Application of Random Walk Model in Mobile Communication Data Optimization

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Abstract. With the continuous development of society and economy, the development and application of mobile communications have become more and more popular, and more people have begun to use mobile devices for office, study and life. The quality of mobile communications network signals directly affects people's experience of use. The scope of actual application has gradually increased with the renewal of the technology itself. Based on the random walk model, this paper constructs a mobile communication data optimization plan. Through data storage, transmission delay, and information total control, the optimization form of wireless network mobile communication data transmission performance is studied. Practice shows that this scheme can effectively improve communication quality and transmission efficiency.

Keywords: Random Walk Model, Mobile Communication, Data Optimization

1. Introduction
With the continuous development of society and economy, the development and application of mobile communication is becoming more and more popular, and more people are beginning to use mobile devices for office, study and life. The quality of mobile communication network signals directly affects people's experience and practical application. The category has gradually increased with the renewal of the technology itself [1-3]. From 4G networks to 5G networks, the data dissemination of mobile communication is not only an increase in speed, but also a rich transmission of content, such as text messages, pictures, and streaming media. Under the application of the 5G information transmission system, it will provide a more efficient and convenient transmission path for the operation of the network system [4-6]. However, in the actual operation process of the network system, it is susceptible to the influence of external environmental factors, which reduces the transmission efficiency of data information in the network system, and then adversely affects the enterprises relying on the development of the network platform [7-10].

This article is based on the random walk model, optimized and analyzed mobile communication data, and improved the transmission quality of data information through corresponding design schemes, aiming to provide users with better communication services.

2. Problems in the optimization process of mobile communication networks
Due to many factors such as technology and economy, the optimization of the current mobile communication network is very difficult. This difficulty is mainly reflected in three aspects: data, funds, and security.

(1) Data issues. The mobile communication network is in a historical period of rapid development, and it is foreseeable that after a period of development, the number of mobile communication network users in my country will no longer have major changes. However, the user's needs have begun to change, becoming higher and higher, and more and more diversified and personalized. In this case, generally speaking, there are more and more data related to telecommunication and mobile communication networks, and the composition becomes more and more complicated. The collection, storage, and processing of these data have become more and more difficult.

(2) Financial issues. The optimization of mobile communication networks is not only related to the research and development of related technologies, but also includes the upgrading of corresponding facilities throughout the country. The development of telecommunications and mobile communication networks in various regions is very different. Once it is necessary to upgrade and optimize the facilities, it is necessary to analyze the data structure and nature of the local situation. In addition to the characteristics of the facility construction itself, a large amount of manpower is required. Financial resources, material resources and time, which have very high requirements for funds.

(3) Security issues. Considering the particularity of telecommunications and mobile communication networks, it has very high requirements for security. As a new technology, big data technology has not been fully developed in all aspects. In this case, the introduction of big data technology in the optimization process of telecommunications and mobile communication networks will cause huge losses and even affect social stability once security problems occur.

In the process of network transmission, data information generally presents the phenomenon of data interconnection, that is, a certain type of data information is used as a node to establish a data structure in the form of directional transmission. However, in the process of data information transmission, there are still serious security problems. First of all, the network address has been tampered with. The motivation for this type of problem is that internal information is stolen when data information is transmitted through the terminal, and then criminals conduct malicious transmission of the data, thereby destroying the network environment. Secondly, the security performance of the data transmission system is low. When the number of external attacks is large, it will affect the established transmission path of data information. If the data node in the network structure is attacked and cannot complete the data transmission task independently, it will definitely reduce the efficiency of data transmission and increase the redundancy of network system operations. Finally, when the Ad-Hoc network transmits data information, such as in the same power transmission environment, the frequency generated by the network will also belong to a qualitative value. If illegal personnel use the same band intrusion method, the transmission will be intercepted. Data information reduces the quality of network transmission.

3. The principle of wireless network mobile communication data transmission

3.1. Network model

The wireless network (Ad-Hoc) studied in this article is a mobile network system, which is similar to P2P. When data is transmitted within the network, the information is generally transmitted in a point-to-point transmission mode. In this type of network structure, all data information transmission nodes belong to an equal form. Compared with traditional cellular networks and local area networks, there is no need to set up a separate central control system, and each data node has corresponding mobile functions and Information forwarding function, etc. Under such a peer-to-peer network structure, if a single data node is damaged, it will not affect the entire network system, and at the same time, the damage resistance of the network structure itself can be enhanced.

During the operation of the Ad-Hoc network system, the data nodes in the network structure will be evenly distributed in the space structure, which shows a certain orderly law on the two-dimensional
plane, and each data node has a separate channel, High-efficiency transmission of data information, while marking data information nodes, such as transmission address, node information, etc., will increase the redundancy of the network topology in the process of information movement. For example, using the network system as the data information framework, such as when the data information inside the system is transmitted at the same frequency, the information transmission power will show a certain range at this time, but in this process, the data information transmission is a two-way transmission Mechanism, there will be a certain intersection between two adjacent data nodes, that is, the critical point formed by information transmission. If a certain data information node is V, the distance between its two nodes is called Euclidean distance under the fixed transmission power P, and the linear relationship can be expressed as \( \Theta_{ij} = \{V : D(v,v) \leq P \} \). When the information transmission shows a feedback phenomenon At this time, the link set presented by its network nodes spatializes the region and accurately links it to the network data nodes. The transmission path of its source node \( V_s \) and information transmission terminal node \( V_f \) is \( L = \{V_s \cdots V \cdots V_f \} \).

3.2. Route discovery
In the Ad-Hoc network structure, if you want to maximize the transmission of information (data transfer from the source node to the terminal node), the network system should cache the information and verify the information transmission path, such as in the network structure. When there is no corresponding data information transmission path, the system will issue a related protocol request to the route, search for data packets in the network structure, then check the available information transmission paths in the network structure, and integrate the relevant path information resources. To ensure that the information transmission path between the source node and the terminal node conforms to the communication protocol benchmark. In addition, the intermediate data nodes in the Ad-Hoc network structure, after receiving the information transmitted by the routing, will nest the available data packets and send the request protocol to another data node. The data information is transmitted until the data packet is accurately transmitted to the corresponding data node, so that the network system can realize accurate data transmission.

3.3. Data packet transmission
In the data packet transmission, the network node counts the data. When the source node sends out the related request protocol, it has a complete information transmission path. For example, after a certain node in the structure receives the data, the data in the structure, The previous transmission node is authenticated, and the path between the source node and the terminal transmission node is reconfirmed, and the data tag information of the node is cleared to ensure that the data information can show the initialized information after the next cycle of transmission. The next node is the initial point of information transmission and completes the information transmission.

Taking the optimized DSR routing technology as an example, when calculating the transmission path of an information node, it is necessary to replace the data packet transmission path of the node with the data node as the center, and then perform the replacement of the same path, which is the previous node transmission cycle. In this process, the data transmission path needs to be smaller than the number of data packets under the data network structure, and then the internal value is compressed. Relying on the binarization split method, the received content of the data information is integrated, and the intermediate node receives the corresponding. In the case of data information, the data transmission path will show a certain point of data set, and this process can represent the transmission path of the data packet between two nodes.

4. Random walk model construction

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The random walk model is to randomly select a certain document as the starting point, randomly walk all the documents, weight the walking routes according to the similarity of information characteristics, and complete the clustering after consulting all the documents. The random walk algorithm uses a unified definition of the data set, takes the given data set as a fixed number of discrete objects of nodes and edges, and converts the data clustering analysis problem into an undirected weighted graph to achieve the solution. First, map the data set into an undirected weighted graph G=(V,E), which is composed of the node \( v_i \in V \) of the data value and the boundary e \( \in E \) that represents the relationship between the data and its neighboring data. \( e_{ij} \) represents the edge connecting the two vertices \( v_i \) and \( v_j \), and each edge uses the weight \( w_{ij} \) to indicate the degree of similarity or difference between the two vertices. The degree of vertex v is defined as \( d_i = \sum w_{ij} \), which is equal to the sum of the weights of all edges associated with the node \( v_i \); secondly, k labeled points are set according to the nature of the data, and each unlabeled data node is assigned a k dimension Vector, to represent a random walk process from an unmarked point to all marked points. Third, each one-dimensional vector represents the probability of reaching k labeled points for the first time starting from each unmarked point, and the largest value among the k probabilities is the class label to which the unmarked point belongs. This method classifies similar data into one category, and realizes data clustering according to the differences between different categories.

The similarity of two text data X and Y can be expressed as formula (1) according to the Tanimoto coefficient:

\[
T(x, y) = \frac{x \ast y}{\|x\|^2 + \|y\|^2 - x \ast y} = \frac{\sum x_i y_j}{\sqrt{\sum x_i^2} \sqrt{\sum y_j^2} - \sum x_i y_j}
\]  
(1)

Among them, the similarity x and y of X and Y are represented by the ratio of the same keywords to the sum of all keywords. After normalization, the similarity is also used as the walking probability, that is, the walking process. Weight processing.

Under certain boundary conditions, the problem of solving the transition probability of random walk is similar to that of the joint Dirichlet problem. Therefore, this paper realizes the random walk algorithm solution by solving the solution of the joint Dirichlet problem. In the region \( \Omega \), given the function u that defines the document node, its Dirichlet integral form is equation (2):

\[
D[u] = \frac{1}{2} \int_{\Omega} \nabla u \cdot d\Omega
\]  
(2)

The probability of a random walk from a non-marked point to a marked point is equal to the Dirichlet function of the marked point under boundary conditions. The problem to be solved is to solve the Laplace function under certain boundary conditions. The parameters i and j are described, as shown in formula (3):

\[
\nabla^2 u = \frac{\partial^2 u}{\partial i^2} + \frac{\partial^2 u}{\partial j^2} = 0
\]  
(3)

The combined Laplacian matrix is defined in the map as equation (4):

\[
L_i = \begin{cases} 
  d_i & i = j \\
  -w_{ij} & \text{v}_i \text{ and } \text{v}_j \text{ are adjacent nodes} \\
  0 & \text{other}
\end{cases}
\]  
(4)
The value of Laplacian $L_{ij}$ is jointly determined by nodes $v_i$ and $v_j$. The matrix is a symmetric positive definite matrix that satisfies the boundary conditions. $d_i$ is the degree of node $v_i$, and $d_i = \sum_{j=1}^{n} w_{ij}$ is defined as the sum of all elements in the i-th row of w.

5. Research on optimization design of wireless network mobile communication data transmission performance

5.1. Data storage optimization
In view of the instability of wireless network mobile communication data transmission, the improvement of data transmission should be increased to provide a safe operating environment for users under the network system. From the perspective of data information transmission, storage capacity is the core carrier of the entire data information system transmission, and its storage performance directly determines the quality of data transmission. When optimizing the storage structure, an assimilation path should be established to optimize each information node in the network structure to ensure that a certain node transmission instruction can be correctly executed during the data information cache process, and the data information can be made. The transmission path meets the operating requirements of the network structure. By controlling and optimizing data nodes, the amount of information storage can be increased, and communication quality and communication efficiency can be improved.

![Figure 1. Data storage optimization architecture based on random walk model](image)

5.2. Transmission delay optimization
When optimizing the transmission delay, the current application of 5G communication technology greatly improves the response efficiency of data information in the transmission process, but because 5G communication technology is not fully popularized, for this reason, when optimizing and improving the wireless network, should reduce the data information transmission delay as the main body, in order to improve the quality of wireless network communication. In the actual optimization, taking into account the coupling effect produced by the data node and the hardware and software interfaces in the wireless network, if you want to ensure that the source data can be transmitted to the next node in real time at the network node to the greatest extent, you should deal with the middle of the data packet. The node is set, and the data information in the network structure is grouped. After the corresponding data parameters are measured, the next data node is optimized to reduce the response efficiency of the data information in the transmission process.
Figure 2. Transmission delay optimization based on random walk model

5.3. Optimization of total information control

The total amount of information control is mainly based on the main body of information transmission in the network structure, which represents the main control amount in the network operation. If the total amount of data information exceeds the established operating range during the processing process, it will indirectly reduce the data processing efficiency. When optimizing this kind of control process, it can be realized by the method of information compression, that is, compressing various transmission information, reducing the operating load of the network structure, and improving the operating efficiency of the network.

Figure 3. Optimization process of total information control
6. Conclusion
Based on the random walk model and relying on wireless network communication technology, this paper constructs a mobile communication data optimization scheme. Based on the frequency of abstract words as the clustering standard, the system enables data information to be transmitted at the same power in the form of multiple data processing, and is not restricted by space and time dimensions, greatly improving the quality of data transmission and providing a basis for safe network operation.

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