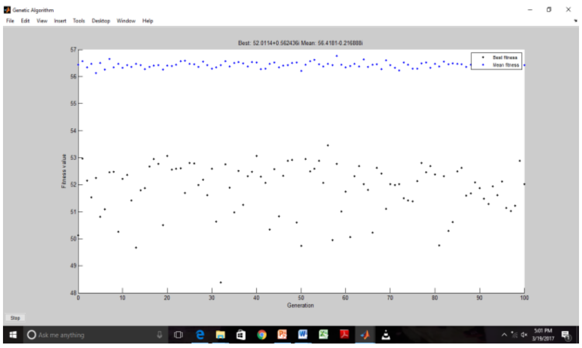

Figure2: Channel Capacity vs Generation

The best fitness and mean value of channel capacity are obtained is 52.0114 and 56.4181 respectively.

Fig.3 represents the channel capacity vs SNR for different values of subsets of optimal transmit antenna.

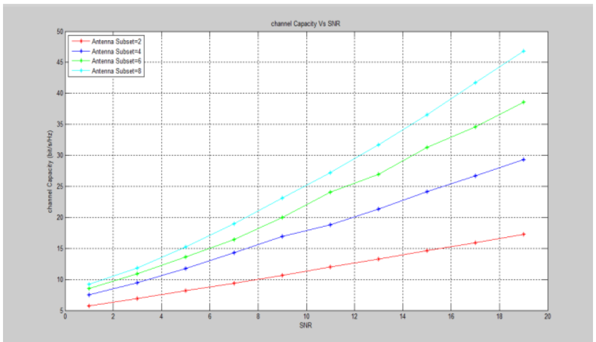

Figure3: Channel Capacity Vs. SNR using nT=2,4,6,8

Clearly , we can see that when we use optimal subsets of transmits antenna are lesser in number, then the MIMO system capacity is small and when the optimal subsets of transmit antennas are larger in number, then the MIMO system capacity is large. Similarly, capacity value is increased with the increase value of SNR.

V.CONCLUSIONS

So this paper brings forward the issue of maximizing the system capacity of MIMO systems when different antenna configurations are used at both transmission link ends. An abstract channel model is employed, which is appropriate for modeling narrow-band Rayleigh channel fading in fixed wireless systems. In this model, spatial correlation matrix is derived with discrete function for different geometries at the receiver, whereas mathematical function for spatial fading correlation of the transmitting antenna is utilized. The search for optimum geometries, under constraints of practicality, and selection of the number of elements have been shown to be performed successfully using genetic algorithm methods for different propagation scenarios, by taking the channel capacity as a fitness function. The GA method has demonstrated its ability to find realistic and economical MIMO array designs requiring only modest numbers of elements at each end of the link.

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