Improving Spectral Efficiency of DOA in 4g Mimo System

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Abstract: In many signal processing applications estimation of signal parameters is a significant problem such as DOA (Direction of Arrival).The subspace methods for estimation of DOA are MUSIC, ESPRIT & Root MUSIC. Among these MUSIC algorithm is commonly used method it decomposes the received signal space into signal subspace& noise subspace using covariance matrix equation. The introduction of smart antennas is used to know about MIMO (Multiple Input Multiple Output) antenna system. MIMO spectral efficiency is better than SISO, increases complexity. Estimation of DOA is influenced by some factors such as number of array elements, signal to noise ratio (SNR) and bit error rate (BER).In MIMO system BER decreases with decreasing DOA. Finally simulate estimation of DOA with different experiments and this may be useful in multipath applications (mobile communication).

Keywords: MIMO, BER, SNR, DOA, SMART ANTENNAS.

1.0 INTRODUCTION

In 1897, Guglielmo Marconi demonstrated first time the radio's ability to provide continuous contact with the sailing ships. Since then there had been tremendous development in wireless communication. Hundreds and thousands of engineers has worked and developed theories and researches on wireless communication**.** The wireless communication systems have gone from different generations from SISO systems to MIMO systems. Bandwidth is one important constraint in wireless communication. In wireless communication, high data transmission rates are essential for the services like data, voice and video.

1.1 SISO ANTENNA SYSTEM

SISO is single input and single output system and is the simplest form of the communication antenna. The capacity of such system is given by Shannon capacity theorem the mathematical form as

$$C= B*\log2 (1+S/R) \quad ---------- \quad (1.1)$$

Due to multipath effect, SISO antenna signal suffers with fading, attenuation loss and number errors increase.

Fig 1.1: SISO Antenna System

1.2 MIMO ANTENNA SYSTEM

MIMO antenna is multiple input and multiple output system, in this the signal can go through many paths between a transmitter and receiver. In MIMO system, the capacity can be increased without increasing the bandwidth and transmit power rather by just putting more antennas at transmitter and receiver side. The most important part to understand and deal the MIMO capacity is the channel Matrix (H).

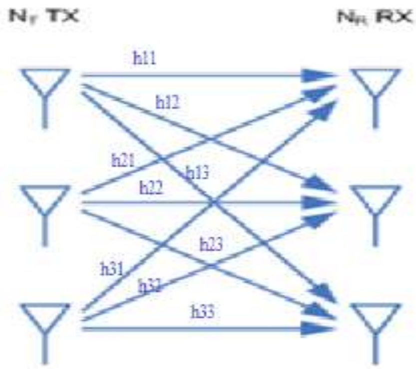

Fig 1.2: 3×3 MIMO Antenna System

$$H = \begin{bmatrix} h11 & h12 & h13 \\ h21 & h22 & h23 \\ h31 & h32 & h33 \end{bmatrix} \quad \text{------} \quad (1.2)$$

MIMO antenna capacity is given by the relation

C = B* log2 (1 + nT * nR *S/R) ----- (1.3)

2.0 PROPOSED METHOD

Direction of Arrival (DOA) estimation is the fundamental problem in many applications such as radar, sonar, wireless communication, seismology, radio astronomy and medical diagnostics. DOA estimation algorithms classified in 3 types – data adaptive algorithms, subspace algorithms and maximum likelihood algorithms. Among all these, subspace method of MUSIC algorithm gives high resolution DOA estimation. DOA estimation is influenced by some factors such as number of array elements, signal to noise ratio (SNR) and bit error rate (BER). In this, we see how these factors effecting DOA estimation by detailed simulation results of MATLAB.

2.1 MUSIC ALGORITHM

The main function of the MUSIC algorithm is finding the most relevant signal. The MUSIC algorithm uses matrix equations to decompose signals in space. The received signal is decomposed into the signal subspace and the noise subspace.

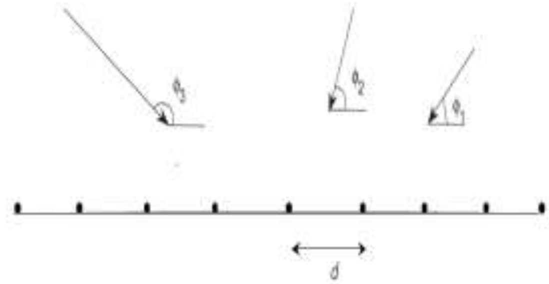

Fig 2.1: DOA Estimation problem

Mathematical equations for covariance matrix is

$$X = S\alpha + n \quad \text{---------} \quad (2.1)$$

$$S = [S(\emptyset_1), S(\emptyset_2) \ldots\ldots, S(\emptyset_M)]$$

$$\alpha = [\alpha_1, \alpha_2 \ldots\ldots, \alpha_M]$$

Where S is a N×M matrix of the M steering vectors, n is noise vector zero mean white Gaussian noise of variance σ^2I and α = ae^{jb}. The correlation matrix of X can be written as

$$R = E[XX^H] \quad \text{----------} \quad (2.2)$$

$$= E[S\alpha\alpha^H S^H] + E[nn^H]$$

$$= SAS^H + \sigma^2 I$$

$$= R_s + \sigma^2 I$$

Where R_s is a covariance matrix. Q_n is an eigen vector then

$$P_{music}(\emptyset) = \frac{1}{S^H Q_n Q_n^H S} \quad \text{--------} \quad (2.3)$$

3.0 SIMULATION RESULTS

a) The MIMO antenna system assumed to have 2 transmitter antennas and 2 receiver antennas and the range of SNR is 0-50dB. Fig (4) depicts the relation between spectral efficiency and average SNR. No matter MIMO or SISO antenna, the value of spectral efficiency is proportional to the value of SNR for SNR < 45dB when SNR > 45dB the growth rate is small. From fig (4) it is observed that the spectral efficiency of MIMO antenna is much better than SISO antenna spectral efficiency.

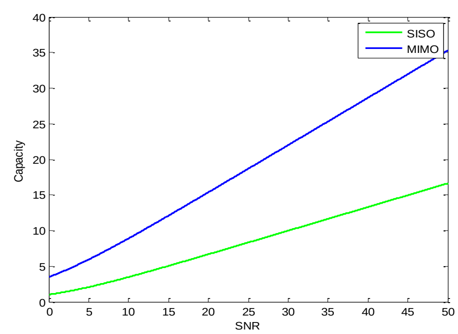

Fig.3.1: Spectral efficiency for SISO and MIMO with SNR

b) MIMO antenna system assumed that it is using BFSK modulation technique. In this simulation we compared the error probabilities of BFSK coherent, non-coherent and simulated error probability of binary orthogonal frequency shift keying. In both cases of the theory and simulation the value of BER is decreasing with increasing value of SNR. From fig (5), it is observed that BER performance of coherent case is better than the BER performance of non coherent case after about 8dB SNR.

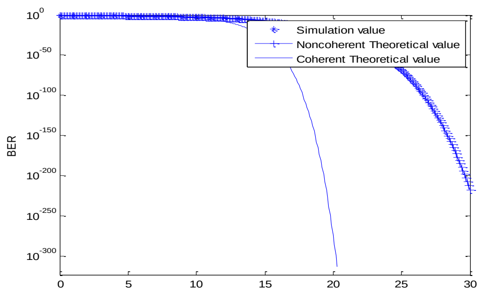

Fig.3.2: Relation between BER and SNR for BFSK coherent and non-coherent case

c) In this simulation, it is assumed that MIMO antenna system is using BFSK coherent case and assumed that the number of transmitter and receiver antennas is 2, SNR is 15dB. Fig () depicts the relation between BER in dB and AOA for ULA. From fig (6), it is observed that BER increases when the central AOA increases and the value of BER reaches the maximum when the central AOA is almost 90°.

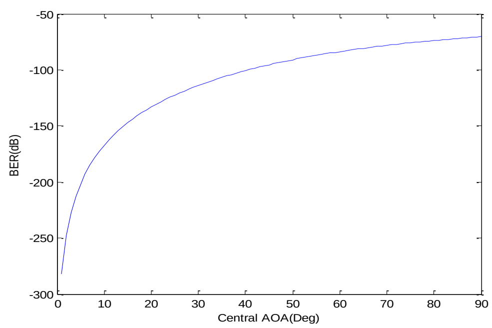

Fig.3.3: Relation between BER and AOA for ULA

d) In this simulation, it is assumed that the number of antennas is 16, the signal direction of two independent narrow band signals are 25° and 45°, the number of snapshots is 100 and SNR is 0dB, 20dB and 30dB. Music algorithm constructs two needle spectrum peaks at 25° and 45° it shows that it estimate the number and direction of the incidence signal. From simulation results it is observed that DOA estimation is increased with increasing SNR.

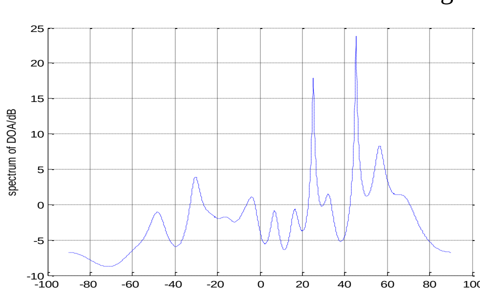

Fig.3.4: Simulation of MUSIC Algorithm for DOA estimation in 0dB

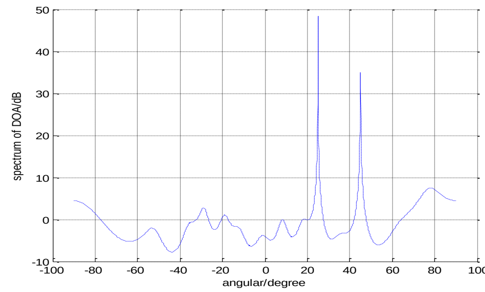

Fig.3.5: Simulation of MUSIC Algorithm for DOA estimation in 20dB

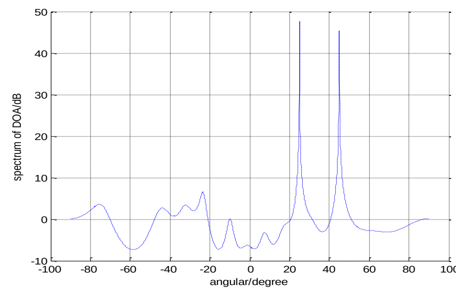

Fig.3.6: Simulation of MUSIC Algorithm for DOA estimation in 30dB

4.0 CONCLUSION

The problem of improving spectral efficiency of DOA using 4G MIMO system is addressed. In this subspace method of MUSIC algorithm is used for DOA estimation with different SNR. Simulation results depicts that MUSIC algorithm gives two needle spectrum peaks and it is more stable. DOA estimation is increased with increasing SNR. After that studied about the spectral efficiency of SISO and MIMO antenna with SNR and observed that spectral efficiency of MIMO is always better than SISO. In MIMO system the BER is shown to decrease with decreasing DOA. MIMO technology has advantages in communication distance, channel capacity and reliability compared to single antenna technology.

5.0 REFERENCES

1) E.T. Tchao , K. Diawuo , W.K. Ofosu , E. Affum," Analysis of MIMO Systems used in planning a 4GWiMAX Network in Ghana", International Journal of Advanced Computer Science and Applications, Vol. 4, No.7, 2013, Pp.197-201.
2) Debasis Kundu,"Modified MUSIC algorithm for estimating DOA of signal, Department of Mathematic", Signal Processing, vol 48, Jan 1996 Pp.85-90.
3) Xia LIU, Marek E. BIALKOWSKI, Feng WANG, Konstanty BIALKOWSKI, "Investigation into the performance of a MIMO system equipped with ULA or UCA antennas: BER, capacity and channel estimation", Int. J.Communications, Network and System Sciences, 2009, 6, 491-503

4) C.H Yu, J.L Li. "A White Noise Filtering Method for DOA Estimation of Coherent Signals in Low SNR". Signal Processing. July 2012. Vol. 28. No. 7. Pp.957-962.
5) Stoica, P.; Nehorai, A. MUSIC, maximum likelihood, and Cramer-Rao bound: Further results and comparisons. IEEE Trans. Acoust. Speech Signal Process. 1990, 38, 2140–2150.
6) M. Sánchez-Fernández, E. Rajo-Iglesias, O. Quevedo-Teruel, and M.L. Pablo-González, "Spectral efficiency in MIMO systems using space and pattern diversities under compactness constraints," IEEE Trans. Veh. Technol., vol. 57, no. 3, pp. 1637–1645, May 2008.
7) Y.J Huang, Y.W Wang, F.J Meng, G.L Wang. "A Spatial Spectrum Estimation Algorithm based on Adaptive Beam forming Nulling". Intelligent Control and Information Processing, 2013 Fourth International Conference on, IEEE, Jun, 2013. Pp220-224.
8) Yong Soo Cho, MIMO-OFDM Wireless communications with Matlab, Wiley, Pp.111-146.
9) Tolga M. Duman and Ali Ghrayeb, Coding for MIMO Communication System, WILEY, 2007, Pp3
10) Farooq Khan, LTE for 4G Mobile Broadband air interface technologies and performance, Cambridge , 2010, Pp1-3