Crossover Covering Algorithm in Intelligent Space Design

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Abstract: With the progress of the times and the development of science and technology, more and more attention has been paid to intelligent space design. Taking office space as the main line, this paper studies the application of cross covering algorithm in intelligent space design. Firstly, the algorithm of cross covering is introduced briefly, then the node coding, node moving and cross are analyzed. Then, the paper validates the algorithm of cross covering in office space. Experimental results show that the coverage rate of the crossover algorithm can reach 97.4%.

Keywords: Intelligent Space Design; Cross Coverage, Node Coding, Node Moving Mode

1. Introduction

With the continuous development of economic society, the design of intelligent space has become a hot issue. From the macro level, intelligent space design is one of the important means to solve the contradiction between human and environment, and can effectively improve people's quality of life and work efficiency.

At present, many scholars at home and abroad have made research on intelligent space, mainly including Zhao Yan, who introduces the innovative application of intelligent space cloud data technology in science laboratory, library and other fields in detail, and looks forward to the future development in order to provide reference for the research on intelligent space cloud data technology [1]. Qin Kun proposed a research framework for intelligent spatial information processing and spatiotemporal analysis, and reviewed the related research. At the same time, the theory, method and application of intelligent spatial information processing and space-time analysis are summarized, and the further research direction is pointed out [2]. By comparing and investigating the development of intelligent space systems in China in these three directions, Wang Dan put forward the scientific problems existing in the current development of intelligent space systems, and formed an analysis of the development trend of key technologies of intelligent space systems in the future [3]. But these researches mainly aim at specific intelligent space, and do not consider the general problem of intelligent space design.

In this paper, the crossover covering algorithm is studied in order to study the intelligent space design from another angle. This paper analyzes and studies the office

ICSETPSD 2023, November 17-18, Coimbatore, India

DOI 10.4108/eai.17-11-2023.2342837

space. First, it expounds the current situation of intelligent space design, and then analyzes the problems in intelligent space design. Finally, a new crossover cover algorithm is proposed by improving the crossover cover algorithm.

2. Cross-covering Algorithm

Crossover Coverage Algorithm (CCA) is a node deployment algorithm for wireless sensor networks. During node deployment, it converts the original isolated WSN into a connected mesh structure by increasing the communication distance between adjacent nodes. In the crossover algorithm, the communication distance between adjacent nodes is determined by network coding. Different coding methods can form different network topologies [4-5]. In article, the cross-coverage algorithm is implemented by improving the coding mode of nodes. At the same time, use formula (1) (2) to assist.

$$F(k_i, b_j) = \frac{nQ(k_i, b_j)Q(\hat{k}_i, \hat{b}_j)}{Q(k_i)Q(b_j)} \tag{1}$$

$$f(k_i, b_j) = \frac{\sqrt{n}Q(k_i, b_j)Q(\hat{k}_i, \hat{b}_j)}{\sqrt{Q(k_i)Q(b_j)}} \tag{2}$$

In formula (1) and (2), n represents the correlation coefficient.

Because the distance between nodes is the main consideration of network coding, and the distance between nodes in wireless sensor networks is mainly affected by power and channel conditions. The communication distance between node 1 and node 2 is determined by its numbers 1 and 2, so numbers 1 and 2 are unique. According to the encoding rules, each node is encoded as 0x1B [6]. When there are more than one adjacent nodes, the communication distance between adjacent nodes can be determined by coding because there are more than one coding value between adjacent nodes. So we can judge whether the communication distance between neighboring nodes satisfies the requirement of distance coding rules by the network topology corresponding to different coding modes.

First, during node deployment, it is assumed that each node has a number that uniquely identifies the communication distance between adjacent nodes. During deployment, the communication distance between adjacent nodes is increased to the maximum, then the distance is spread outwards, and the communication distance between adjacent nodes is increased to the next number. In order to make the partition result more pertinent and accurate, it is necessary to classify the neighboring nodes with the same number in the partition process. At the same time, because each node has only one number when it is initialized, the communication distance between adjacent nodes can be increased by adjusting the network topology. In the crossover algorithm, each newly added node has two numbers. For each class of adjacent nodes with the same number, they are considered different subclasses of the same class [7]. Therefore, the communication distance between them can be increased by adjusting the communication distance between them.

In order to verify the effectiveness of the cross covering algorithm, experiments are carried out on PC. In the simulation experiment, the node number is 1 ~ 200, which simulates 5 offices with different sizes. In each office, an employee was randomly selected for the study, and set the position of the employee to 1 to 200. In the simulation experiment, dynamic coding is used to increase the communication distance between neighboring nodes in order to avoid the change of the network topology caused by the movement of an employee. Based on the above experimental results, we can see that the cross-covering algorithm makes better use of network resources than the traditional algorithm under the designed network topology. At the same time, in some special cases, such as the space environment such as office and school laboratory, the cross covering algorithm has better adaptability to the network topology [8]. In this paper, the performance comparison of the two different coding methods is studied. According to the simulation results, the network topology is more reasonable when the improved cross-covering algorithm is used.

3. Application of Cross Coverage in Office Space

In the traditional office space, people often judge whether the office environment is comfortable by their own body feeling, but this feeling cannot make people feel very accurate. This judgment is based on some physiological reactions such as temperature and humidity. Therefore, when the office space design, it should take into account the human physiological response, combined with artificial environment to create a suitable space for human work. However, this approach imposes significant requirements on the human body, such as the need to ensure that obstacles or other objects are not present within the person's line of sight [9-10]. In this case, the cross covering algorithm can help solve this problem.

When designing an office space, it is necessary to ensure that obstacles or other objects do not appear within sight. In this process, the cross-overlay algorithm can provide a more appropriate solution. According to the cross-cover algorithm, each node can be assigned to a coordinate point with a minimum distance of d (x) from its own coordinates, and each path is connected to other nodes. This ensures that all nodes are fully utilized. Compared with the traditional method, this method can show the superiority of the cross covering algorithm [11].

3.1 Design Scheme

The cross-overlay algorithm is designed as follows:

When designing the crossover algorithm, we need to locate the nodes in the office space. Generally speaking, the space structure of the office is complex, and there is no guarantee that the distance between each node and the coordinate axis is the same. Cross-covering algorithm can make up for this shortcoming. In the crossover algorithm, each node is connected to other nodes so that each node can be fully utilized. In addition, because there are many objects in the office, including tables, chairs, walls and so on. The existence of these objects has caused certain obstacles. When these obstacles are removed, the task can be successfully completed [12-13].

When designing the office space, we should first consider that every node in the office has a certain distance from the coordinate axis. This distance must be in line with the human body's own physiological response, that is, people cannot appear in the line of sight of obstacles or other objects. So we can use the cross overlay algorithm to work. Specifically, the first step is to determine the distance between the cross node and the axis. These nodes are then positioned to minimize their distance from the axis. Finally, the cross nodes select the appropriate nodes to connect them, so as to complete the task. When all nodes in the office space are located, they can be connected using a cross-overlay algorithm [14-15].

3.2 Design Process

In the crossover algorithm, the position of the node is not fixed, but determined by the minimum distance between the node and the local coordinate. At the same time, the crossover node needs to be connected to other nodes so that they can proceed to the next operation. Only in this way can the selected nodes meet the needs of users and achieve their design purposes. In the crossover algorithm, the first step is to initialize the user and assign it to a coordinate with a minimum distance of d (x) from the local coordinates. Next, it needs to determine the distance d (x) between the user and the node. In this process, two methods can be used for determination: the first method is to solve d (x) directly and the second method is to compare d (x) with node coordinates. The minimum distance between the two can be used to determine the crossing node and the distance between nodes d (x). In this process, d (x) can be solved using the shortest path algorithm. Through the shortest path algorithm can make the user in the shortest possible time to reach their desired place.

4. Indicators of Observation

In the study of crossover algorithm in intelligent space design, the following observation indicator can be used: Coverage: measure the coverage of crossover algorithm in space. It can be the coverage of the entire space or the coverage of a specific area. Signal Strength: indicates the signal strength of each position in the intelligent space, indicating whether the crossover algorithm can provide sufficient signal strength coverage. Data Transfer Efficiency: indicates the rate of data transfer at each location in the smart space, indicating whether the crossover algorithm can provide adequate data transfer performance. Interference: measure the degree of interference from cross-coverage algorithms to other devices or signals. Low interference level can improve communication quality and performance. Delay: indicates the time delay between sending and receiving data. Low latency is critical for real-time applications such as video transmissions and interactive games. Energy Consumption: measure the energy consumption of cross-coverage algorithms in smart space. Lower power consumption can extend the battery life of the device. Reliability: indicates whether the service provided by the cross-coverage algorithm is reliable and can maintain stable performance under various environmental conditions. Cost-effectiveness: assess the economics and benefits of cross-coverage algorithms, including equipment costs, network construction costs and maintenance costs. These observations can help researchers evaluate and compare the effectiveness and performance of different cross-coverage algorithms in intelligent space design.

5. Research and Experiment of Cross Covering Algorithm in Intelligent Space Design

This paper selects three of the above eight observational indicators, namely, coverage (Figure 1), transmission speed (Figure 2) and delay (Figure 3), and conducts research experiments by comparing them with traditional algorithms.

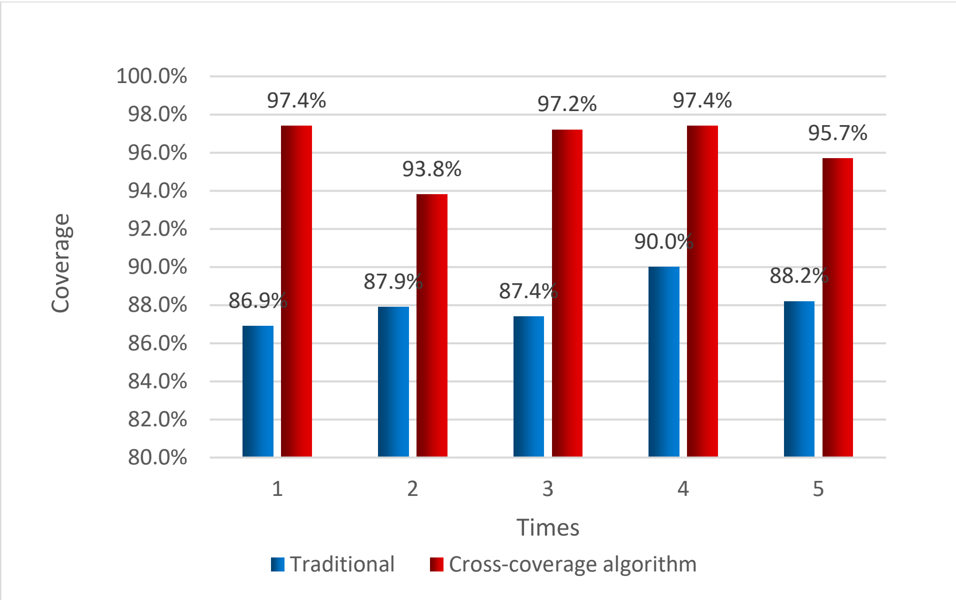

Fig.1 Coverage

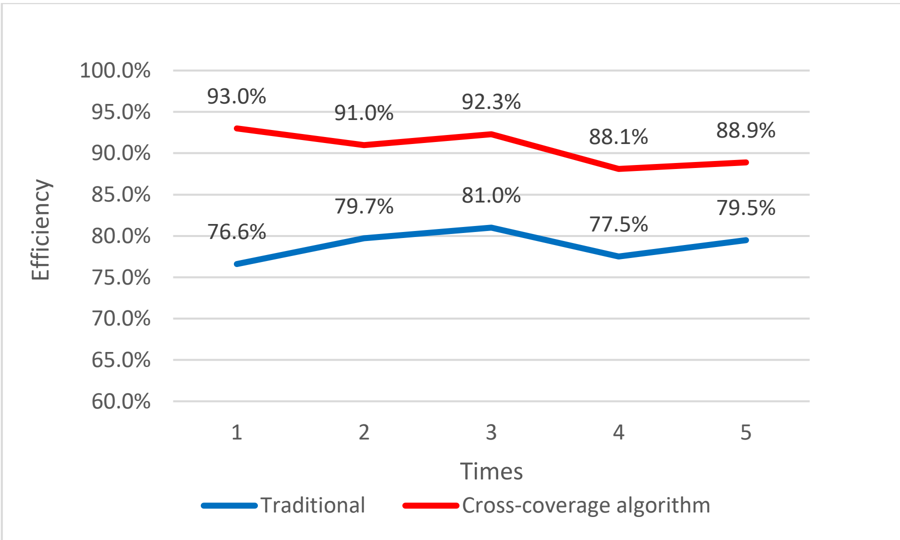

Fig.2 Transmission efficiency

As can be seen from Figure 1, the coverage under the traditional algorithm is up to 90 per cent and 86.9 per cent, and the calculated average coverage is 88.08 per cent; the coverage under the cross-coverage algorithm is up to 97.4 per cent and the calculated average coverage is 93.8 per cent. Therefore, the crossover coverage algorithm in intelligent space design has higher coverage rate.

As can be seen from Figure 2, the transmission efficiency under the traditional algorithm is highest at 81 per cent and lowest at 76.6 per cent, and the calculated average transmission efficiency is 78.86 per cent; the transmission efficiency under the cross-overlay algorithm is highest at 93 per cent, lowest at 88.1 per cent, and calculated average transmission efficiency is 90.66 per cent. Therefore, the crossover covering algorithm in intelligent space design has higher data transmission efficiency.

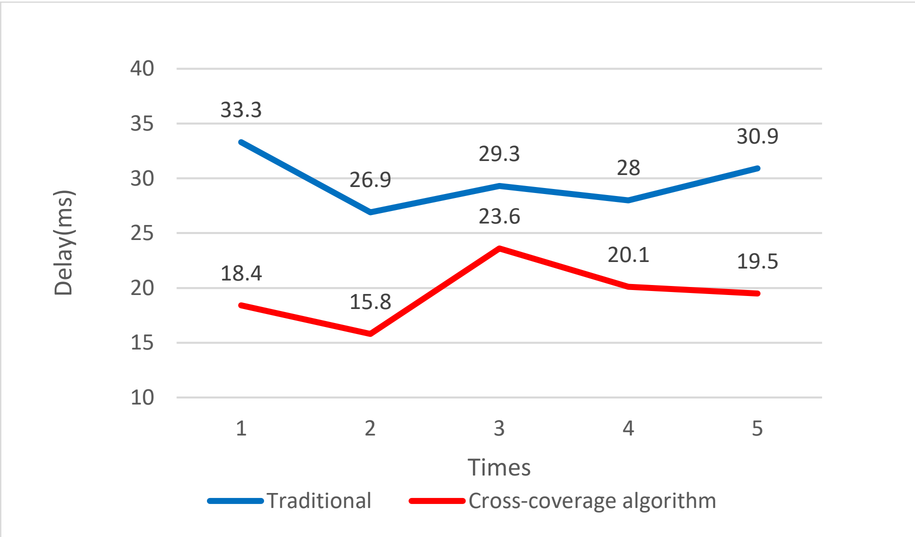

Fig.3 Delay

As can be seen from Figure 3, the data latency under the traditional algorithm is 26.9 ms and 33.3 ms respectively, and the calculated average latency is 29.68 ms; the data latency under the cross-overlay algorithm is 15.8 ms and 23.6 ms respectively, and the calculated average latency is 19.48 ms. Therefore, the crossover covering algorithm in intelligent space design has lower data delay. Finally, a questionnaire is designed based on the designed intelligent space. The results are shown in Table 1.

Table 1. Questionnaire

	Very poor	Poor	General	Good	Very good
Coverage	3%	10%	39%	26%	22%
Efficiency	7%	8%	35%	26%	24%
Delay	7%	5%	37%	30%	21%

As can be seen from Table 1, the proportion of the "good" or above evaluations of the three indicators is about 50%, and the "bad" or below evaluations account for less than 20%. Therefore, it can be determined that the cross-covering algorithm in intelligent space design has a good practical application effect.

The article proves the effectiveness of the cross-covering algorithm in intelligent space design through experiments, and draws a conclusion through the article experiments: The cross-coverage algorithm optimizes the network performance while keeping the network coverage constant, and the cross-coverage algorithm can also be used to solve other types of network coverage problems.

Aiming at the problem of network performance optimization, a number of algorithms for network performance optimization have been proposed. The nodal broadcast algorithm solves the problem of redundant nodes by adjusting the distance and position between nodes, and the nodal broadcast algorithm has strong scalability. However, for the optimization of network performance, the node-broadcast algorithm can not achieve the desired results, because it is only based on the original network to adjust, it can achieve the effect of many factors. For example, the node moving speed, node itself, environmental factors and so on. In order to further study the application of node broadcast algorithm in intelligent space design, a new network performance optimization method, cross covering algorithm based on dynamic programming, is proposed.

Cross-covering algorithm is a method based on dynamic programming theory and genetic algorithm. This method utilizes the mutual restriction, mutual influence and adjustable characteristics of genes in genetic algorithm, and combines genetic algorithm with particle swarm optimization to optimize network performance. Specifically, firstly, the nodes in the network are searched by genetic algorithm and particle swarm, and after the trajectory of the nodes in the network is determined, then the cross-covering algorithm is used to search all the nodes in the network to minimize the moving distance of the nodes and find the optimal solution . Through the experiment of the article, it can be seen that the cross-covering algorithm has a better optimization effect than the node broadcasting algorithm. First of all, the cross-covering algorithm has higher computing efficiency than the node broadcasting method in terms of computing power.

6. Conclusions

The article mainly studies the application of cross-covering algorithm in intelligent space design. Firstly, this paper briefly introduces the cross-covering algorithm, then analyzes the node code, node moving mode and crossing mode in the algorithm, then takes the office space as an example to verify the cross-covering algorithm, and finally looks forward to the cross-covering algorithm from the perspective of intelligent space design. Through the research of the article, it can be seen that the cross-covering algorithm has a good application prospect in intelligent space design, but due to the complexity of the cross-covering algorithm itself, it needs to be continuously improved in future research.

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