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Solution to improve the signal coverage intensity under cluster analysis

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Abstract: *In the construction of communication infrastructure, how to reasonably allocate base station types and base station locations according to different business volume in different regions, so as to improve the communication efficiency of the base station coverage area and improve the sharing of resources. In view of the problem that the communication bandwidth is getting larger and larger, but the energy coverage of the base station is getting smaller and smaller, making the number of required base stations to cover the same area, we simplify the types to macro station and micro base station according to the requirements of the topic, and use the base station characteristics given by the problem to conduct mathematical modeling. When considering the different business volume in different regions, priority is given to solving the areas with high business volume and weak coverage. Our use of effective site selection work can not only improve the investment efficiency, but also reduce the construction and maintenance cost of base stations in the actual construction process. Therefore, it is a practical significance to study the site selection of base station. Conduct an example simulation. After the simulation software simulates the grille, the clustering algorithm merges all the weak coverage areas into one group, namely, the similar data is merged, and then the base station is optimized to effectively improve its coverage.*

Keywords: *cluster analysis, grille planning*

1. Background

With the progress of science and technology and the rapid development of the Internet industry, people's requirements for the Internet are constantly improving[1-3]. The unbalance between the updating block and development of communication network and the demand of people's life is becoming increasingly prominent[4-5]. As the floors are higher and higher, the spacing is smaller and the situation is more and more complex, the signal strength is easily weakened after repeated reflection and diffraction of communication signals in the transmission process. And the new communication equipment is not built in time, in some signal coverage areas prone to weak coverage, coverage hole, over coverage and overfrequency coverage and other serious problems[6]. In this case, although the communication terminal can barely connect to the network, it cannot communicate normally due to poor signal quality. If the terminal receives poor signals, the normal transmission of voice data and network data cannot be ensured, and even the connection and communication of voice calls are affected[7].

2. Analysis of existing problems

In the actual network planning, considering the construction cost of the base station and some other factors, sometimes all the weak coverage areas may be unable to solve. At this time, it is necessary to consider the factors of business volume, and try to give priority to the weak coverage areas with high business volume.

For computational convenience, a given region is divided by a very small grid, considering only the central point of each grid, that is, any given region, can be divided into a limited number of points. Each point has some attribute values, including: coordinates, whether it is a weak coverage point, business volume, etc.

The selection of the site and location is very important for the communication network planning. To build in a certain site communication network base station often depends on the environment and terrain and then choose the optimal terrain combination for building communication network base station finally according to the local actual situation of base station location fine tuning, relative to the large area of base station location, in a smaller area to fine tuning, more convenient and efficient. Therefore, to determine the site selection site of a communication base station, it is first necessary to determine its approximate site selection scope, and then fine-tuning according to the specific local terrain and environment characteristics, so as to determine the overall site selection site.

Considering that the Angle angle between the main direction of any two sectors of each station should not be less than 45 degrees, and other conditions such as the base station cost in the previous question, we ask whether the new station can cover 90% of the total business volume of the weak coverage point under the optimal site and sector angle. If possible, give the results of the optimal site and sector angle; otherwise, give the results of the optimal site and sector angle, and give the proportion of the total business volume of the weak coverage points that can be covered.

In practice, in order to better solve the weak coverage problem, it is necessary to cluster the weak coverage points, gather the close weak coverage points into a class, and can get the weak coverage area, so that different weak coverage areas can be managed separately to better solve the weak coverage problem.

If the distance of the two weak coverage points is not more than 20, then the two weak coverage points should cluster into one class, and consider that the clustering property is transitive, that is, if points A and B and points B and C are one, points A, B and C are all one class. Try to cluster all the weak coverage points and require that the total time complexity of the method used for clustering is as low as possible.

3. Problem Solution

(1) Ensure that the base stations can be connected with each other, but a fixed part of the base station antenna is that the directional antenna cannot be used to broaden the signal coverage area, uneven terrain will cause great attenuation to signal transmission, the distance between base stations should meet the maximum communication distance under the influence of terrain.

(2) The establishment of the base station will form a circular coverage area with the center, and the terminal must be located in the signal coverage area, so the coverage area formed by all the base stations is large enough[8]. When the terminal moves between different base station coverage areas, causing the process of disconnection from one terminal and reconnecting to the next base station, we should try to avoid the base station to reduce the risk of communication interruption.

Based on the above analysis, it is necessary to grid a base station distribution area and discretize it, and establish the polygon graph of the coverage area of each base station to analyze the optimal location of the base station. Based on this detailed analysis of the macro and micro base stations, the given data are screened and applied to the specific model to obtain the results[9].

4. Model establishment and solution

In order to improve the efficiency and quality of location level planning, the method of reasonable evaluation of key scheme, programming and network accounting of workers in the automation industry.This method can improve the efficiency and quality of planning and save departmental resources.Cell achieves frequency multiplexing; that is, using the same frequency in different small systems greatly increases the capacity of small systems.However, when the number of users reaches the maximum number of services that each cell can provide, the cell area is divided into smaller areas, and the frequency multiplexing of the phase example is used.Frequency multiplexing can also be achieved by using sector partitions in the same cellular cell.When the beam with an Angle θ replaces the omnidirectional round beam, the interference distance between the adjacent regions is shown as shown in the figure $(D-R)$:

$$\{D^2+R^2-2DR\cos(\theta_s)\}\frac{1}{2}_w \tag{1}$$

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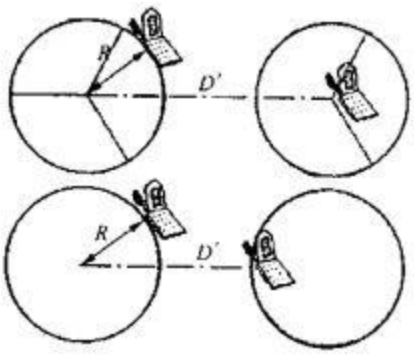

Figure 1: Interinterference between adjacent regions

As shown in Figure 1. Considering that the attribute point-level planning target is too grand to achieve accurate analysis, the attribute point-level planning target grid is turned into a 50 m * 50 or 100 m * 100 tm grid, and the smaller the grid accuracy, the higher the grid accuracy.For the point-level planning objectives, the main service stations are matched based on the station-level coverage capability.The determination of station-level coverage capacity requires families to consider the scene mode, site hanging height, lintel, station distance and other factors.The modeling process of disease coverage planning is shown in Fig.Finally, the problem of planning the base station labor parameters is transformed into a cluster analysis problem of the grid around the site, as shown in Fig.Considering that the planning angle can be combined with the antenna hanging height, coverage target height, maximum coverage target distance and antenna parameter calculation, the paper introduces the base station azimuth instrument classification method based on cluster analysis.

The fanning gain is expressed as Figure 2.

$$x = N \frac{1+\beta_o}{1+\beta_s} \tag{2}$$

$$10\lg x = 10\lg 2.6 = 4.1dB \tag{3}$$

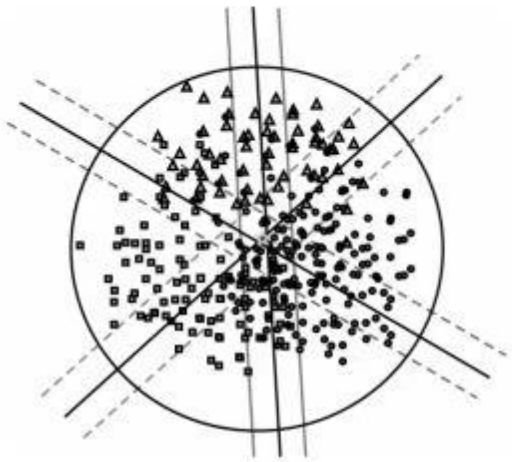

Figure 2: The STM plan of the sector base Station

The SVM plane of the base station in the sector and the maximum parallel spacing line.

Computing result:The optimized sector Angle is about 46,11740 property points in problem 1,231,600 grids, and the total number of TD-LTE sites increased to 213,500, accounting for 92.3% of the total grid, meeting the requirements.

To facilitate the grid as the boundary during sampling, you can establish the grid with the longitude and longitude lines as the reference.

(1) Draw the boundary map to the target planning area

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Find out that the maximum value and the minimum value point of the map latitude and longitude are set to a, b, c, d whose latitude and longitude is*(LONa,LATa),(LONb,LATb),(LONc,LATc),(LONd,LATd),*Make a and c and the longitude direction to the extension, b and d and the dimension direction, they intersect A, B, C, D, respectively, the latitude and longitude of these four points are*(LONd,LATa),(LONb,LATa),(LONb,LATc),(LONd,LATc)*.

(2)Position the coordinates of the set grid

Set the grid size, and refine the grid according to the local map, set the final grid as N vertical and M horizontal horizontal, the intersection of all grid lines can be positioned respectively(m,n).

$$\begin{cases} LON(m,n) = LONd + [(2m-1)*(LONb - LODd)/2M] \\ LAT(m,n) = LATc + [(2n-1)*(LATa - LATc)/2N] \end{cases} \tag{4}$$

The test and MR simulation data are imported into the map, where MR, road test and frequency sampling point data are presented as the main data of the grid, and CQT is presented as the auxiliary data. After the sampling corresponds to the grid, the grid staining is realized by setting the valve value.

Identification between valid grid and bad points:

(1) MR valid grid: the sampling point of MR grid is greater than the valve value (the MR sampling point is less than 50 within three days).

(2) Road test effective grid: grid road test sampling point is greater than the valve value (the number of sampling points is greater than 5).

(3) CQT valid grid: a grid with CQT test data exists.

(4) Sweep effective grid: the grid sweep sampling point is greater than the valve value (the number of sweep sampling points in the grid is greater than 5).

(5) Effective data bad point: the lowest level of the sampling point is less than the valve value (the level is less than-110dBm).

The collated data can be classified into four groups,.The sum of the sampling points for these four sets of data is, respectively N_a, N_b, N_c, N_d ; Their bad-point data are, respectively M_a, M_b, M_c, M_d ; The weight values are respectively $\omega A, \omega B, \omega C, \omega D,$;On this basis, if the value of the internal data of the grid is the effective value, the preset weight value can be directly used for the weight here, and the size of the weight can directly reflect the importance of the four groups of data，If the internal data value of the grid is invalid, the weight is zero, and in this way, all the valid data of the grid is weighted and the overall bad point rate is obtained.

Gaster Clustering:The clustering algorithm is used to merge all weak coverage regions into one group, or to merge similar data.The application of the algorithm can be manifested as finding the grid directly related to it on the basis of the known grid and further finding the indirectly related grid, in this way looking repeatedly in all the grids until finding all the relevant grids in all the grids.

The problem area (1, 2, 3, 4,...N) obtained by the above calculation method and the distance D between the grid of the problem area and the base station address point in the grid, the minimum distance of all the obtained distance is Dmin and the data is within the threshold allowable range; finally the area with no candidate plan address point is deleted.For LTE signal network, signal coverage radius is about 200m-2000m, and the signal coverage range of micro base station signal is about 50m.

Optimization of the base station address:In all the addresses that the base stations will take, the business volume in each address should be given priority to areas with large business volume.The distance formula is

$$d(s_i,p_j) = \sqrt{\left(\tilde{x}_i - x_i\right)^2 + \left(\tilde{y}_j - y_j\right)^2} \tag{5}$$

Building a base station in a certain place requires a variety of considerations:

(1)Base station construction cost:

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$$f_i = \frac{N - N_0}{N} \tag{6}$$

(fi:Construction cost index,N_0:Number of base stations selected)

(2)The area that the base station can cover:

$$P(r_{ij}) = \begin{cases} 1, d(s_i, p_j) \le R) \\ 0, otherwise \end{cases} \tag{7}$$

When locating a base station, all alternative base stations appear only two states (1) are selected.(2) Not selected.Because it has only two states, so the secondary coding can be used instead of the operation, using this method to calculate a random individual in the low-k generation population can be represented by the following formula.The variation strategy improves the upper formula to cope with the differential evolution algorithm by using the real number code:

$$v_{i,j}^{t+1} = x_{ri,j}^{t} + (-1)^{sig}(x_{r2,j}^{t} - x_{r3,j}^{t})$$

$$sig = \begin{cases} 0, \ rand < 0.5 \\ 1, \ otherwise \end{cases} \tag{8}$$

Optimization of the differential evolution algorithm:

The population generated when using differential evolution algorithm is completely random, which is obviously a serious neglect of known information, so the initial population obtained by this method cannot meet the quality requirements; and introducing cluster-based population initialization strategy can solve this problem; the decision is established as follows:The base station in choosing set address priority test point relatively concentrated area, so can first to all the test points cluster analysis, there is an alternative base station clustering geometric center and test point cluster analysis geometric center nearest, set the alternative base station set for s, s can contain a lot of child data, extract them into the optimization operation.

Simulation operation and result analysis:Weak coverage area raster data front

For screening the grid of the weak coverage area of 4,5G signal or individual 5G signal simulation results by adjusting the preset weak coverage threshold n and the distance threshold d (the base station is mostly set in the area of more traffic, so the optimization of the area near the base station should be preferred) conditions and screening flow chart:

We extract grid data filtered from the signal weak coverage network, determine their geographic location coordinates, and classify all adjacent signal weak coverage regions into one category using the DBSCAN density clustering algorithm.

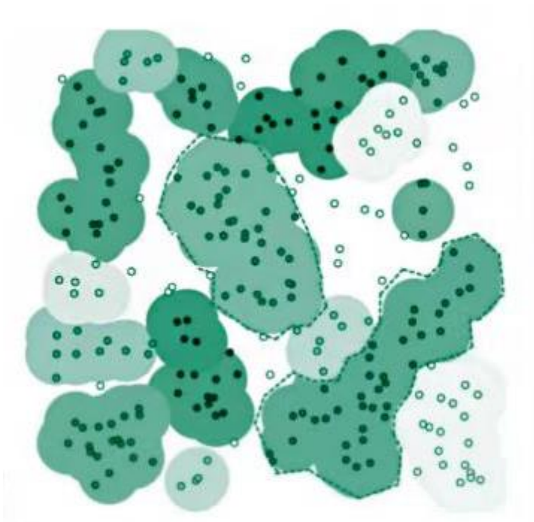

Figure 3: Results diagram of the density clustering optimization algorithm

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The data were calculated using the particle swarm algorithm:

Particle group algorithm and simulated annealing algorithm is similar, it is also from the random solution, through looking for the optimal solution, it is also through fitness to evaluate the quality of the solution, but it is simpler than genetic algorithm rules, it has no genetic algorithm "cross" (Crossover "and" variation " (Mutation) operation, it by following the current search to the optimal value to find the global optimal. As shown in Figure 3.

Time complexity:For the time complexity problem in this paper, the problem area by algorithm operation, and then the problem area coverage optimization, comparing the calculation process and results of the two algorithms algorithm coverage effect is almost the same, but the particle swarm algorithm calculation book is obviously better than the calculation speed of ant colony algorithm.

5. Model promotion

Compared with traditional manual planning, this model reflects its high efficiency, and the use of intelligent iterative optimization solves the problem of insufficient accuracy of traditional planning. On the whole, it adjusts dynamic RF parameters, observes the change trend of grid quality, and is ready to adjust the grid quality and network coverage.Can reduce a lot of manpower and material resources and save time.Compared with the base station location, base station site optimization is the key in the network coverage planning, after the concrete analysis of the base station address creatively puts forward a binary coding differential evolution algorithm based on clustering strategy, to obtain the optimal network coverage scheme, according to the final result, with high practicability.

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