Modeling and Performance of Mine MIMO Channel Based on Geometric Stochastic Characteristics

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Abstract. MIMO technology has become one of the most promising content in mobile wireless communication, and it has shown positive application value in both application and innovation. On the basis of understanding the current development status of MIMO channel technology, this paper analyzes the standardization of MIMO to the future development trend according to the modeling of broadband dryness ratio of GBSM.

1. Introduction
As the general term of the information transmitted by the receiving end and the sending end of the communication system, the channel directly determines the quality and efficiency of communication. In other words, channel characteristics determine the performance of the communication system. Under the background of the new era, wireless communication as an important part of the innovation and development of the communication industry, it is easy to be disturbed by the environment and other factors appear communication problems. The selection of most multi-output technologies, also known as MIMO, for wireless communication optimization can not only truly achieve space utilization, but also enhance the diversity of space, so as to ensure that the wireless system still has a high peak data without increasing the transmission efficiency[1-5].

2. System modeling and performance analysis
2.1. System model
Based on the analysis of Figure 1 below, it can be seen that base station BS in this study conforms to the Poisson distribution of λBS in the infinite two-dimensional plane, so all UWB interference sources are independent of each other and the power is P. The equivalent baseband signal from the ith base station is expressed as

\[ s_i(t) = \sqrt{2E}w_i(t)\cos(2\pi F_u t + \theta) \]

Where, E represents the average transmitted symbol power, P=E/ F represents the average transmitted symbol power, T represents the symbol period, \( \theta \) represents the carrier phase emitted by the ith base station, F U belongs to the carrier phase of
broadband signal, a IE I0i represents the symbol of transmitted signal, and conforms to $E\{\mu_i\} = 1$. This is the formula.

![System model diagram of Poisson distribution](image)

**Fig. 1** System model diagram of Poisson distribution

Meanwhile, $W_i(t)$ is expressed as unit power waveform, and the specific expression formula is

$$w_i(t) = \sum_{k=0}^{N-1} p(t - kT_f - c_k^T_f).$$

And N represents the number of shots to the sign signal; $P(t)$ represents the transmitted monopulse shape, and the specific energy is 1/Ns; $T_f$ represents the time of pulse repetition, which can also be called the length of the frame. The relationship between this value and the period $T$ is $T = T_f/N_i$. $\{c_k^t\}_{k=0}^{N-1}$ is a direct sequence, and $\{T_f\}_{k=0}^{N-1}$ represents time jump sequence. Since WI(t) belongs to a pseudo-random sequence with an extremely long period, its essence is to improve spread spectrum and gain, and pay attention to improve the resistance of system operation, so its Fourier transform formula

$$W_i(f) = P(f)\sum_{k=0}^{N-1} c_k^t e^{-j2\pi iT_f c_k^t f}$$

is. At this point, $P(f) = F\{p(t)\}$ Fourier transform.

### 2.2. Transmission model

This model is mainly used to predict the influence of channel on the signal. If all the signals need to go through an independent path for loss, and will produce shadow effect and multipath effect, then the path loss $S = e^{\sigma aG}$ Formula for $PL = k/r_i^{\sigma}$, $R_i$ represents the distance between base station I and the origin, or represents the exponent of path loss, and k is a constant value of -31.54dB. The shadow effect is lognormal shadow effect, where $G \sim N(0,1)$ belongs to any number conforming to the normal distribution of (0,1), and $dB$ represents the coefficient of shadow fading. At this point, when calculating the small-scale fading in the UWB node, the multipath fading channel can be studied by using the simplified IMT-A new arrival model[6-9].

### 2.3. Modeling

According to the above analysis, the formula for the client to obtain the overlay signal can be written

$$z(t) = d(t) + y(t) + n(t)$$

Where $D(t)$ represents the expected signal acquired by the base station in the region, $Y(t)$ represents the superimposed interference emitted by other base stations, and $N(t)$
represents AWGN. Its bilateral efficiency spectral density is \( \text{PSD} = \frac{N_0}{2} \), which can exist independently with \( Y(t) \).

The multipath components beyond the noise background are taken out by the Rake receiving mechanism, and delayed and corrected to ensure that they can be aligned at a certain stage, and fused according to the specific intensity ratio, so as to turn the original interference signals into useful signals. After the completion of this processing, the signal is formulated as \( Z(t) = \int_{-\infty}^{\infty} z(t) \Psi(t) \, dt \), and available. At this point, the stacking interference can be expressed as \( Z(t) = D + Y + N \).

Assuming that the transmitted signal belongs to the product of Rayleigh distribution and complex unit vector, and the vector Angle \( \theta \sim U(0, 2\pi) \), then the approximation by using the cyclic symmetric complex Gaussian distribution (NC) in combination with the above formula can obtain the same results as that obtained by Kullback-Leibler. The validity and rationality of this distribution can be evaluated by using the dispersion theory. It should be noted that, at this time, \( Y \) represents the superposition of all independent cyclic symmetric complex Gaussian distributions, while the definition formula of \( A \) is

\[
A = \sum_{i=1}^{\infty} \frac{e^{2v_r G_i}}{R_i^2 v},
\]

In the case that the base station BS is in the Poisson distribution state, \( A \) conforms to the stable distribution of \( \alpha \), and the formula \( A \sim S \left( \alpha, v, \beta, \gamma, \mu \right) \), Where \( R \) represents the radius of the area, \( V_r \) represents the loss factor of the interference path, \( \lambda_b s \) represents the density of the Poisson distribution of the base station, and \( V_d b \) represents the decline standard deviation of the interference shadow. \( X \) is defined to conform to the \( \alpha \)-Stable part \( X \sim \text{Stable} (\alpha, \beta, \gamma, \mu) \). In the brackets, the characteristic factor, skew parameter, scale parameter and position parameter are respectively represented. In general, \( \mu \) can be treated as 0 when calculating analysis. From the perspective of inverse Fourier transform, the actual distribution can be obtained as shown in Fig. 2:

![Fig. 2 Probability density function of parameter A](image)

Combined with the analysis of practical cases, the research model in this paper is more suitable for describing some random distributions with Chinese and Venezuelan characteristics, which can integrate and consider some small probability events that are easy to be ignored, and can be used
in scenes with many interference nodes. Through comparison and discussion, it can be seen that the actual error rate of MIMO channel modeling based on geometric stochastic characteristics will continue to rise with the decrease of average signal-to-dryness ratio, and the corresponding system performance will continue to decline.

2.4. Performance
As one of the standards to evaluate the performance of the system, the signal-to-dryness ratio has a direct influence on the quality and efficiency of the whole communication system. For example, under normal circumstances, the continuous decline of the average signal dryness ratio will reduce the system capacity and affect the quality of communication. According to this result, the calculation formula of letter to dry ratio can be obtained, and the actual system performance evaluation should be studied from this.

3. Future development
According to the analysis of the current development of MIMO channel technology concept, the following figure 3 is the channel model of this content [1]. In the new era, the future research direction will focus on system performance stability and related modeling. Although there are still many problems in mine MIMO channel modeling based on geometric random characteristics, with the continuous optimization of signal drying ratio modeling, researchers are bound to accumulate more experience and research data in the perfect channel, so as to deduct and study all performance indicators of the system. Combined with the analysis of the GBSM signal-interference model studied above, it can be seen that the influence of interference distribution on the Angle of each cluster and its location must be clearly defined. Only in this way can the application advantages of this channel be fully demonstrated, as well as the parameter information constituted by it in the geographical location. Therefore, in the future industry innovation and development, researchers and institutions are bound to focus on MIMO channel modeling and performance research, in order to build a perfect model, and at the same time, put forward effective innovation countermeasures [2].

![Channel model diagram of MIMO](image)

Fig. 3 Channel model diagram of MIMO

4. Conclusion
To sum up, on the basis of understanding the advantages of MIMO technology, according to the technical requirements emerging from the market development in recent years. In the face of the development trend of wireless system operation and channel technology innovation, the modeling of mine MIMO channel based on geometric random characteristics has attracted the attention of
the whole society. It should be noted that although it provides more technical support for system efficiency and peak data transmission, and effectively improves the effectiveness of the link, there are still deviations in the actual modeling, and most of the research results are based on ideal assumptions. Therefore, in the future technological innovation, it is necessary to increase the active exploration in this field.

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