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Performance Comparison of Centralized and Distributed Antenna System in 5G

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Abstract. The usage range of nowadays wireless communications become wide, all of the develop applications uses wireless communication which improve the mobility and improve the mobility of the network subscribers. As known that the antenna diversity scheme developed from “SISO” to “MIMO” that has a maximum capacity and ability to improve the communication quality with a good shields among the fading effects and other impairments. In this research work study and analysis to the antenna systems and antenna schemes was done taking into consideration the central antenna system and the distributed antenna system “CAS” and “DAS”. A Matlab simulation was developed to test antenna configuration system in term of effeteness of fading channel while using different modulation order.

1. Introduction

As known that the wireless networks handle considerable growth of data broadcast cause of the number of developing applications that includes machine-to-machine (M2M) communications systems and video streaming over network [1]- [4]. Due to the very huge volume of data exchanged is likely to continue and increase in the next period or so, presenting a very important task to inventors of “5G” systems [4]. In particular, “MIMO” signal processing will have a vital role in dealing with the impairments of the physical medium and in providing cost-effective tools for processing information.

Problem Definition

The Massive “MIMO” technology was designed for reducing the effects of fading among the communication channel, two main techniques used in massive “MIMO” technology “CAS” and “DAS”, the problem is the efficiency of the two techniques among the antenna configuration while using the fading channel and also the optimal required power to enhance the performance of the network with the reliable power and “QoS” parameters. The objective of this paper focus on simulating the antenna systems “CAS” and “DAS” and evaluate the performance while using different modulation order and applying fading Rayleigh channel. “QAM” modulation was chosen because it is one of the modulation techniques that supported by the “5th” generation.

Methodology

The methodology starts from simulating of the system using Matlab simulation software cover a full study to the antenna systems including the centralized antenna system “CAS” and the Distributed Antenna System, and “DAS”.

In the following table a set of parameters that used to adjust the simulation environment including the number of element used, modulation type and the antenna system scheme used.

Table 1. Scenario (I) Parameters Used:

Parameter	Value/Description
Number of Elements	64 elements
Modulation Type	8-256 “QAM”
Antenna Diversity	“MIMO”

Scheme	
Scenario Area	1k x 1k
Noise AWGN	0 to 20 SNR adjusting
Fading Effects	Rayleigh Fading
Antenna System	"CAS"

In the following table a set of parameters that used to adjust the simulation environment including the number of element used, modulation type and the antenna system scheme used.

Table 2. Scenario (II) Parameters Used:

Parameter	**Value/Description**
Number of Elements	64 elements
Modulation Type	8-256 "QAM"
Antenna Diversity Scheme	"MIMO"
Scenario Area	1k x 1k
Noise AWGN	0 to 20 SNR adjusting
Fading Effects	Rayleigh Fading
Antenna System	"DAS"

Mathematical Model

Fading Rayleigh

The mobile antenna, instead of receiving the signal over one line-of-sight path, receives a number of reflected and scattered waves. The phases are random, and consequently, Because of varying path multi-length, the instant established power become an arbitrary number. However, signal that sent at frequency "ωc" connected to the source via a multi roads, the "i^{th}" road that have an amplitude "ai", as well as a phase "φi". If presumed which there is no straight road of sight "LOS" element, the target signal "s(t)" may be expressed as

$$s(t) = \sum_{i=1}^{N} a_i \cos(\omega_c t + \varphi_i) \qquad \textbf{(1)}$$

where "N" is the number of roads. The cycle "φi" based on the difference path lengths, changing by "2π" when the road length variations by a wavelength. Therefore, the phases are consistently dispersed over "[0,2π]". When there is virtual motion between the transmitters to receiver.

Signal to Noise and Bit Error Rate

$$BER = \frac{Number\ of\ Error\ Bits}{Total\ Transmitted\ Bits} \qquad (2)$$

Fig1: system flowchart of antenna system

Computer Model

The flowchart of the simulation stars with generating random data and set the number of transmitters and receiver elements and then a “16QAM” was used to modulate the data, moreover the noise is inserted to simulate the real noise environment. The system then is evaluated in term of required power after the simulation time is ended.

Simulation Results of discussion

In Fig. 2 an analysis to the signal to noise ratio vs. the bit error rate was shown while using different modulation order. It was found that increasing the signal to noise ratio decrease bit error rate and the “CAS” requires less power compared to the Fig. 3 and the percentage of different is 18% in power.

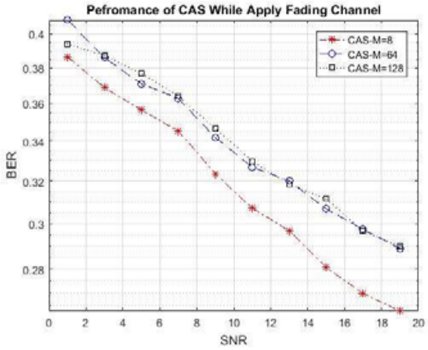

Fig 2: “SNR” vs. “BER” in “CAS”

In Fig. 3 an analysis to the signal to noise ratio vs. the bit error rate was shown while using different modulation order. It was found that the “DAS” requires high power and still the bit error rate is high compared to “CAS” and it occurs due to the number of channels used in the distributed and the centralized. And the percentage is around “22%”.

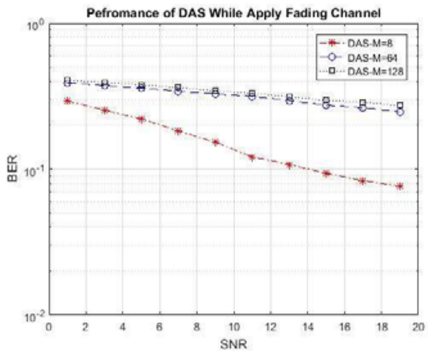

Fig 3: “SNR” vs. “BER” in “DAS”

It was found that as usual increasing the signal to noise ratio decrease the bit error rate and increasing the modulation order increases the required power to get an ideal and optimal bit error rate and it was found that the centralized antenna system requires less power while the distributed requires high power.

Conclusion

As a conclusion the centralized antenna system has a good performing in the communication system while meeting a fading effects in the “CAS” by “11.5%” not recovered and for the “DAS” is “24%” not recovered then it was concluded that the “CAS” has an increased performance with “12%” higher compared with the “DAS”. And the distributed may have a problem of pathloss which effect on the network performance and increase the bit error rate. Increasing the power is not an optimal solution since the antenna may have a maximum power gain limits that can be handle. A buffering stage can be used to collect information through distributed antenna system but it will increase the delay time.

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