International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-5, March 2020

An Optimal Receive Antenna Selection Algorithm using GA in MIMO Communication System

Sasmita Padhy, Satya Narayan Tripathy, Sisira Kumar Kapat, Susanta Kumar Das

Abstract: ***MIMO technology offers large improvements in data transfer and connection range no bandwidth extra or processing potential in wireless communication,. Multiple transmitters and receivers are used to simultaneously transfer enormous amounts of data. Using many antennas transmitting and receiving, efficiency can be enhanced for wireless communication systems operating in fading environments. But the key downside in the new MIMO scheme, due to multiple Radio Frequency chains, is increased complexity and high cost. A daunting incentive is the development of techniques to reduce hardware and computing costs of the systems with a huge amount of antennas. The optimum selection of the receiver antenna subset is a very effective approach to achieving this goal. Genetic algorithm is used in this paper to choose the receivers from the available set of antennas that would then be compared with an existing receiving antenna selection process.***

Keywords: ***Antenna selection, MIMO System, Channel capacity, Cost, Complexity, Genetic Algorithm.***

I. INTRODUCTION

"Multi Input Multi Output" systems uses multiple transmitter and receiver antennas. By using multiple transmitting and receiving antennas, the conduct of wireless communication networks operating in fading environments can be greatly increased [1–14]. But, because of multiple radio frequency chains at both connection ends maximizes cost and complexity (such as mixers and A/D converters, amplifiers etc). Selection of antennas has been suggested in recent years as an effective method for rising uncertainty in Multi Input and Multi Output (MIMO) systems and absorbing high attention. The bottom line consideration of antenna selection is to consider a finest subset of transmitting and receiving antenna in MIMO network. It has been demonstrated that the achievement of systems immensely greater when selection techniques were used as compared with the systems on the outside any selection where total amount of antennas are same [5][16]. Gorokhov has been suggested an approach for decremental selection, which could reach nearly the same capacity.

Revised Manuscript Received on March 30, 2020.
* Correspondence Author

Dr. Sasmita Padhy, Associate professor, Department of CSE, Vignan Institute of Technology and Management, Berhampur, Ganjam, Odisha. e-mail: pinky.sasmita@gmail.com

Dr. Satya Narayan Tripathy **(**0000-0002-6005-687X), Assistant Proffessor, Department of Computer Science, Berhampur University, Odisha. e-mail: snt.cs@buodisha.ac.in

Er. Sisira Kumar Kapat **(**0000-0002-2489-6214**)**, Lecturer, Department of CSE/IT, Uma Charan Patnaik Engineering School, Berhampur, Odisha, e-mail: skk.rs.cs@buodisha.edu.in

Dr. Susanta Kumar Das , Reader, Department of Berhampur University, Odisha, email: skd.cs@buodisha.edu.in

The procedure starts at the entire set of antennas usable, after that eliminates one antenna every step. The procedure eliminates one antenna at each iteration resulting in a loss of minimum power. The procedure executes before maintaining the number of antennas needed. A procedure of incrementing technique for near-optimal antenna selection was suggested in [23], and an explanation is based on QR decomposition. The incrementing near-optimal selecting receive antenna procedure begins with an null set, and every time the antenna is selected, thus increasing the highest capacity. In [17], suggested sub-optimal antenna selection algorithm embrace a consecutive selection method based on standard and M correlation. Gharavi-Alkhansari, A. B. Gershman presented in MIMO Systems a paper on Fast Antenna Subset Selection, the calculation complexity of which is much lower than that of the algorithm[19]. The approach begins including a null set of selected receive antennas after that increments one antenna to the indicated set at individual iteration. The antenna with the greatest possible contribution to system performance is added to the selected antennas set at each level. Two effective near-optimal antenna selection approaches focused on increment of channel power. The focused idea is to employ an efficient iterative method to cut down computating complexity and preserve near-optimal achievement [15]. J.S Park and D.J Park, G.dong, Y.gu and Daejeon [18], proposed the algorithm "A modern antenna Selection Algorithm with very less Complexity in MIMO Wireless System" based on standard and uncorrelated power maximization selection. Q.Guo, S.C. and Kim D.C.Park [21] published a paper on selecting antenna using the MIMO Systems Genetic Algorithm. The selection of antennas was at the transmitter side and the selection of genetic algorithms to maximize capacity is applied. In this paper we find collection of subsets of antennas with IID (independent and identically distributed) flat fading links at the receiver. We have used a genetic algorithm for selection which is one of the algorithms of random search. GA works well when you have broad search space. Since we are choosing a subgroup of antennas from a broad set of antennas, it has a mixture of many sets from which we have to choose a set with a larger capacity of channels. Section-II of this paper describes the MIMO system in detail. The process of selecting antennas using genetic algorithm is described in Section-III. In Section-IV, we reviewed numerically; Section-V presents the implemented outcomes using the GA which again correlated with other antenna selection approaches of A. Gorokhov, the optimal selection process and the sub-optimal method of the Gorokhov. Section-VI gives the conclusion of our work.

II. MIMO SYSTEM

We recognize a MIMO system with sum l of Mt number of transmitter and Mr receiver antennas, where Mr ≥ Mt. . The communication channel is expected as quasi-static Rayleigh flat fading and the system is modeled as,

$$y(t) = \sqrt{\frac{\rho}{M_t}} Hx(t) + n(t)$$

y(t) is the signal vector obtained at receiver Mr ×1, test taken at time t,

x(t) denotes the signal vector transmitted by Mt ×1 test taken at time t , and

n(t) represents Gaussian noise vector with mean=0 and variance=1.

The average SNR ratio is ρ . The MIMO channel matrix is H.

H= Mr × Mt.

$$H = \begin{bmatrix} h_{11} & h_{21} & . & h_{m1} \\ h_{12} & h_{22} & . & h_{m2} \\ . & . & . & . \\ h_{1m} & h_{2m} & . & h_{mm} \end{bmatrix}$$

We assume that at the receivers of the channel is well defined, and the transmitters not having any idea about the channel matrix. Power is distributed equally at the transmitter side, MIMO network power with matrix H is cited by [1].

$$C(H) = \log_2 \det(I_{M_t} + \frac{\rho}{M_t} Hermitian(H)H)$$

$$C(H) = \log_2 \det(I_{M_r} + \frac{\rho}{M_t} Hermitian(H)H)$$

I_{m_r} signifies the $M_r \times M_r$ identity matrix.

det(·) denotes the determinant of the matrix.

Hermitian(H) signifies Hermitian transpose of matrix ‘H’.

A hermitian transpose is formally defined by

$$(H^*)_{ij} = \overline{H}_{ji}$$

The SVD of a channel matrix H is determined by,

$$H = U \sum V^H$$

Here U denoted as m×m real , complex unitary matrix.

Σ signifies a m×n diagonal rectangular matrix of non-negative real diagonal numbers l .

V* (the conjugate transpose of V) signifies a n×n real or complex unitary matrix.

MIMO network channel power using SVD is,

$$C'(H) = \sum_{i=1}^{l} \log_2 \left(1 + \left(\frac{\rho}{M_t}\right) a_i^2\right)$$

The efficiency can be approximated with maximum SNR ratio, as,

$$C'(H) \approx l \log\left(\frac{\rho}{M_t}\right) + \sum_{i=1}^{l} \log_2 a_i^2$$

Where, channel matrix rank is l; ρ is the signal to noise ratio; and i th singular value is a_i.

III. ANTENNA SELECTION USING GENETIC ALGORITHM

Evolution in a genetic algorithm usually begins with a population of generated random individuals. Every individual's fitness is measured in the population, in each generation. The most healthy individuals are chosen from the very recent population, then every individual's genome is changed to generate a new population. The generated population is further used in the next loop of the procedure. Typically, the iteration of the algorithm ends when either a maximum number of generations has been generated, or a satisfactory fitness level for the population has been achieved [21]. There are two distinct terms to the channel power. The 1st terminology is an operation of the channel rank, the amount of transmitters and receiving SNR (signal to noise ratio). Since the overall power is restricted to be constant and the SNR stays about the same at the receiving antennas [8], we can disregard the first term to get the maximum capacity value and calculate only the second term. The highest value of the 2nd term gives the highest capacity of the channel. It can further applied to the selection process of antenna to obtain the most suitable subset of the antennas, and this is considered as an evaluation function to generate one individual as

$$C'(H) = \sum_{i=1}^{l} \log_2 a_i^2 = \log_2 (\prod_{i=1}^{l} a_i^2)$$

For Genetic Algorithm technique for optimization, the desired fitness function is achieved from the above equation as

$$F(H_L) = \frac{C'(H_L)}{\sum_{L=1}^{L} C'(H_L)}$$

Where the size of the population is L, with the individual Lth. After repeated operations of initialization, collection, mutation and crossover, we can eventually achieve nearly the clone variety of optimum one [6].

IV. NUMERICAL STUDY

We contrasted the efficiency of the three separate algorithms GA, optimum algorithm [6], and sub-optimal algorithm Gorokhov[10]. We have taken 4 and 16 transmit and receive antennas, respectively, and out of 16 receiving antennas 4 are chosen for efficiency comparison. We find the (i.i.d) Rayleigh flat fading loop, where the H components are complex Gaussian variables with mean is zero and variance is 1. independently and identically distributed [22]. Chance for fusion and chance of mutation are 0.2 and 0.1 respectively.

Retrieval Number: E2502039520/2020©BEIESP
DOI: 10.35940/ijitee.E2502.039520
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

The size of population we taken here is 10 and the number of generations or variations is 20.

V. SIMULATION RESULTS

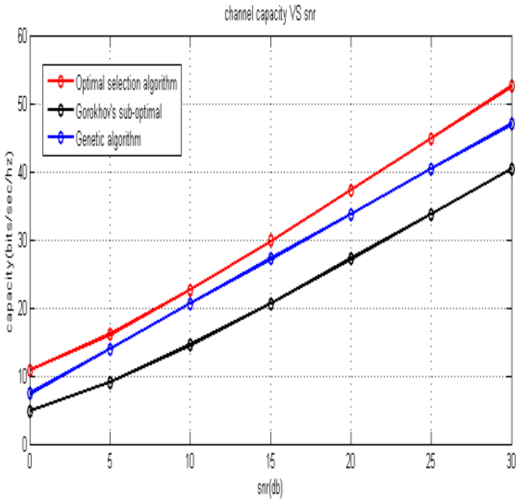

Figure.1 channel capacity vs. SNR (max.generation20)

Fig 1 indicates the channel power as opposed to SNR when 20 is the extremity number of generation that implies the number of the executed steps or iterations. Larger maximum number of generations means greater difficulty in the computation. All the points represented in the figure are obtained by an average of more than 1000 channel realizations. After that we measured the SNR 0 to 30 channel capability. 4 receiving antennas are chosen from 16 receiving antennas according to their optimum fitness value compared to others.

This figure shows that when the desired generated papulation is 20, there is a limited loss of capability compared to the most favorable selection process. On the other hand Genetic Algorithm gets similar efficiency with the optimum selection method, with the increased number of generation. The Genetic Algorithm's efficiency of the channel is greater than that of Gorokhov's sub-optimal algorithm of selection of antennas [10].

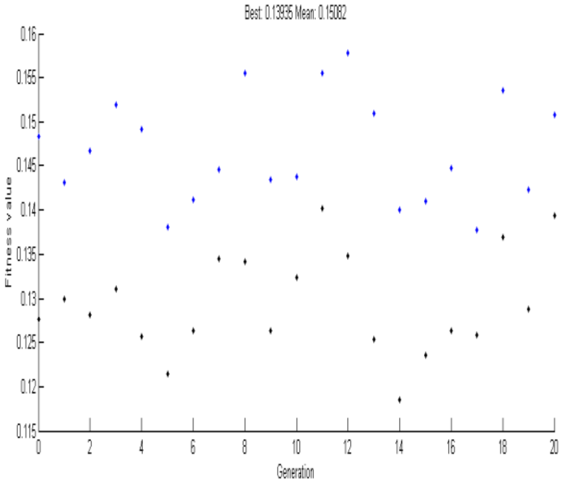

Fig.2 Fitness value versus Generation (max. generation 20)

Figure 2 shows the value of fitness per generation. In the toolbox for the genetic algorithm the fitness function is invoked. Our selected variables are 4. Consider the crossover=0.2 and mutation=0.1. The crossover is heuristic style and the type of mutation is uniform, and the type of population is a double vector that we have selected.

Then the plot shows every generation with the best and mean fitness worth. The best fitness value is 0.13935 and the fitness value averages 0.15082.

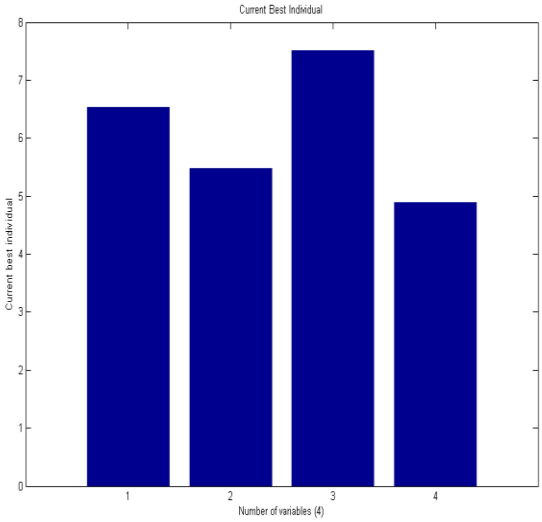

Fig. 3 fitness value versus current generation

Figure 3 indicates the point co-ordinates with the best fitness attribute of the current generation.

VI. CONCLUSION

Using Genetic Algorithm, the receive antennas were selected to optimize channel power. The evaluated value shows that the suggested algorithm using GA achieved roughly the same efficiency as the optimum technique of selection, with minimum computation and better performance than the other methods of selection.

The other algorithms may be used to find transmitting or receiving antennas from the available collection of antennas to minimize cost and complexity of computations.

REFERENCES

1. E. Telatar, “Capacity of multi-antenna Gaussian channels,” Eur. Trans.Telecommun., vol. 10, pp. 585-595, Nov. 1999.
2. G. J. Foschini and M. J. Gans, “On limits of wireless communications in a fading environment when using multiple antennas,” Wireless Personal Commun., vol. 6, pp. 311-335, Mar. 1998.
3. J. H. Winters, “On the capacity of radio communications systems with diversity in Rayleigh fading environments,” IEEE Journal on Selected Areas in Comm., pp. 871-878, Jun. 1987.
4. A. F. Molisch, M. Z. Win, and J. H. Winters, “Reduced-complexity transmit/receive-diversity systems” IEEE Trans. Signal Processing, vol. 51, pp. 2729-2738, Nov. 2003.
5. A. F. Molisch, M. Z. Win, and J. H. Winters, “Capacity of MIMO systems with antenna selection,” in Proc. Int. Conf. Commun., vol. 2, pp. 570-574, Jun. 2001.
6. D. A. Gore, R. U. Nabar, and A. Paulraj, “Selecting an optimal set of transmit antennas for a low rank matrix channel,” in Proc. IEEE Conf. Acoustics, Speech, and Signal Processing, vol. 5, pp. 2785 - 2788, Jun.2000.
7. D. A. Gore, A. J. Paulraj, “MIMO antenna subset selection with space-time coding,” IEEE Trans. Signal Processing, vol. 50, pp. 2580-2588, Oct. 2002.

8. I. Bahceci, T. M. Duman, and Y. Altunbasak, "Antenna selection for multiple-antenna transmission systems," IEEE Trans. Infomation Theory, vol. 49, pp. 2669-2681, Oct. 2003.
9. R. Heath and A. Paulraj, "Antenna selection for spatial multiplexing systems based on minimum error rate," in Proc. IEEE Int. Conf. Commu., vol. 7 , pp. 2276-2280, Jun. 2001.
10. A. Gorokhov, "Antenna selection algorithms for MEA transmission systems," in Proc. IEEE Conf. Acoustics, Speech, and Signal Processing, vol. 3, pp. 2857-2860, May 2002.
11. A. Gorokhov, D. A. Gore, and A. Paulraj, "Receive antenna selection for MIMO spatial multiplexing," IEEE Trans. Signal Processing, vol. 51,pp. 2796-2807, Nov. 2003.
12. M. Gharavi-Alkhansari and A. B. Gershman, "Fast antenna subset selection in MIMO systems," IEEE Trans. Signal Processing, vol. 52, pp. 339-347, Feb. 2004.
13. A. Gorokhov, D. Gore, and A. J. Paulraj, "Performance bounds for antenna selection in MIMO systems," in Proc. IEEE Int. Conf. Commu., vol. 5, pp. 3021-3025, May 2003.
14. Y. S. Choi, A. F. Molisch, M. Z. Win, and J. H. Winter, "Fast algorithms for antenna selection in MIMO systems," in Proc. VTC, vol. 3, pp. 1733-1737, Oct. 2003.
15. J.Fan, Q.Yin and W.Wang, "Low Complexity Transmit Antenna s1election for MIMO system," IEEE Conf. Global Telecommunications, pp. 5-9, Dec. 2011.
16. S.Sanayei and A.Nosratinia, "Capacity of MIMO Channels With Antenna Selection," IEEE Transaction On Information Theory, vol. 53, no.11, Nov. 2007.
17. S. Liu, Z.He, W. Wu, X. Chang, Z.Li and E.Schulz, "A Fast Sub-Optimal Antenna Selection Algorithm in MIMO Systems," IEEE WCNC proceeding, 2006.
18. J.Park ,D.Park, G.dong, Y.Daejeon, "A New Antenna Selection Algorithm with Low Complexity for MIMO Wireless Systems," IEEE, Transaction 2005.
19. M.G.Alkhansari and A.B. Gershman, "Fast Antenna Subset Selection in MIMO Systems," IEEE Transaction Signal Processing, vol. 52, no. 2, Feb 2004.
20. H.Y. Lu, and W.H Fang, "Joint Transmit/Receive Antenna Selection in MIMO Systems Based on the Priority-Based Genetic Algorithm", IEEE Journal and Magazine, vol.6, pp-588-591, Dec 2007.
21. Q.Guo, S.C Kim, and D.C Park, "Antenna Selection Using GA for MIMO Systems", Journal IEICE Transactions on Fundamentals of Electronics, Communications and Computer Sciences, Vol. E89-A Issue6, June 2006, pp. 1773-1775.
22. A.Gorokhov, D.Gore and A.Paulraj, "Receive Antenna Selection for MIMO Flat-Fading Channels: Theory and Algorithms", IEEE Transaction on Information theory, Vol. 49, No. 10, Oct 2003.
23. S.Sanayei and A.Nosratinia, "Antenna Selection in MIMO Systems", IEEE Communications Magazine, Oct 2004.

AUTHORS PROFILE

Dr. Sasmita Padhy belongs to Berhampur and borned on 10th June 1979. She received the B.E. degree in Computer Science from Utkal University, Odisha in 2001 and received M. Tech. in Computer Science from Biju Patnaik University of Technology (BPUT), Odisha in 2007. She also completed Ph.D. from Berhampur University, Berhampur, Odisha in 2012. Her area of interest is software testing, software engineer. She is currently working in Vignan Institute of Technology and Management, Berhampur as an Associate Professor in Computer Science and Engineering department. Before joining this college she had been worked in NIST(2010-2018), GIIT(2009-2010), JITM(2007-2009), GIET(2005-2007) and SMIT(2001-2005).

Dr. Satya Narayan Tripathy received his M.C.A. and Ph.D. degrees in Computer Science from Berhampur University, Berhampur, Odisha, India, in the years 1998 and 2010 respectively. He is associated with Department of Computer Science, Berhampur University as Assistant Professor since 2011. He is member of several professional bodies such as, Life Member of CSI (Computer Society of India), Life Member of OITS (Orissa Information Technology Society). He has published numerous journal and conference papers in the area of data mining, malware analysis and computer security.

Er. Sisira Kumar Kapat, is Lecturer in Department of CSE, UCP Engineering School, Berhampur, Odisha, India. He has published several research papers in Journals of repute. He has also presented several research papers in several national and international conferences. He is a member of IEEE, member of IAENG, member of ICSES. The area of research is Malware analysis and detection, Computer Security, Data Mining.

Dr. Susanta Kumar Das, is Reader in Department of Computer Science, Berhampur University. He has published several publications in national and international Journals of repute over a span of 23 years in the area of software engineering, management information system and computer network security. He has supervised many doctoral and post-doctoral research works. He has felicitated award of honor by Department of Mathematics, Maharshi Dayanand University, Rohtak.