Research on Anti-interference Dynamic Allocation Algorithm of Channel Resources in Heterogeneous Cellular Networks for Social Communication

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Abstract. The current channel allocation method does not consider the user transmission power problem, which leads to the problems of high user power consumption and low average transmission capacity, so a new anti-interference dynamic allocation algorithm for social communication channel resources in heterogeneous cellular networks is proposed. Determining a reusable set of channel resources for social network users; Under the premise that a given social network user reuses an arbitrary set of resources, the transmission power of the user is adjusted to measure the throughput of each network user on different channel resource sets. At the same time, the undirected graph theory in graph theory and ant colony genetic algorithm are used to cluster social network users, and as heterogeneous network scenarios change, the undirected graph will dynamically change, forming a new clustering scheme. Using intra cluster orthogonal inter cluster multiplexing as a criterion, auction method is used to allocate channel resources for social network users to reduce inter user interference. According to the selfishness of user behavior, a non cooperative game model is established, which combines fixed point theory and iterative algorithms to allocate power to users who complete channel allocation, maximizing user energy efficiency. The experimental results show that the proposed algorithm can reduce the power consumption and greatly increase the average user data amount.

Keywords: Social Communication Heterogeneous · Cellular Network · Channel Resources · Anti-Interference · Dynamic Allocation

1 Introduction

Due to the development of mobile communication network and Internet technology, mobile communication has become an indispensable part of people's life. Currently, with the passage of time, the number of users of mobile communication networks and the amount of data generated in the network are showing an exponential growth trend at an alarming speed. To deal with the above situation and more complex application scenarios, it is urgent to study the fifth generation mobile communication system to adapt to the

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current development [1]. Presently, although the data transmission speed of 4G mobile communication system is fast, the spectrum efficiency is high, and the compatibility is good, there are still some defects, such as waste of resources and limited communication capacity. Compared with 4G communication system, 5G system can effectively make up for the shortcomings of 4G communication system, and can greatly improve the data transmission capacity and system capacity.

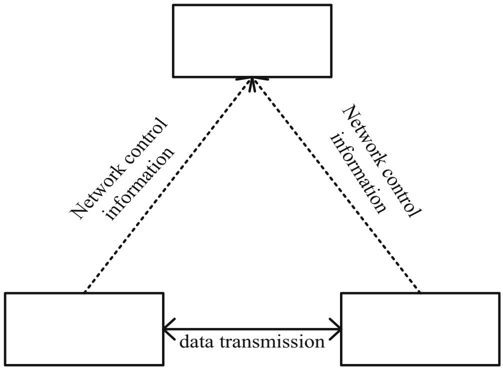
The use of social communication technology can directly realize the direct communication between user equipment without base station relay. Therefore, social communication can not only alleviate the load of the base station, but also bring high-speed data services to users [2]. Research shows that social communication technology has many advantages, such as reducing base station load and mobile terminal battery consumption, improving spectrum utilization and robustness of network infrastructure failure. For example, Document [3] the file first identifies the Small Cell Base Station (SBS) with the strongest interference to User Equipment (MUE), and dynamically allocates subchannels for SBS through cross layer interference information to serve its Small Cell User Equipment (SUE) and achieve network resource allocation. Literature [4] studied a joint optimization method for mode selection and channel allocation. Firstly, the distributed multi-agent deep Q-network algorithm is utilized to redefine the reward function based on the goal of maximizing system and rate. Then, a local information sharing strategy is adopted to reduce signaling overhead, allowing the agent to learn and select the optimal channel allocation in a low-cost mode. Reference [5] proposes a resource allocation algorithm with robust security. This method constrains the minimum security rate and cross layer interference power of each cell user, as well as the maximum transmission power of each base station, a resource allocation model based on energy efficiency maximization is established under bounded channel uncertainty. Using the Dinkelbach method, the worst case method, and the successive convex approximation method, the optimization problem is transformed reasonably, and the Lagrangian dual function method is used to solve the problem, thereby achieving reasonable allocation of channel resources.

Although the above methods have achieved significant research results at this stage, due to the lack of consideration of the user's transmission power issues, resulting in large power consumption and a small average amount of data sent by the user. Therefore, an anti interference dynamic allocation algorithm for channel resources in heterogeneous cellular networks for social communication is proposed. After verification, the proposed method can reduce power consumption and increase the average data transmission volume of users.

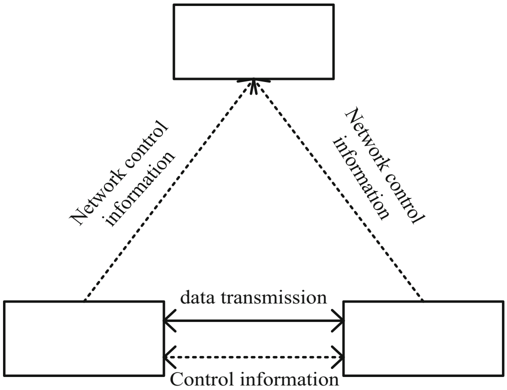
2 Algorithm

2.1 Adjustment of User Transmit Power

In social communication system, adjacent users can establish the communication links directly and thus to complete information transmission. In the process of link establishment, auxiliary control is needed to ensure the stability and reliability of the link [6]. In terms of network control, the architecture of social network communication can be divided into two parts: network central control and network auxiliary control (Fig. 1).



(a) Architecture of Network Center Control Network



(b) Architecture of Auxiliary Control Network

Fig. 1. Architecture of social communication Network

(1) Network center control architecture

Network Central Control Network architecture is a centralized control architecture in which there is a central control node to manage and coordinate the operation of the entire network. This control node is responsible for processing and allocating network resources, scheduling and directing traffic, managing connections and routing, and other functions. By collecting and analyzing network information, the central control node realizes intelligent decision-making and optimizes resource allocation to improve network efficiency and performance. This architecture is usually suitable for small-scale or domain-specific networks, such as sensor networks or factory automation networks. Such a system can realize the management of inter-user interference [7], and can determine whether neighboring users have established direct communication links in time by the environment where users are located. However, using this control structure, the signaling overhead is large.

(2) Architecture of auxiliary control network

Network-assisted control architecture is a distributed control architecture in which there is no single central control node, but the control functions are distributed to each node of the network. Each node has certain control capabilities to achieve network management and coordination based on local information and local decisions [8]. The nodes in the network auxiliary control architecture communicate and work together to complete the tasks of network resource allocation, route selection, data transmission control and so on. This architecture is more suitable for large-scale and complex networks, such as the Internet or mobile communication networks. Using this control structure, devices can be discovered independently, transmission power can be dynamically adjusted, and communication links can be directly established between users. The difference between this structure and the above structure is that the signaling overhead is smaller, but the efficiency is lower.

On the basis of the above communication architecture of social networks, the modes of social networks mainly include cellular mode, dedicated mode and sharing mode, which are described as follows:

(1) Cellular mode

Cellular communication is a common wireless communication mode, in this mode, there is no direct communication link between users, can only rely on the base station to achieve data transmission, each user is assigned to a specific cell. However, compared with the social communication mode, the advantage of this mode is that it can avoid interference between users and provide more stable and reliable communication[9]. However, there is the problem of low interest rate of spectrum resources, because the spectrum resources of the same frequency band are idle and wasted between different cells, and the allocation of spectrum resources requires higher management and coordination costs. The schema structure is shown in Fig. 2.

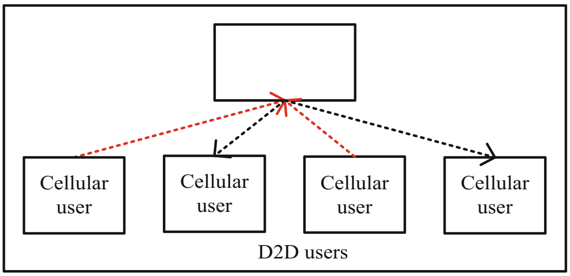


Fig. 2. Cellular Mode

(2) Dedicated mode

By using the dedicated mode, direct communication between adjacent users can be realized, avoiding the interference and delay of intermediate nodes, thus improving the efficiency and responsiveness of communication. Compared with cellular mode, dedicated mode only needs one downlink spectrum or upstream spectrum to complete social communication, so it has a higher utilization rate of spectrum resources [10]. However, in dedicated mode, the user device needs to have the ability to establish a communication link directly. This involves the support of device hardware and communication protocols to ensure that devices can communicate in the appropriate frequency band and achieve efficient data transmission. At the same time, interoperability and compatibility between devices also need to be considered, so that devices from different manufacturers can seamlessly connect and communicate to achieve the interconnection of social networks.

(3) Sharing mode

In shared mode, social network users can reuse licensed frequency bands in the cellular network to transmit data. This practice of reusing frequency bands enables more users to share spectrum resources, thus improving the efficiency of spectrum utilization. Compared with the above two modes, the shared mode has higher spectral efficiency. However, the reuse of cellular users' spectrum resources may cause interference problems among users. Therefore, it is necessary to prevent interference problems through certain resource allocation methods and interference management schemes [11, 12]. These algorithms and schemes can be intelligently adjusted based on information such as users' communication needs, network topology and spectrum conditions to optimize resource allocation and reduce interference.

A complete social communication process mainly includes three steps: device discovery, communication establishment and data transmission. In the cellular network, according to the needs of the service and the relevant information among the users, the cellular user can obtain the users who communicate with themselves independently or through the base station. Therefore, communication links are built through base stations to complete data transmission between users [13]. This process needs to ensure interoperability and compatibility between devices while safeguarding the security of communication and signal quality. The implementation process of this pattern is shown in Fig. 3.

The analysis and research of the process of social communication, taking two adjacent users as an example, describes the realization process as follows.

(1) User A needs to send a request to the base station in its area to establish a communication link with User B. The request will contain user B's basic information.
(2) When the base station receives the request from user A, the base station will determine the specific location of user B according to the basic information of user B sent by User A. After this process is completed, the base station will send social measurement signaling to the two users respectively to measure their social distance.
(3) After the two users receive the measurement signaling, the two users will respectively measure the channel state between them to ensure the accuracy of the judgment results. The channel status message measured by the two users is then sent to the base station.

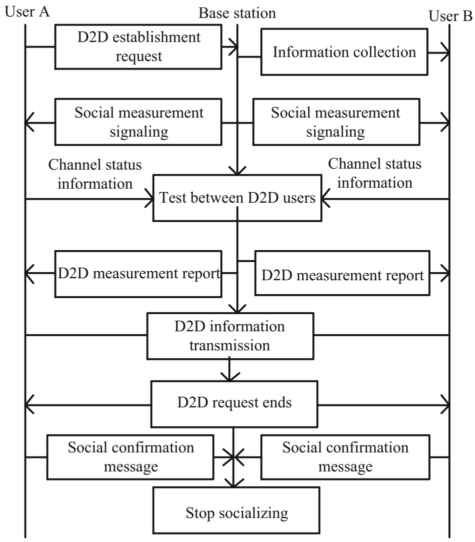


Fig. 3. Realization Flow of social communication

(4) After receiving the measurement information of the two users, the base station will match the received measurement information with the preset establishment conditions to complete the final judgment and determine whether the two meet the conditions for the establishment of the social link. If the conditions of establishment are met, the base station will send the judgment result to the two users.
(5) When the two users receive the construction results, the communication link will be directly established to complete the data transmission.
(6) At the end of the transmission, both users will send a request to stop social communication to the base station.
(7) After receiving the request, the base station will modify the network parameter configuration to a certain extent, and extract and confirm the termination information request sent by the two users again to ensure the accuracy of the operation. After confirming the error, the social communication between the two users will be terminated.

In the social communication system, according to the number of users participating in the social communication and the different functions, the social communication has three modes.

(1) Unicast communication mode:

In fact, the unicast communication mode is a one-to-one data transmission for users. According to the coverage range of social network users the and different relay functions, the unicast communication mode can be divided into:

1) User-to-user direct communication
2) Relay and forward communication mode

(2) Multicast communication mode

In social communication system, the multicast communication mode is to combine with multiple social network users, and make them share the same content and realize the information transmission of multiple social network users at one time[14]. Thanks to the addition of multicast technology, social network users can combine with multiple users to form the multicast communication, and transmit the same data resources to other users, so as to reduce the number of communications between social network users and improve the utilization efficiency of resources[15]. In a multicast communication group, each user plays the role of sender and receiver. A user can choose to send data to one of the users in the communication group or to multiple users at the same time. This flexible data transmission method can meet the individual needs of users and diversified social relationships. The communication mode is shown in Fig. 4.

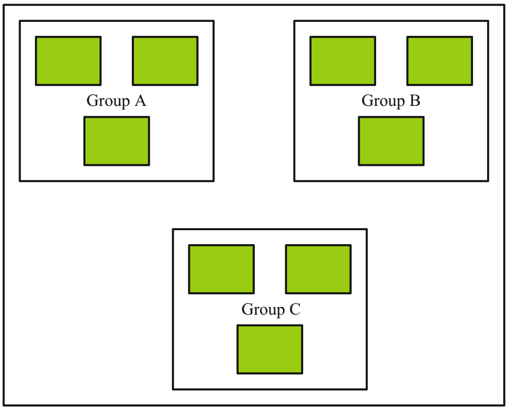


Fig. 4. Social Network Multicast (Multicast) Communication Method

(3) Broadcast communication mode

In social network broadcast communication, social network users can transmit information so that other users within a certain distance can receive information. However, the increase in the number of users leads to a corresponding increase in the base station load, and it is difficult to ensure that all users can provide better communication services.

To solve this problem, social communication has become one of the key technologies in communication systems such as LTE and 5G. It allows data routing between adjacent users to communicate directly under the control of the cellular system without passing through the base station. The technology reduces the load of the base station significantly, and also reduces the delay of the end-to-end information communication between users. In addition, it also allows social network users to reuse the channel resources of cellular users, which greatly improves the utilization of high-frequency spectrum and system capacity. However, this causes the problem of common frequency interference, which leads to the interference between users in the process of communication, and reduces the communication effect. Therefore, in order to solve this problem, it is necessary to develop interference management and resource allocation schemes. These schemes can maximize the throughput of social network links in the system and reduce interference levels through spectrum allocation, power control, and channel scheduling.

In social communication, the channel model takes many factors into account. In addition to path loss, fast fading due to multipath effect and slow fading due to shadow effect are also considered. This more accurately reflects the channel characteristics between social network users and cellular users. The channel gain can be modeled and analyzed according to these characteristics to optimize the performance of the system. Therefore, the channel gain between a cellular user and a social network user receiver is expressed as:

$$h_{cd} = k \cdot \delta_{cld} \cdot \xi_{cld} \cdot d_{cld}^{-\alpha} \tag{1}$$

In Formula (1), k represents the coefficient of path loss; α represents the index of path loss; δ_{cld} represents the fast fading factor following exponential distribution; ξ_{cld} represents the slow fading factor following logarithmic positive attitude distribution; $d_{cld}^{-\alpha}$ represents the distance between cellular user and social network user receiver.

If there are D pairs of social network users in the system, and C cellular users communicate with each other in orthogonal channels. When social network user d reuses the channel resource of cellular user i, the formulas of calculating SINR γ_i and rate r^i of cellular user i are shown as formula (2)–(5):

$$\gamma_i = \frac{P^i h_{cd}}{P_d^i h_{cd} + N_0} \tag{2}$$

$$r^i = \lg(1 + \gamma_i) \tag{3}$$

In the formula, P^i represents the signal power received by the cellular user i; P_d^i represents indicates the signal power of communication between cellular users i and social network users d; N_0 represents indicates interference noise power.

The SINR (signal to interference plus noise ratio) and speed of social network user d are shown as follows:

$$\gamma_d^i = \frac{P_d^i h_{cd}}{P^i \lg(1 + N_0)} \tag{4}$$

$$r_d^i = \lg\left(1 + \gamma_d^i\right) \tag{5}$$

Co-channel interference occurs when social network users and cellular users use the same channel at the same time. There is a certain connection between the interference intensity and the distance, in general, the smaller the distance, the stronger the interference intensity. In general, the number of users who simultaneously conduct social communication in a residential district is less than that of cellular users, so multiple cellular channel resources may become potential multiplexing objects of social network users. When the interference of cellular users to social network users is less than a certain threshold, the base station will allow social network users to reuse channel resources, and through such constraints, ensure the QoS requirements of social network users. The areas that restrict the reuse of cellular users are shown as follows:

$$P_{c,\max} h_{cd} \leq I_{c,d} \tag{6}$$

In the formula, $P_{c,\max}$ represents the maximum power received by cellular users; $I_{c,d}$ represents the power limit for signal reception in this area.

After the set of channel resources reused by social network users is given, the transmit power of social network users is optimized by power control, and maximize the throughput of social network communication links under resource constraints. Based on the previous step, any social network user D and the reusable potential cellular channel can be determined. On this basis, the reusable resource set S_d of social network user D is obtained. Therefore, the transmission power target of optimized social network users can be expressed as:

$$\begin{cases} \max u_d^k = \sum\limits_{i \in S_d} \log_2\left(1 + \frac{P_d^i h_{cd}}{P^i \log_2(1+\gamma_d^i)}\right) \\ 0 \leq P_d^i \leq P_{c,\max} \\ \sum\limits_{i \in s_d} \leq P_{c,\max} \end{cases} \tag{7}$$

In the formula, u_d^k represents the transmission power target of the optimized social network user.

Next, under the optimization objectives and constraints, the water filling algorithm is applied to achieve the rational distribution of power for social network users. According to Karush-Kuhn-Tucker (KKT) condition, we can get:

$$L\left(P_d^i, \alpha, \beta\right) = \sum_{i \in S_d} \log_2\left(1 + \frac{P_d^i h_{cd}}{P^i \log_2\left(1 + \gamma_d^i\right)}\right) - \alpha\left(P_d^i - P_{c,\max}\right) - \beta\left(\sum_{i \in S_d} P_d^i - P_{c,\max}\right) \tag{8}$$

In the equation, α and β are both distribution condition coefficients.

After calculating the partial derivatives, we can get:

$$P_d^i = \left[\varphi - \frac{1}{H}\right]^+ \tag{9}$$

where,

$$[\varphi]^+ = \max\{0, \varphi\} \tag{10}$$

$$H = \frac{h_{cd}}{P^i \log_2\left(1 + \gamma_d^i\right)} \tag{11}$$

Based on the power control, we can see that the maximum throughput and the corresponding transmission power of reusing any resource set by social network users in the set time. In the process of channel allocation, the scheme of power control is used to complete the power adjustment of user on different channels.

2.2 An Anti Interference Dynamic Allocation Algorithm for Channel Resources in Heterogeneous Cellular Networks in Social Communications

With the development of wireless services, users need to consume more energy. However, the battery capacity of mobile terminals is finite, and the existing battery technology has not been further developed. How to effectively improve the energy efficiency, spectrum efficiency and user experience is an urgent problem to be solved. In order to improve the spectrum efficiency, a cellular channel resource is allowed to be reused by multiple social network users at the same time. Because many pairs of social network users reuse the same channel resource, the interference environment in the system becomes more complex. It not only includes the cross-layer interference between the original cellular users and social network users, but also the same layer interference between social network users who reuse the same channel resource.

The uplink transmission system of heterogeneous network with dense social network users includes cellular users and social network users randomly distributed in the residential area. The eNB is located in the center of the residential area. During the uplink cycle of cellular network, the cellular user sends data to eNB, and eNB suffers interference from social communication transmitters. In the communication process, social network user receivers will be interfered by cellular users and other social network user transmitters sharing the same channel. It is assumed that the channel condition follows Rayleigh distribution. In order to completely simulate the real environment, different channel selection will lead to different channel selective fading (frequency selective fading).

Let's suppose that there are D pairs of social network users in the system, and C cellular users use the orthogonal channel for communication, but there is no residual channel resource in the system. If q denotes the set of social network users that share the resources of the k th cellular channel, the Signal to Interference plus Noise Ratio (SINR) of the cellular user on the k th channel is:

$$\gamma_c^k = \frac{P_d^k h_{cd}}{\sum_{k \in C} p_d^k h_{cd} + N_0} \tag{12}$$

In the formula, p_d^k represents the signal power of the k-th channel in the orthogonal channel used by social network users d.

The SINR of the D th social network user on the k th channel is:

$$\gamma_d^k = \frac{P_d^k h_{cd}}{\sum_{k \in C} p_d^k h_{cd} + P_d^k h_{cd} + N_0} \tag{13}$$

Next, r_c^k and r_d^k represent the rates of the k th cellular user and the d th social network user, respectively:

$$r_c^k = \log_2\left(1 + \gamma_c^k\right) \tag{14}$$

$$r_d^k = \log_2\left(1 + \gamma_d^k\right) \tag{15}$$

The battery capacity of mobile devices is limited, lacking of new technological breakthroughs, so the energy consumption becomes particularly important. Therefore, new optimization criteria should be adopted to fully balance the energy consumption and transmission quality. The battery life will be an important optimization parameter. The energy consumption of each user in the system includes two parts: transmitting energy and circuit energy. The circuit energy refers to the energy consumed by all circuit blocks along the signal path. It has an important impact on battery life, so it can't be ignored. Without loss of generality, it is assumed that all users have the same constant circuit power consumption P_0. In order to capture nonlinear effects, Peukert law is used to model the battery life.

$$T = \frac{P_0 B_{\mathrm{c}}}{I^{\alpha}} \tag{16}$$

In the formula, B_{c} represents the circuit energy; I^{α} represents a constant current in the circuit.

Therefore, for the user whose transmitting power is p_i and working voltage is V_0, the battery life is:

$$T_i = \frac{B_c V_0^a}{(p_i + p_0)^a} \tag{17}$$

In the equation, a represents the loss coefficient.

Next, measure the user's energy efficiency by setting the expected data volume of the battery. That is to say, the maximum amount of data can be transmitted within a limited battery capacity.

$$u_i = \left(r_c^k + r_d^k\right) T_i \tag{18}$$

In order to ensure the normal communication between users, this section mainly considers the QoS requirements of users, and the utility function is shown in formula (19).

$$\begin{cases} \max u_i\left(p^i, p_{c,\max}\right) = \left(r_c^k + r_d^k\right) T_i \\ s.t \ \left(r_c^k + r_d^k\right) \geq r_{i,\min} \\ \sum\limits_{i=0}^{N} \frac{p_i^k}{V_{i,c}^k} \leq I_{k,\max}^c \\ 0 \leq p_k^i \leq p_{c,\max} \end{cases} \tag{19}$$

In the formula, $r_{i,\min}$ represents the minimum transmission rate of cellular network users i; p_k^i represents the signal power of the k-th channel in the orthogonal channel used by cellular network users i; $V_{i,c}^k$ represents the working voltage of the k-th channel in the orthogonal channel C used by cellular network users i; N represents the number of users; $I_{k,\max}^c$ is defined as the maximum tolerable interference of the k th cellular user.

If B-bits content must be sent within time $T_{i,\max}$, $T_{i,\max}$ is the maximum delay. Let's assume that the channel is static during the optimization, the utility function can be expressed by Formula (20) under the QoS constraint of maximum delay.

$$\begin{cases} \max u_i\left(p^i, p_{c,\max}\right) = \left(r_c^k + r_d^k\right)T_i \\ s.t\ \frac{B_{i,\min}^k}{\left(r_c^k + r_d^k\right)} \le T_{i,\min} \\ 0 \le p_k^i \le p_{c,\max} \end{cases} \tag{20}$$

In the equation, $B_{i,\min}^k$ represents the minimum circuit energy of the cellular network user i in the k-th channel.

The interference threshold is also an important factor affecting QoS, which is particularly important to ensure the normal communication of cellular user. If $I_{k,\max}^c$ is defined as the maximum tolerable interference of the k th cellular user, the utility function under the QoS constraint of maximum interference threshold can be shown in formula (21).

$$\begin{cases} \max u_i\left(p^i, p_{c,\max}\right) = \left(r_c^k + r_d^k\right)T_i \\ s.t\ \sum_{i=0}^{N} \frac{p_i^k}{V_{i,c}^k} \le I_{k,\max}^c \\ 0 \le p_k^i \le p_{c,\max} \end{cases} \tag{21}$$

The undirected graph is defined as $G = (W, V, E)$. V is the set of vertices, which represents social network users in the system. E represents the set of edges connecting each point. W represents the set of weights of edges. And the greater the weight W, the greater the interference between social network users. The maximum weight between social network users is represented by w_{ij}.

Based on the graph coloring principle, the social network users with large interference are divided into the same cluster, and the social network users with small interference are divided into different clusters to maximize the total interference in the same cluster. D_k denotes social network users in the same cluster. The optimization target is expressed in formula (22).

$$\begin{cases} \max \sum_{i=1}^{D} \sum_{j=1}^{D} \sum_{m=1}^{M} e_{im} e_{jm} w_{ij} \\ s.t\ \bigcup_{k=1}^{M} D_k = D \\ e_{im} = \{0, 1\} \\ e_{jm} = \{0, 1\} \end{cases} \tag{22}$$

In the formula, e_{im}, e_{jm} represents the clustering coefficients of different social network user divisions.

Clustering is still a NP difficult problem. In this section, the ant colony genetic algorithm (ACGA) is used to solve the social network user clustering problem. The ACGA is based on genetic algorithm. Firstly, a solution set of excellent initial population can be obtained through one iteration of ant colony algorithm, and then the solution set is taken as the initial population of genetic algorithm. Finally, the genetic algorithm is used to find the clustering result and thus to find out the optimal solution of the original problem. The operation flow of ACGA is described as follows:

(1) Initialization

Set the parameters of ant colony algorithm and the amount of information on the corresponding path;

(2) m ants are randomly placed on n vertexes;
(3) Ant k selects the next colored vertex according to the state transition probability and adds it to the tabu list;
(4) Repeat Step (3) to find the first traversal path of m ants respectively, and $S(D \times P)$ denotes the initial colored matrix solved by ant colony algorithm;
(5) The vertices with 1 element in each column of $S(D \times P)$ are combined to form a substring population. And then, the genetic algorithm parameters are initialized.
(6) The fitness function of individual in the population is calculated;
(7) The selection, crossover and mutation are performed to generate new clustering results;
(8) $t < NG, t = t+1.$. Return to Step (6), otherwise the genetic algorithm is terminated.

The channel allocation is to improve the energy efficiency of users as much as possible. According to the clustering results, the interference between users in the same cluster is larger than that in different clusters. In order to reduce the interference between users, the channel allocation follows the principle of intra-cluster orthogonality and inter-cluster reuse. Next, the auction algorithm will be used to complete channel allocation. Social network users are regarded as the bidders, and the cellular channels are regarded as lots. If the social network user d wins the channel resource of the i th cellular user, the private valuation of the social network user d can be expressed as $v(d, i)$.

In the auction, social network users improve their energy efficiency by sharing channel resources, but they will also pay some costs. In order to fully reflect the fairness of auction, the linear anonymous price is adopted, and the formula of calculating the payment price is shown as formula (23).

$$P_d(i) = \beta_\tau p_d^i \tag{23}$$

In the formula, β_τ represents the elasticity coefficient of resource prices; p_d^i represents the sharing channel resource price between social network user d and cellular user i.

Therefore, the utility function of the bidder (the satisfaction with the channel resource of the i th cellular user) can be defined as formula (24).

$$U_d(i) = v(d, i) - P_d(i) \tag{24}$$

After the channel allocation, the problem of resource allocation is transformed into the power allocation of user. Because users are only interested in maximizing their energy efficiency, the problem of user power allocation is modeled as a model of non-cooperative game theory, and the participants are the users in the same channel. The fixed-point theory and iterative algorithm are combined to allocate the power to the users who complete the channel allocation, so as to maximize the energy efficiency.

3 Simulation Experiment

In order to verify the comprehensive effectiveness of the proposed algorithm, simulation experiments in heterogeneous cellular networks are required. The specific experimental parameters are shown in Table 1.

Table 1. The parameter of simulation experiment

Parameter	Setting value
Cellular network radius	1500 m
Number of cellular users	25
Maximum power of cellular users	20 dBm
Rate requirements for cellular users	1000 bps
Number of social network user pairs	1–50
Maximum power of social network communication sender	20 dBm
Channel bandwidth	1.8e5 Hz
Noise power	−100 dBm

In the MATLAB platform, 1000 distributed scenes are randomly generated each time by Monte Carlo method. The experimental system configuration is as follows: the CPU is Intel dual core e8400, the main frequency is 3.0 GHz, the memory is 4.0 gb, and the operating system is windows 2008, 64-bit system. Taking power consumption and average data transmission as factors, the algorithm proposed in this paper is compared with the dynamic channel allocation (DCA) algorithm (reference [3] algorithm), the joint optimization algorithm for mode selection and channel allocation (reference [4]), and the robust security resource allocation algorithm (reference [5] algorithm).

(1) Power consumption/(W)

In order to verify the effectiveness of the algorithm in this paper, 100 simulation experiments are carried out under different number of users. The results are shown in Table 1.

As shown in Table 2, The power consumption of each algorithm will increase with the increase of the number of experiments. However, by adjusting the user's generating power, the interference generated by the transmitter is reduced, thus effectively reducing the power consumption of the whole algorithm.

(2) Average amount of data sent for users / (bit /Hz)

Figure 5 shows the comparison results of average data transmission volume of different algorithms.

Table 2. The comparison for power consumption of different algorithms

Number of experiments/(times)	Power consumption/(W)			
	The method	The dynamic channel allocation (DCA) algorithm	The joint optimization algorithm for mode selection and channel allocation	The robust security resource allocation algorithm
10	1.25	1.30	1.28	1.40
20	1.30	1.38	1.34	1.47
30	1.42	1.47	1.46	1.52
40	1.47	1.58	1.52	1.60
50	1.54	1.67	1.59	1.67
60	1.60	1.74	1.63	1.74
70	1.66	1.80	1.69	1.78
80	1.71	1.88	1.74	1.83
90	1.80	1.94	1.83	1.90
100	1.86	2.00	1.87	2.01
Average value / (W)	1.561	1.676	1.595	1.692

Analysis of the experimental data in Fig. 5 shows that, the average amount of data sent by users increases with the number of users. Although the average user data transmission volume of this algorithm is higher than the other three methods, the algorithm effectively solves the user's transmission power, avoids the interference generated by the transmitter, and improves the average transmission data amount. Therefore, the algorithm in this paper is superior to the other three algorithms.

To further verify the superiority of the proposed algorithm, the transmission time was used as an evaluation indicator to compare the data transmission rates of the four algorithms. The results are shown in Fig. 6.

According to the results obtained in Fig. 6, there is a certain gap in the results obtained by the four algorithms as the amount of data increases. The transmission time shows an increasing trend. When the transmission data volume reaches 1000, the transmission time consumption of the algorithm proposed in this paper, along with the dynamic channel allocation (DCA) algorithm (reference [3] algorithm), the joint optimization algorithm for mode selection and channel allocation (reference [4] algorithm), and the robust security resource allocation algorithm (reference [5] algorithm), is 1s, 3.4s, 4s, and 3.3s. Comparing the results obtained from the four algorithms, it can be seen that the algorithm proposed in this paper can effectively shorten the time required for data transmission, improve transmission efficiency, and have strong practicality.

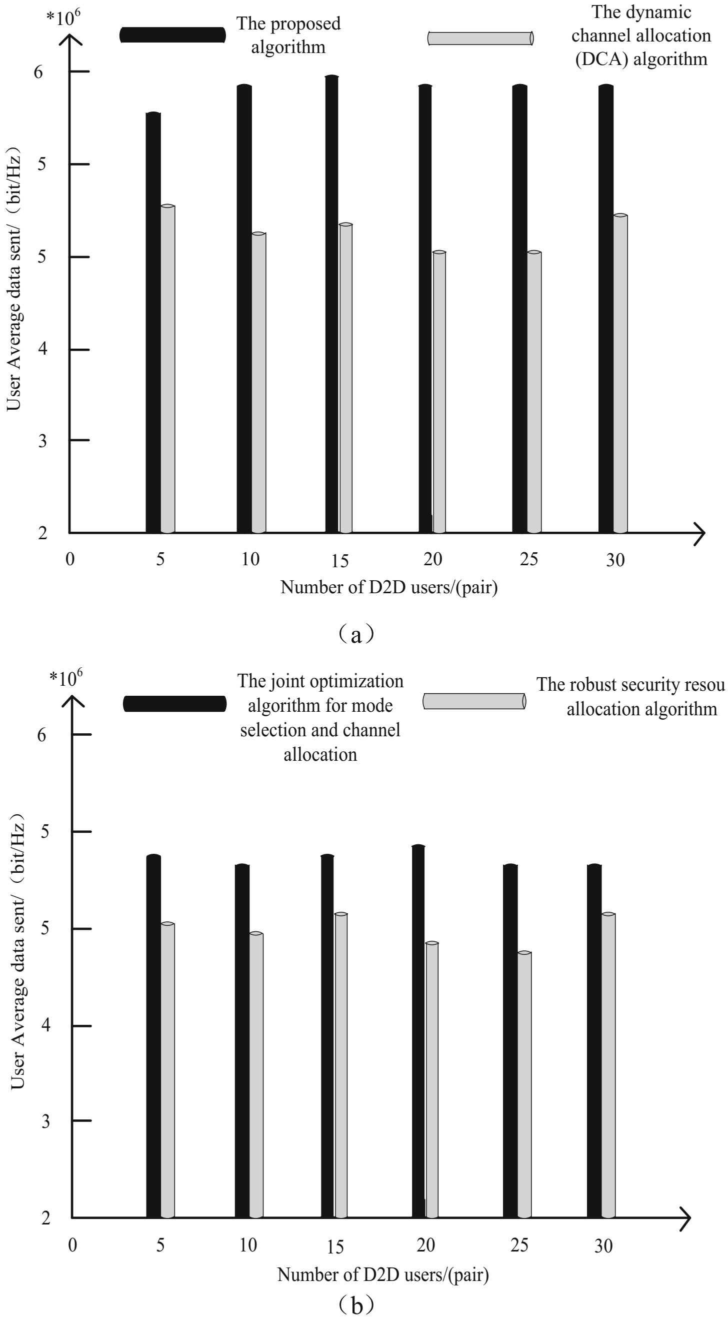


Fig. 5. The comparison results for average data sent of different algorithms

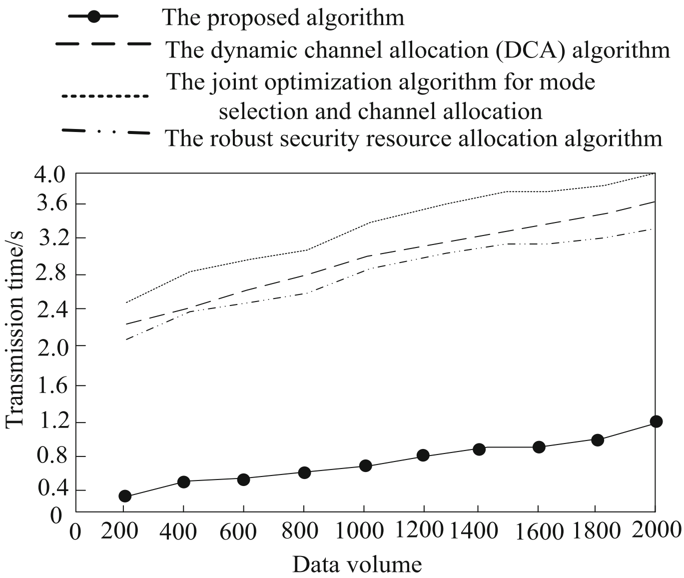


Fig. 6. Data Transmission Rate

4 Conclusions

With the rapid growth of terminal devices such as smartphones and wearable devices, as well as the continuous development of wireless services, people's demand for bandwidth is increasing, and wireless spectrum resources are becoming increasingly scarce. Therefore, how to improve the utilization of spectrum resources has become a research hotspot in recent years. At the same time, a dynamic anti-interference channel resource allocation algorithm for heterogeneous cellular networks in social communication was designed and proposed to address a series of issues with traditional algorithms. This algorithm addresses the common frequency interference problem in heterogeneous networks composed of social network users and cellular users, and combines a resource allocation mechanism based on combinatorial auctions to maximize the throughput of social traffic information links in the system. At the same time, using undirected graph theory and ant colony genetic algorithm in graph theory to cluster social network users, as heterogeneous network scenarios change, the undirected graph will dynamically change, forming a new clustering scheme. Based on the principle of reuse between orthogonal clusters within a cluster, auction method is used to allocate channel resources for social network users to reduce inter user interference. Based on the selfishness of user behavior, a non cooperative game model is established, which combines fixed point theory with iterative algorithms to allocate electricity to users who complete channel allocation, maximizing user energy efficiency. The results show that the average power consumption of this algorithm is 1.561W, which can effectively reduce power consumption. The data transmission volume is maintained above 5bit/Hz, and the transmission time is less than 1s, effectively improving the user data transmission volume and having high transmission efficiency. However, due to limitations in research time and personal academic abilities, there are still shortcomings in research work. The future research focus will be on the following aspects:

(1) Research resource allocation algorithms in multi to multi scenarios to further improve spectrum utilization and system performance.
(2) The algorithm in this article only considers slow motion within the specified range. But in actual network environments, there are high-speed mobile users and cross community users. Therefore, we will improve our algorithms in this area in the future.

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