iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** IX **Month of publication:** September 2021

DOI: https://doi.org/10.22214/ijraset.2021.38144

Performance Analysis of Spectrally Efficient Adaptive Spatial Modulation in MIMO System by using QAM

Prabha Kumari[1], Dr. Ashutosh Singh[2]
[1, 2]Department of Electronics & Communication Engineering, Harcourt Butler Technical University, Kanpur, Uttar Pradesh, India

***Abstract:** In this article, we proposed a multiple input multiple outputs (MIMO) technique such as spectrally efficient adaptive quadrature spatial modulation (SEAQSM) which is based on space modulation techniques (SMTs). SMTs are logarithmically proportional to transmitting antenna & this technique fulfills the requirement of high data rate in the MIMO system. The Spatial position of the transmitting antenna improves the performance of the MIMO system. In space modulation technique spectral efficiency is logarithmically proportional to transmit antenna, if we increase the antenna at the transmitter end then the bandwidth efficiency significantly improved. We have to improve the performance MIMO system, minimize the latency and low power consumption. The proposed technique performance is explored over Rayleigh fading channel for a particular MIMO. These techniques underestimate the transmit antennas with less RF chain. In this paper, we analyzed the performance of our proposed scheme with conventional SM and QSM by using MONTE CARLO Simulation in term of BER with distinct order of QAM symbol. SE acquired for varying SNR at a BER of 10−3are obtained for uncorrelated Rayleigh channel.*

***Keywords:** Spatial Modulation(SM), MIMO, Spectral efficiency, Energy efficiency, Quadrature Spatial Modulation (QAM), Maximum Likelihood (ML) detector.*

I. INTRODUCTION

In today's Now a days the requirement of a high data bit rate is increasing because all things depend on net service and every year cellular base stations are doubled. In modernistic time, the requirement of wireless network and the cellular user have been increased, which inspired the scientist to evolve new communication methods and system structure to increase the throughput and spectral efficiency [7].There are different techniques that are introduced for improving the bandwidth efficiency of wireless system like preceding, spatial multiplexing and space-time shift keying which increase the time diversity[1][3]. MIMO system exploits a significant enhance the spectral efficiency as comparison to single antenna system & other technique [16].MIMO plays a keys role in wireless system, this techniques are a very good technology for wireless emerging communication in terms of transmitting a large number of antennas. In [15], MIMO system, some the challenge occurs like of computational complexity by using a large number of RF chain (RF consider the amplifier, oscillator and other electronic devices that's why its complexity rises) [16].

We have need of dominant Transmission scheme which can improve the bandwidth efficiency at the instant of time and without any interference & low computational complexity is known as SM which is used for multi-uses scenarios according to the user requirement of good quality of communication services for social networking Wi-Fi as Spatial Modulation. In [4] spatial modulation working on a single RF chain that's why complexity is reduced because RF chain occurs amplifier, oscillator and also consumed a large amount of power. Main concept of SM has to map a block of message bits into a constellation point in the signal domain (constellation symbol) and a constellation point in the spatial domain (spatial symbol) [15]. In [2] [5] different authors proposed a different technique for good quality of communication service like STBC-SM scheme is proposed for sending the information symbols have expanded space and time domains as well as the spatial (antenna) a domain which equivalent to transmitter antennas present at the space domain, So core STBC and antenna indices are used to carry information bits. The recline of the paper is arranged in following parts. Part II represented the previous work done by researchers related to system models, Part III shows the proposed spectrally efficient quadrature spatial modulation (SEQSM) system and then implements the result and section IV presents section V presented the conclusion.

II. EXISTING RELATED WORK ON SM-MIMO

Already A conventional MIMO system is a good solution to increase the spectral efficiency of wireless communication but the technique consumes a lot of energy by using a large number of radio frequency chains. In [2][4], SM introduced a MIMO system that is activated when only one antenna is in active mode but the others in passive mode but by spatial indexing of active antenna sends the additional information. So that, bit rate increases by log base logarithmic that is

$$SE_{SM} = \log 2(M) + \log 2(Nt) \quad (1)$$

ή = p+ẓ; p represented the data bit and particular time instant data is transmitted & ẓ represented the active antenna index. In [7], the author proposed quadrature spatial modulation (QSM) [4].This is an advance version of SM which communicate some extra necessary information by expending its spatial constellation into the in-phase and quadrature-phase dimensions, so it increases the system efficiency. The system model of QSM Nr×Nt with MIMO configuration, Nr is the receiving antenna and Nt is the transmitting antenna. A block of information bits are mapped of (p bits = $\log_2(MNt^2)$) that is data bits are divided into the three-set first set is data is modulated by any modulation scheme which is M-ary QAM and the second and third sets is modulated by transmit antenna index[7].

$$SE_{QSM} = \log_2(M)+\log_2(Nt^2) \quad (2)$$

In QSM network the in-phase components are modulated into cosine and quadrature components modulated in sine carriers which totally avoiding the inter-channel interference & inter antenna synchronization (IAS) [7]. After some time in a LAB proposed a technology that is based on transmitting antenna and spectral efficiency is given below [11]

$$SE_{F\text{-}QAM} = \log_2(M)+2(Nt-1) \quad (3)$$

III. PROPOSED WORK

In this section, with refer to an existing literature proposed a spectrally efficient adaptive quadrature spatial modulation (SEAQSM which is based on space modulation techniques**,** that is straightforwardly relative to the log base to logarithm and number of send recieving wire. Proposed conspire is examined over Rayleigh blurring channels for a very long time existing QSM have done in lethargic blurring and quick blurring channel with less number of radio wire. When we risen the transmitting antenna in our work then increases the bandwidth efficiency, this gives a significant performance. SMTs employ additional information with low complexity and better error performance. System model of AQSM is Nr×Nt MIMO system, Nr and Nt be receiving and transmitting antenna Therefore received signal [8] Y = Hx+w where H shows the channel network. It is autonomous indistinguishably dispersed (i.i.d) of Nr×Nt recieving wire is thought to be an uncorrelated Rayleigh blurring channel with wonderful channel state data (CSIR) utilized at the beneficiary end, x addressed the communicated vector and w is the added substance white Gaussian commotion. The noise present at each receiving end of the antenna is considered as AWGN with mean zero and variance one. For detection of information, we have let maximum likelihood detection (ML) decoder for received signal [13 .Monte Carlo reproductions are run for no less than 106 direct acknowledge in MATLAB script. We utilize Gray planning when fitting for QAM balance. In [11], spectrally efficient adaptive quadrature spatial modulation is represented by (2Nt-1).In this, information bit are divided into three different set, first set of information is modulated by quadrature amplitude modulation (QAM) and further divided into in-phase & Q-phase (real part in cosine & imaginary part in sin term) and after that second and third set are modulated by spatial domain. The BER Vs SNR of SM and AQSM under uncorrelated Rayleigh fading channel with AWGN channel mean

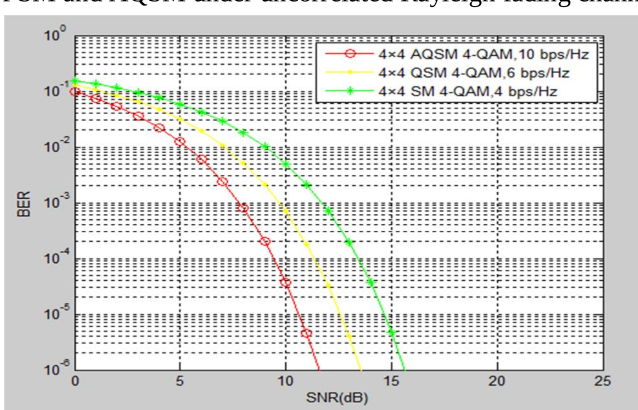


Figure1.Nt=4, Nr=4, M=4, BER comparison of SM, QSM and AQSM

In Fig.1, shown the performance of AQSM with number of transmitting antenna Nt = 4, number of receiving antennas Nr = 4 and modulation order M=4 as the same BER of 10^{-3}achieves 2dB gain as compare to QSM & 4dB as SM. Comparative analysis of SM,QSM and AQSM under the same transmitting antenna, receiving antenna and M-QAM modulation order with 4-QAM. As compare to [10, Fig.4] AQSM gives a better performance with 4bps/Hz as compare to QSM and 6bps/Hz as compare to SM. Therefore, the performance of MIMO system has improved and SEAQSM in Rayleigh fading channel achieves a better error performance which is significant.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue IX Sep 2021- Available at www.ijraset.com

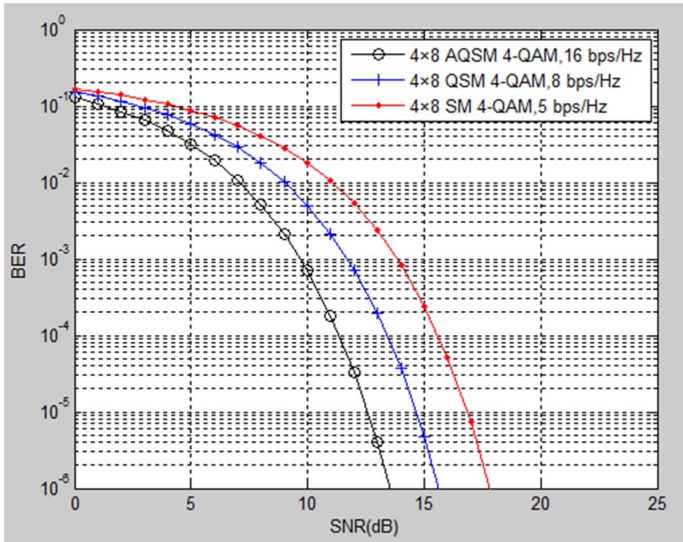


Figure 2.BER Vs SNR of SM, QSM & AQSM with 4-QAM

In figure2, we can see the BER Vs SNR performance graph of AQSM scheme with 4×8 antenna,Nt = 8 and Nr =4 as same modulation order (M=4).The analysis of proposed adaptive quadrature spatial modulation is calculated by using Monte Carlo simulation and then compare the performances with Standard SM&QAM .In proposed method spectral efficiency increases as QAM 8 b/s/Hz & as SM 13b/s/Hz. Therefore, if we increase the number of transmitting antenna bandwidth efficiency is improved up to double which gives a significant result.

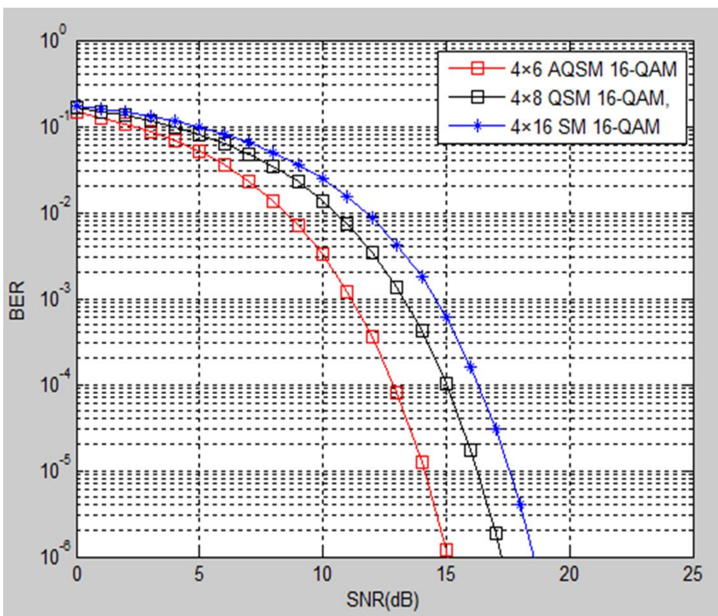


Figure 3BER versus SNR of the proposed technique (AQSM) in comparison with QSM & SM.

In above Figure -3 we can see the performance characteristics of AQSM with respect to SM and QSM when we enhance the transmitting antennas Nr×Nt, Nt=8 modulation order are used 16-QAM. Just upgrading the communicating recieving wire further develop the otherworldly proficiency since space regulation strategy is straightforwardly extent to the quantity of sending antenna[10]. AQSM enhance the SE as compare to QSM [10] and SM [10].Performance of SEAQSM having signal constellation of16-QAM and various transmitting antenna, it could be seen that from the curves wherein the constellation size having 16-QAM by maintaining remaining parameters same, the system performance reduced to around 2.5dB at BER = 10^{-3}.

IV. CONCLUSION

In this paper, we have proposed a spectrally efficient adaptive quadrature spatial modulation (SEAQSM) for MIMO system by using M-QAM in different order over Rayleigh fading channel and also analysis of AQSM with comparison SM. Analyze the performance of AQSM with respect to QSM & conventional SM in Rayleigh fading channel. AQSM gives a better performance by utilizing the large number of antenna used because this proposed model totally depends on space modulation technique (SMTs). If we increase the transmit antenna at same modulation order spectral efficiency improved as compare to QSM 8bps/Hz. AQSM is slightly better than QSM at lower modulation order. This means that the AQSM is a good for MIMO and Massive MIMO due to advantage of improved spectral efficiency & SNR with lower BER (10^{-3}).

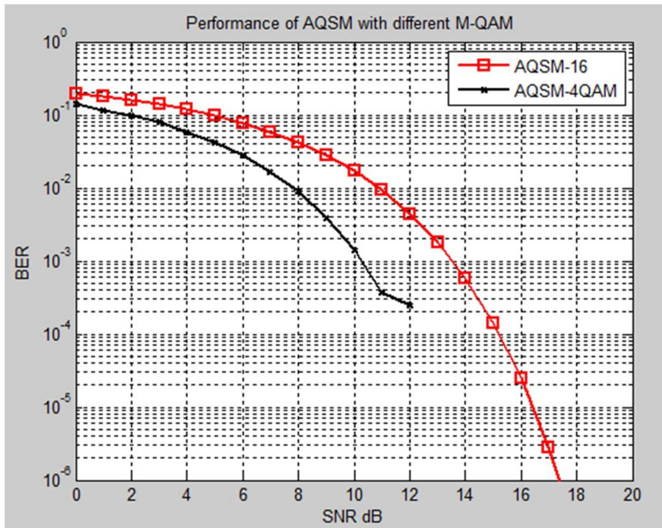


Figure 4 BER Vs SNR of the proposed technique (AQSM) in comparison for a different order of M-QAM modulation.

Figure 4 shows the BER Vs SNR performance of SEAQSM, we have been seen from the curves where in the size of constellation diagram is raised from 4-QAM to 16-QAM by maintain remaining parameters same. the system performance reduced to around 2.5dB at BER = 10^{-3}.The performance of the system decrease due to some reason. The season behind this degradation is, when the size of constellation diagram enhances from 4-QAM to 16 QAM, the distance between the signaling points on constellation diagram decreases which enhance the error probability. Therefore, in AQSM the system spectral efficiency increases with the expense of reduction in system performance with lowest modulation order.

REFERENCES

[1] Tarokh, N. Seshadri, and A. R. Calderbank, ``Space-time codes for high data rate wireless communication: Performance criterion and code construction,"IEEE Trans. Inf. Theory, vol. 44, no. 2, pp. 744_765, Mar. 1998
[2] R. Y. Mesleh, H. Haas, and S. Sinaovic, C. W. Ahn, and S. Yun, ``Spatial modulation," IEEE Trans. Veh. Technol., vol. 57, no. 4, pp. 2228_2241, Jul. 2008.
[3] S. Sugiura, S. Chen, and L. Hanzo, ``Generalized space-time shift keying designed for _edible diversity-, multiplexing- and complexity-tradeoffs,"IEEE Trans. Wireless Commun., vol. 10, no. 4, pp. 1144_1153, Apr. 2011.
[4] Mesleh, Read, Harald Haas, Chang WookAhn, and Sangboh Yun. "Spatial modulation-a new low complexity spectral efficiency enhancing technique." In 2006 First International Conference on Communications and Networking in China, pp. 1-5. IEEE, 2006.
[5] J. Jeganathan, A. Ghrayeb, and L. Szczecinski, “Spatial Modulation: Optimal Detection and Performance Analysis,” IEEE Commun. Lett., vol. 12, no. 8, pp. 545–547, 2008.
[6] R. Mesleh, S. S. Ikki, and H. M. Aggoune, “Quadrature spatial modulation,” IEEE Trans. Veh. Technol., Vol. 64, no. 6, pp. 2738–42, Jul. 2014.
[7] Z. Yigit, and E. Basar, “Space-time quadrature spatial modulation”, in Proceedings of the IEEE International Black Sea Conference on Communications and Networking (BlackSeaCom), 2017, pp. 1–5.
[8] M. Di Renzo and H. Haas, "Bit Error Probability of SM-MIMO Over Generalized Fading Channels," in IEEE Transactions on Vehicular Technology, vol. 61, no. 3, pp. 1124-1144, March 2012, doi: 10.1109/TVT.2012.2186158
[9] Lai et al., "Spatial Permutation Modulation for Multiple-Input Multiple-Output (MIMO) Systems," in IEEE Access, vol. 7, pp. 68206-68218, 2019, doi: 10.1109/ACCESS.2019.2918710]
[10] Hussein, Hany S., and Mohamed Elsayed. "Fully-quadrature spatial modulation." In 2018 IEEE international black sea conference on communications and networking (BlackSeaCom), pp. 1-5. IEEE, 2018
[11] M. Di Renzo, H. Haas, A. Ghrayeb, S. Sugiura, and L. Hanzo, ``Spatial modulation for generalized MIMO: Challenges, opportunities, and implementation,"Proc. IEEE, vol. 102, no. 1, pp. 56103, Jan. 2014
[12] S. Althunibat and R. Mesleh, ``Enhancing spatial modulation system performance through signal space diversity," IEEE Commun. Lett., vol. 22, no. 6, pp. 1136_1139, Jun. 2018

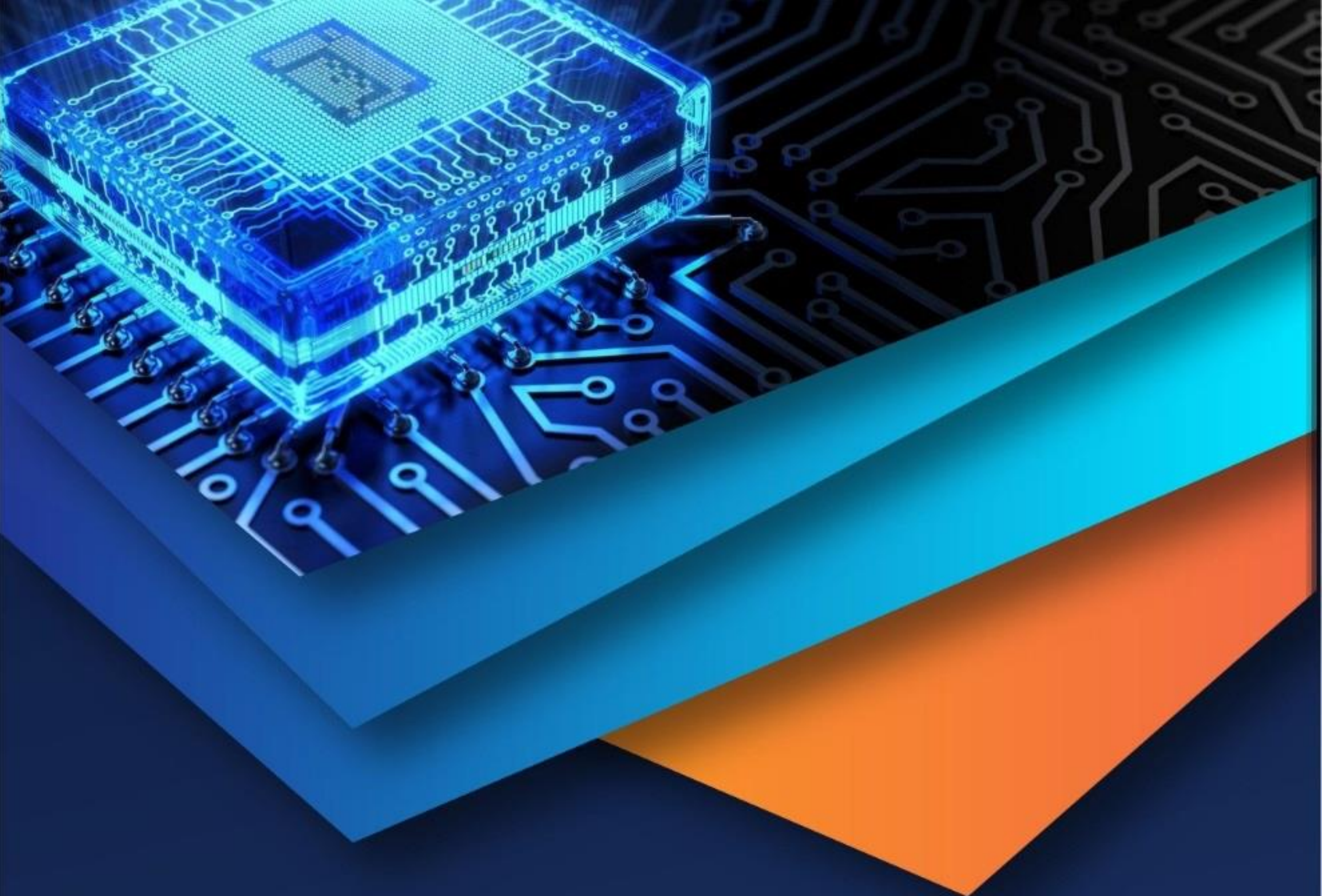
[13] B. T. Vo, H. H. Nguyen, and N. Quoc-Tuan, ``High-rate space_time block coded spatial modulation,'' in Proc. IEEE Adv. Technol. Commun.,Oct. 2015, pp. 1_5.

[14] R. Mesleh, H. Hass,Y. Lee, and S. Yun, "International Interference Avoidance in MIMO Transmission by Exploiting Spatial Information ," in Proc of the 16th IEEE Int. Symp. on Personal, Indoor and Mobile Radio Commun. (PIMRC), vol 1, Berlin Germany, 11-14 Sep. 2005, pp. 141-145

[15] J. Meitzer, R. Schober, L. Lampe, W. H. Gerstacker, and P. A. Hoecher, "Multiple Antenna Technique for Wireless Communication – A Comprehensive Survey," IEEE Commun. Surveys Tutorials, vol. 11,no.2, pp.87-105, 2009.

[16] E. Ba³ar, Ü.Aygölü, E. Panay_rc_, and H.V. Poor, ``Space-time block coded spatial modulation,'' IEEE Trans. Commun., vol. 59, no. 3, pp. 823_832, Mar. 2011.

[17] K. Gunde and K. V. S. Hari, "Modified Generalised Quadrature Spatial Modulation," 2019 National Conference on Communications (NCC), 2019, pp. 1-5, doi: 10.1109/NCC.2019.8732234.



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY