A GENERALIZED APPROACH FOR MIMO DETECTION

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ABSTRACT

The simulation of any block in a communication system is an important issue. This importance increased especially when introduce new technology. The massive MIMO, where the number of antennas is very large is a promising technology to achieve high through put and better power efficiency. So, the simulation of it is very important. Here in a new scheme is introduced and compared with existence methods. The new method is clearly have big advantages over the exits methods and identical with those results.

KEYWORDS: This Importance Increased Especially when Introduce New Technology

INTRODUCTION

Days after days the requirement of speed and capacity are increased. The 5G procure the following requirements: higher rates, better coverage, lower latency and lower battery consumption [1]. Massive MIMO (multi input multi output) play an important role in 5G era [2], and it is one of five disruptive technology directions of the 5G [3] [4].

The massive MIMO or referred to by "Large scale MIMO" is a form of MU_MIMO (multiuser MIMO) systems, where the number of antennas at base station is larger than the number of users. The number may be hundreds or even thousands. The impact of massive MIMO is to smoothens the channel or in other word reduce the frequency dependencies [3]. So modeling of massive MIMO is very essential in computing the performance of wireless systems [5]. In [5] a good survey on the channel models is introduces.

The problem is (and this is true for other papers) that all the channels are introduced in a general mathematical model. No explanation or clarification is made on how transmission and /or receiving is done. And if one move back to traditional MIMO systems (2×2) (4×4) or even (8×8) one can find programs on the web like [6] and [7] or even books like [8]. But the problem is raised and face the researcher when one tries to implement the model to simulate a communication system with larger number of antennas. Here a general model for SIMO, MISO and MIMO with their transmission / reception technique and its details are presented to help future development of wireless communication system in 5G.

SYSTEM MODEL

The general model for MIMO is a dynamic model that its input / outputs depend on the desired system size. In general the system structure is as shown in figure 1 below:

The received signal can be describe as

$$Y = GX + N$$

Where

Y= the received vector

G= the channel matrix

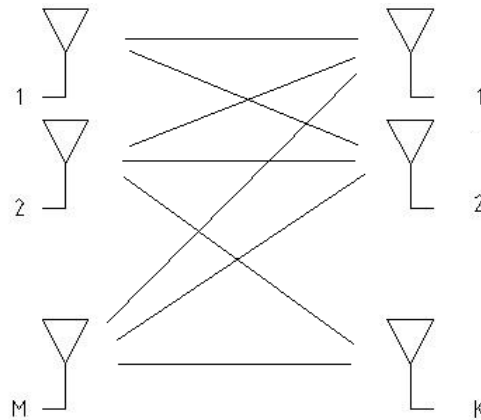*X*= the transmitted vector

and

N= the noise vector.

Figure 1: General MIMO Structure

The channel matrix is modeled by [5] and [9] as:

$$G = HD^{\frac{1}{2}}$$

Where

H= is the fast fading matrix

D= is the large scale propagation matrix.

The orientation of X and its length depend on the transmission technique as described next.

TRANSMISSION / RECEPTION TECHNIQUES

Here the transmission / reception technique for MISO, SIMO and MIMO are described respectively.

Before start it is worth to mention that the multi means diversity in either input (transmitter) or output (receiver). Also the channel state is to be perfect known by the receiver.

a. **Single Input Multi Output (SIMO):** Here in the symbol is to be transmitted via single antenna like traditional systems, and at the receiver multi copies (non-identical neither in amplitude delay nor phase) are to be captured by using more than one antenna. The conjugate of each of these values is to be multiplied by related channel factor. The produced vector is to be summed; the result will be a single value. The detection is to be made on that result.
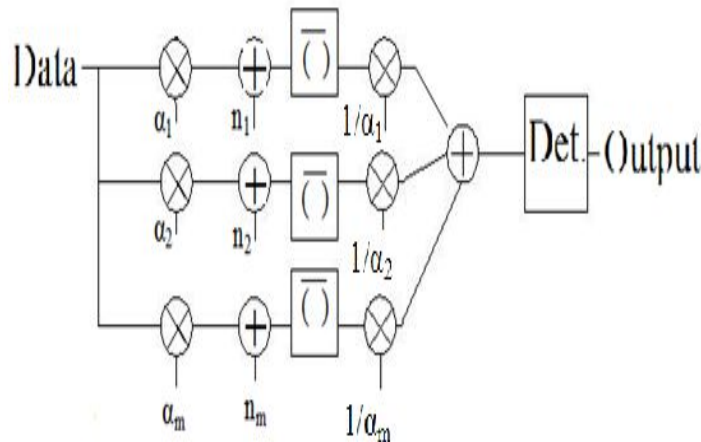
Figure 2: Multi-Input Single Output (MISO)

b. **Multi-Input Single Output (MISO):** Here the system configuration is as shown in figure 2. At each transmission time a single symbol is to be transmitted. This symbol is cloned over all of the transmitter antennas. At each symbol time the receiver antenna receive the summation of the transmitted clones over the channel. The conjugate of the received signal at each antenna is multiplied by the summation of the effect of the links between each of transmitter antennas and receiver antenna. The received bit is depending on the sign of the real part of the resultant.
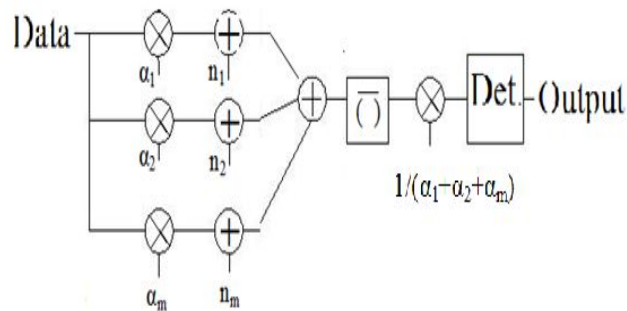

Figure 3: Multi-Input Multi Output (MIMO)

c. **Multi-Input Multi Output (MIMO):** This is the general transmission configuration where at transmitter a multi copies of the symbol are to be transmitted and at the receiver, each antenna receive multi signals each of related to one of the transmitter antennas. It is worth to note that single symbol is transmitted each time. At receiver, like MISO, the summation of channel values between all transmitters' antennas and each of the receiver antennas are summed to generate one vector. This vector is multiplied in element wise method with the conjugate of the received signal vector. Now, like SIMO, the resultant vector is summed to generate single value. The detection is done on this value.

RESULTS

Here in the results of the simulation is presemted. First of all a comparsion between exist methods (like zero forcing and MMSE) and the proposed method is done for 2X2.
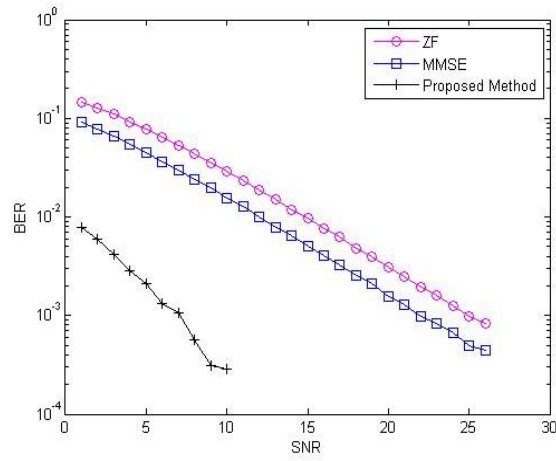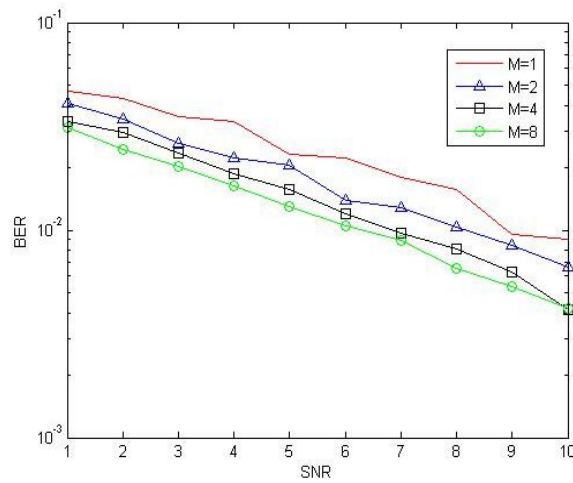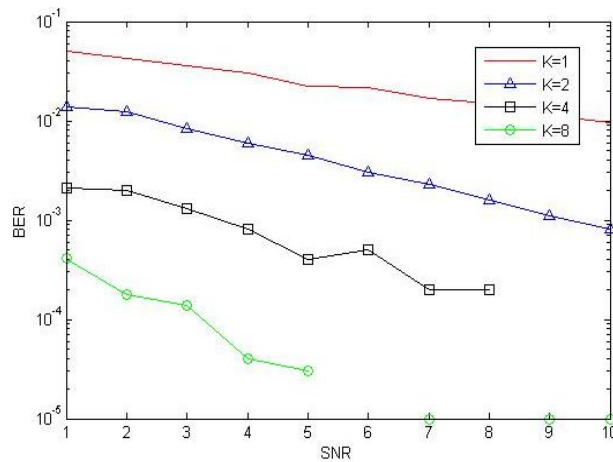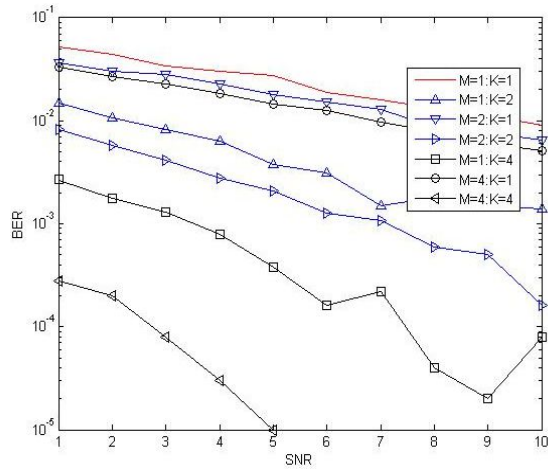
Figure 4: Performance Comparsion

The following figures present the performance of MISO, SIMO and MIMO using BPSK.
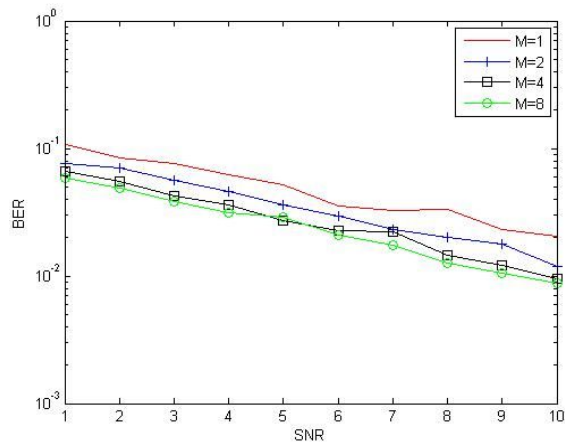

a) MISO Configuration Performance
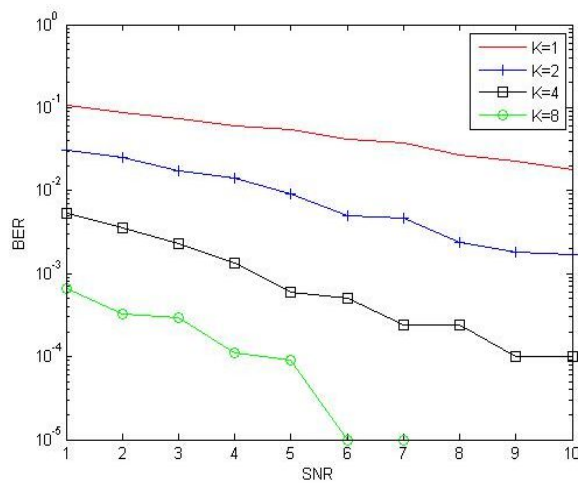

b) SIMO Configuration Performance

c) MIMO Configuration Performance

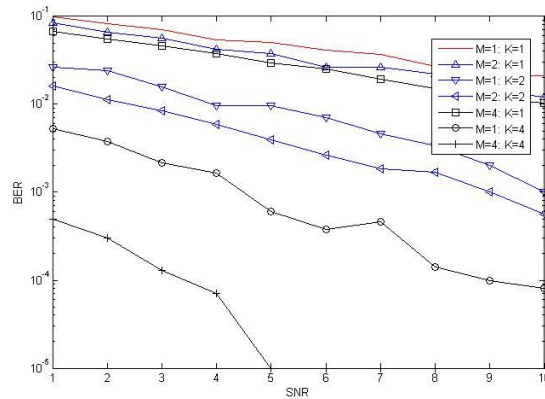**Figure 5: Performance of BPSK**

The last figures present the performance of QPSK.

a) MISO Configuration Performance

b) SIMO Configuration Performance

c) MIMO Configuration Performance

Figure 6: Performance of QPSK

CONCLUSIONS

The result can be divided into two categories. The first one figure 4, where a comparison between the existing methods of detection and the proposed is presented. Here one can see obviously that the proposed method is better than those exist.

The second group (figure 5a to figure 5b) compare between many configurations for the proposed method (from 1 by 1 to 4 by 4). Like conventional methods, increase number of antennas lead to increase performance the system (i.e. decrease the BER). The results are compatible with results of old methods, where the performance of SIMO is better than that of MISO. This can be explained in the following way. If the system considered as a set of equation and the output is the solution of this equation, the channel matrix is the corner stone of the issue. The increase in transmitter number will lead to increase the number of variables only, which is not necessary enhance the detection of the signal. On the other side the increase in receiver antennas (receiver diversity), consider as an increasing in the number of equations used in the system. This increment will effect directly the solving of the system and lead to enhance performance as a result.

Finally it is worth to mention that the increase of transmitter antennas alone give a very poor results, while if this increment is accompanied with increase in receiver antennas, it will have big boost over the single increment in either transmitter or receiver.

REFERENCES

1. Technology Development in Recent Trends Using 5G Technology, Aman Mohammed et al., Proceeding of NCRIET-2015 & Indian J.Sci.Res.12(1):488-493, 2015

2. Networks and Devices for the 5G Era, Boyd Bangerter et al., IEEE Communication Magazine, February 2014.

3. Five Disruptive Technology Directions for 5G, Federico Boccardi et al. IEEE Communication Magazine, February 2014.

4. Cellular Architecture and key technologies for 5G Wireless Communication Networks, Cheng-Xiang Wang et al, IEEE Communication Magazine, February 2014.

5. Massive MIMO Channel Models: A Survey, Kan Zheng, SulingOu, and Xuefeng Yin; Hindawi Publishing Corporation, International Journal of Antennas and Propagation, Volume 2014, Article ID 848071.

6. http://spacetimecodes.blogspot.com/

7. http://dsplog.com

8. MIMO-OFDM wireless communications with matlab, Yong Soo Cho et al, John Wiley & Sons (Asia) Pte Ltd, 2 Clementi Loop, # 02-01,Singapore 129809,2010.

9. Full-Duplex Multiuser MIMO with Massive Arrays, Hussain A. Wannas, Linköpings University 2014.