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Design of Batch Cooperative Allocation System of Wireless Communication Spectrum Resources in Forest Based on Big Data

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Abstract:

The stability and reliability of wireless communication in complex forest environment have a vital impact on forest security. Aiming at the problems of electromagnetic environment deterioration, spectrum resource shortage, uneven distribution and high correlation in space, time and frequency domain, this paper proposes a wireless communication spectrum resource batch cooperative allocation system based on big data analysis. The system consists of three functional modules: spectrum monitoring and storage, data analysis and processing, and control center. Firstly, this paper uses distributed data acquisition architecture to collect spectrum information and GPS information. Then, this paper uses big data analysis technology to predict the use of spectrum resources in the next time. In this paper, reasonable detection of available channels, improve the efficiency of spectrum monitoring, optimize the strategy of spectrum monitoring. In view of the role and influence of feedback signal in cooperative communication, this paper proposes two design methods of feedback signal from the perspective of data compression and joint feedback. In this paper, considering the characteristics of users' feedback signals for cooperative base stations in cooperative communication system, a joint feedback signal design method is proposed. Secondly, considering that the existing feedback signal design methods are based on the linear compression, this paper uses the nonlinear compression method to design the feedback signal, and compares the performance differences between the two methods. The simulation test results show that the system can effectively process massive spectrum data and improve the efficiency of wireless communication spectrum resource allocation in batches.

***Keywords**: Big data, forestry wireless communication, spectrum resources, batch cooperation, distribution system.*

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I. INTRODUCTION

Cooperative communication system is a research hotspot at present, covering MIMO technology, OFDM technology, radio resource allocation technology, and cross-layer network optimization and design technology [1-2]. How to combine these technologies to optimize the radio resource utilization of communication system will be a research hotspot of the next generation mobile communication system. Therefore, the research on cross-layer wireless resource allocation in cooperative communication system has theoretical significance and great application value.

With the development of MIMO technology, the development of other technologies has been guaranteed, such as cooperative communication technology, relay technology. Cooperative communication technology refers to the use of the same time-frequency resources between adjacent base stations to send signals [3]. For a single user, the two signals can be received by a specific method, so as to improve the channel capacity. Cooperative communication technology is actually the application of mim0 technology in the actual system. The next generation mobile communication technology is based on P network as the core network architecture, so the data service and voice service will occupy the same time-frequency resources [4-6]. The voice service includes video call service and voice call service, and there are many kinds of data service. Different services have different requirements for bit rate and bit error rate. Voice services require that the bit error rate be lower than a certain threshold while the transmission rate remains unchanged. Data services require that the transmission rate be as high as possible while the bit error rate is lower than a certain threshold [7]. Therefore, for different types of services, the allocation of wireless resources is also very different.

II. RESEARCH ON RESOURCE ALLOCATION OF MULTI BASE STATION COOPERATION IN COOPERATIVE COMMUNICATION

2.1System model and problem description

Suppose the system has B base stations, K mobile stations, each base station has Nt antennas, and each mobile station has Nr antennas. Hk; b represents the channel information from the b-th base station to the k-th mobile station. The whole base station set is β. This chapter focuses on the dynamic selection of cooperative base stations, so it is not particularly concerned about how many antennas each node has. Therefore, it is assumed that each base station has one antenna and each mobile station has one antenna, that is, Nt = 1 and Nr= 1.

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It is assumed that the cooperative base station group is a cluster of base stations, and each base station in the cluster is equivalent to a virtual antenna in the cooperative base station group. Therefore, joint and coding can be used to eliminate intra cluster interference and increase the total transmission rate. Suppose C is the set of all base station clusters, and $c \in C$ is a base station cluster. |c| is the number of base stations in the cluster. Assuming that there are Kc mobile stations scheduling and allocating resources in the base station cluster, the channel matrix from the base station cluster to the mobile station can be expressed as [8-10]:

$$H^{(c)} = \left[h_1^{(c)^T}, h_2^{(c)^T}, \ldots, h_{Kc}^{(c)^T} \right]^T \quad (1)$$

Where $h_k^{(c)}$ represents the channel matrix of 1 ×| c | from all base stations of base station cluster C to mobile station k, as shown in Fig. 1.

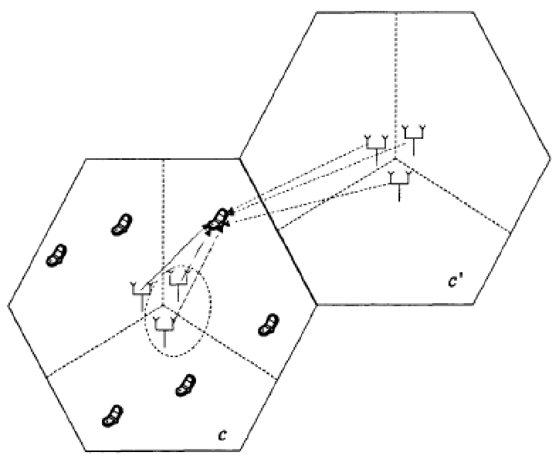

Fig 1: Block diagram of multi base station cooperation system

The total transmission rate of base station cluster C is R(c). Because power allocation is based on a single cluster, the performance of base stations and users in the cluster can be optimized. For the purpose of the system, the transmission rate of the system should be maximized. However, in the actual system, a cluster cannot contain all base stations, that is, | c | < Bc:

$$\max_{c} \sum_{c \in C} R^{(c)} \quad (2)$$

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Suppose nc = B / Bc is an integer, then there are B! / ((Bc!) ncnc!) possibilities to determine the composition of set C. Exhaustive method will become more and more complex with the increase of B, so a more simple and effective algorithm is needed to study this problem.

2.2 Simulation results and discussion

This section evaluates the performance of the algorithm through system level simulation. Suppose there are 36 BSs in the network, each BS is a regular hexagon area (as shown in Figure 2), and the radius length is 1km. Each BS has three sectors, and each sector is a cell. Let Nr = Nt = 1, consider Linear Precoding with ZF. In every 1000 Monte Carlo simulations, each MS is randomly generated in each cell based on the rould robin strategy. The channel coefficients from the b-th BS to the k-th MS are expressed as:

$$h_{k,b} = \alpha_{k,b}\sqrt{\frac{G\eta_{k,b}}{l_{k,b}}} \quad (3)$$

Where αk,b are the small-scale Rayleigh fading coefficients, G= 9dB is the antenna gain of the base station, ηk,b are the shadow fading, set as 8dB, lk,b are the path loss. According to the 3GPPLTE model, the path loss can be expressed as:

$$l_{k,b}^{dB} = 148.1 + 37.6lg\left(d_{k,b}^{km}\right) \quad (4)$$

Where $d_{k,b}^{km}$ is the distance from the B th BS to the k th MS. In addition, set the base station power limit to PB = 1W.

By comparing with the other two algorithms, this paper shows the advantages of this algorithm:

(1) Static selection method. In this method, the selection of base station cluster will not change in real time, and the adjacent BSS are selected based on the pre scheme. This method has no overhead in base station cluster selection. However, when the mobile station is at the edge of the cluster, it will bear more out of cluster interference.

(2) Centralized greedy selection algorithm. In this algorithm, the central processing unit undertakes all the processing and collects CSI of all base stations.

Figure 2 shows the relationship between SNR and total transmission rate under different

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algorithms. By reducing the inter cell interference, the system performance of cooperative technology is obviously superior to that of non cooperative single cell. Compared with the static selection method, the dynamic base station cluster selection method can provide obvious performance gain, because it can adapt to the BS to MS channel conditions. For example, when BC = 3, the SNR of dynamic selection algorithm is significantly lower than that of static selection algorithm. In addition, the performance of distributed algorithm is better than centralized greedy algorithm, while reducing the system overhead and complexity.

Figure 3 shows the cumulative probability density distribution (CDF) of user rate. Although the distributed dynamic selection algorithm can increase the average performance of the system, it can not provide gain in fairness criteria. Because rouild robin scheduling method is independent of channel conditions and base station cluster selection method, and the purpose of power control process is to maximize the total rate, thus reducing the fairness of MSS. It also lays a foundation for future scheduling algorithms based on channel conditions.

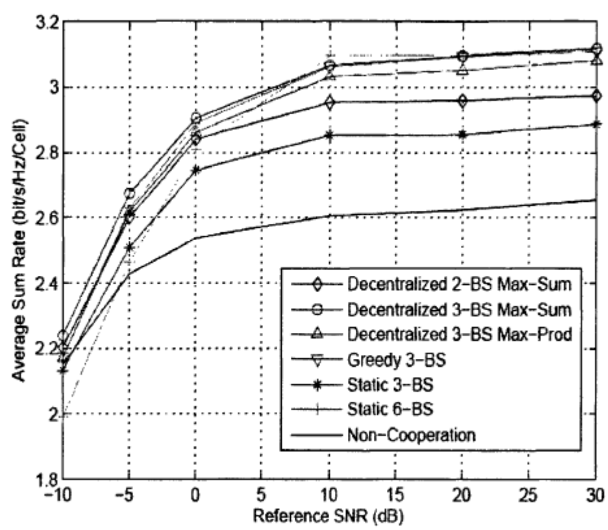

Fig 2: Relationship between average transmission rate and SNR

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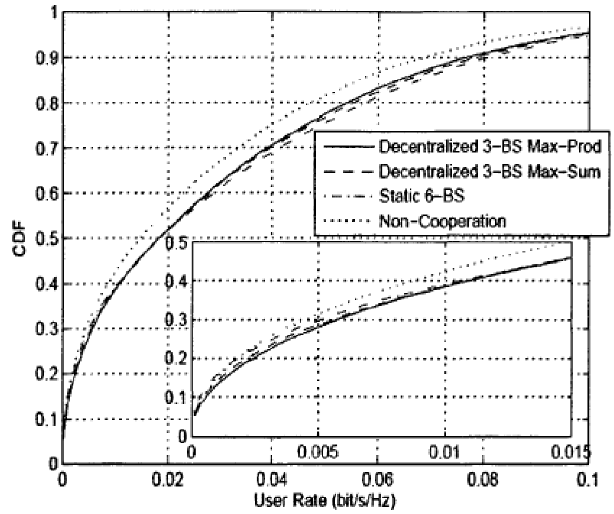

Fig 3: Cumulative probability density distribution of user rate

2.3 Structure principle of relay system

Due to the asymmetry of wireless communication data services, the downlink data transmission rate and throughput are more important than the uplink data transmission rate, and affect the algorithm and performance of the system to a great extent. This paper only considers the downlink data transmission process. In order to evaluate the system throughput, this paper needs to consider error correction coding, modulation and coding techniques, which is no longer a simple analysis of channel capacity.

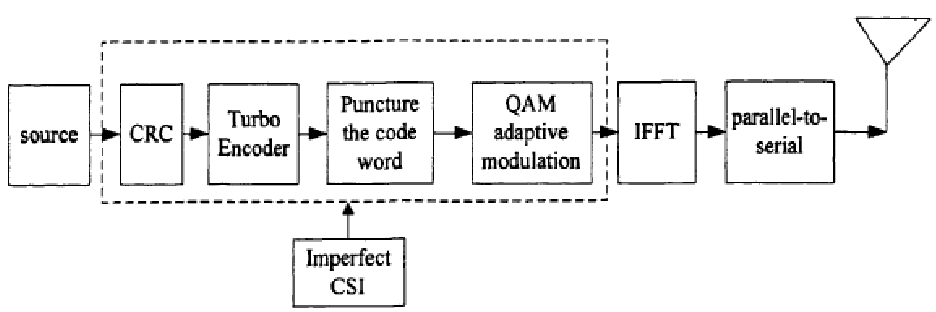

Fig 4: Function block diagram of base station

In this system, QAM modulation is used for adaptive modulation and turbo coding is used for coding. Considering the feedback retransmission mechanism, if a packet is received incorrectly, the automatic feedback retransmission mechanism will make the data

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retransmission.

In a two relay network, there are four types of relay service. In mode a, the BS MS link has poor quality and can not transmit data, so the relay node decodes and forwards the data from BS to MS directly.

In mode B, the link quality of bs-ms may lead to a certain bit error rate in slow fading channel, but it also has a chance to maintain the correct transmission of data. When a packet cannot be correctly transmitted from the base station to the mobile station, the nearby relay node can listen to the packet. In the second retransmission, the relay node and the base station cooperate to transmit the same packets to the mobile station.

In mode C, the data error from BS to MS is caused by burst error. In slow fading environment, the quality of bs-ms link is very good. In this case, only the second data retransmission can be performed by BS.

In mode D, the link quality of bs-ms may lead to a certain bit error rate in slow fading channel. When a packet cannot be correctly transmitted from the base station to the mobile station, the nearby relay node can listen to the packet. In the second retransmission, the relay node forwards the packet to the mobile station, and the base station can use the same time-frequency resources to serve other mobile stations.

Time frequency resource allocation is a very important problem in relay networks, which directly affects the inter cell interference and inter channel interference. In order to simplify the system complexity, this paper considers the time-frequency resource access mode with fairness of mobile station. At the same time, different relay service types have different resource allocation strategies. When the first data transmission is successful, the data retransmission process will not occur. Only when the first data transmission fails, the data retransmission process can be carried out. For different relay service types, the resource allocation method is as follows:

Mode A: BS relay and irelay MS use the same frequency resources and use different time slots to avoid mutual interference. The bs-msl link and relay-ms2 link will not use the same frequency resources, that is, when BS serves MS, relay will not use the same frequency resources to serve other Ms.

Mode B: during the first data transmission, BS can use all time-frequency resources, but relay node does not work. In the process of data retransmission, relay node and BS use the same

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time-frequency resources to carry out cooperative data transmission to Ms.

Mode C: during all data transmission, BS can use all time-frequency resources, but relay node does not work.

Mode D: during the first data transmission, BS can use all time-frequency resources, but relay node does not work. In the process of data retransmission, relay node uses a certain time-frequency resource for data retransmission, while BS uses the same time-frequency resource to serve other mobile stations.

III. DESIGN METHOD OF NONLINEAR FEEDBACK SIGNAL

In this paper, the feedback signal is quantized and coded by using the PCM coding method. The compression characteristic usually adopts the logarithmic compression characteristic, that is, the output and input of the compressor are approximately logarithmic. The logarithm squeezing can be divided into A-Law and p-law. In this paper, we mainly consider A-Law compression.

The relationship between output y and input signal x of A-Law characteristic satisfies the following equation:

$$y=\begin{cases}\dfrac{Ax}{1+Inx}, & 0\leqslant x\leqslant \dfrac{1}{A}\\ \dfrac{1+InAx}{1+InA}, & \dfrac{1}{A}<x\leqslant 1\end{cases} \quad (5)$$

Where, y is the normalized compressor output value, i.e. the ratio of the actual output value to the maximum possible output value; xA is the normalized compressor input value, i.e. the ratio of the actual input value to the maximum possible input value; a is the compression coefficient, indicating the degree of compression. It can be seen from equation (5) that the compression characteristic is a straight line in the range of $0 \le x \le 1 / A$, which is equivalent to the uniform quantization characteristic, and a logarithmic curve in the range of $1 / A < x \le 1$. Generally, internationally, $A = 87.6$.

The probability distribution criterion based on the actual measurement is that the mobile station continuously measures the channel condition and feeds back the channel condition to the base station. The base station continuously analyzes the probability density distribution of the

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channel condition of the mobile station according to the feedback channel condition.

It should be noted that the precoding matrix in MIMO system and cooperative system needs high real-time feedback signal, and reflects the change of fast fading, so this method is not applicable. This method is only suitable for long time feedback channel information, such as average SNR, average received channel strength, average received power and so on.

The implementation process is as follows:

1. Mobile terminal parameter measurement;

2. The parameters of the mobile station are quantized by the quantized coding method set by the base station;

3. Feedback from mobile station:

4. The base station receives the feedback signal;

5. In a long period of time, the base station receives n feedback signals. Through the N feedback signals, the probability distribution function of the feedback signal is obtained by mathematical statistics;

6. The base station uses the estimated probability distribution function to set the quantization coding mode;

7. The base station transmits the update to the mobile station. Because the mobile station also has n times of feedback signals, considering the game between the two, the mobile station receives the update and updates the quantization coding by using the same criteria.

From the above process, it can be found that the mobile station needs to use the quantization coding method updated by the base station, but the base station needs the feedback signal of the mobile station to formulate the quantization coding method. The two are interdependent, so an initialization input is needed to determine one of the processes. Therefore, it can be assumed that the quantization coding method adopted by the mobile station in the first implementation is uniform quantization coding method. After the first base station decides the quantization coding mode, the mobile station encodes according to the quantization coding mode set by the base station.

IV. CONCLUSION

In this paper, we study the resource allocation of single user MIMO space division multiplexing system with only sub stream SNR feedback, and propose a transmission method to provide different QoS on sub stream at the same time, so that real-time and non real-time traffic can be transmitted in the same frequency band at the same time. Through this method, the remaining space resources can be allocated to non real time services while transmitting real-time services, so as to further improve the resource utilization of the system. This paper also proposes a search method to simplify the operation, which makes the proposed resource allocation method more practical. This paper discusses the radio resource allocation method in relay system, and discusses the influence of different relay service types on the system performance. An adaptive scheduling strategy is proposed to increase the system throughput by adopting different relay service types under different channel conditions. At present, there are still many problems to be solved in wireless resource management, which is also a very active field in the academic community. With the emergence of new technologies, there are new challenges in this field.

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