A Nodal Arranging and Covering Algorithm Based on the Energy of Multi Sensors

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***Abstract*-The main research in this article is wireless sensor network design problem about radar engineering vehicle. The core of the research in the text relates to a multi-sensor energy nodes arrangement based and covering algorithm. Firstly, Sensor nodes arrangements and coverage area was descript in this text. Then, we propose the solving algorithm for the maximum disjoint sets of mutually exclusive problem. The example analysis show that if N is the cardinality of mutually exclusive set, the network can continue to extend the N time times. This gives a reference for the random arrangement of uneven distribution condition sensor node position.**

Keywords-sensor network; node layout; multi-sensor; random distribution

I. INTRODUCTION

The development of wireless sensor networks which provides an effective means to radically solve artificial weather signal transmission, data analysis and intelligence warning. The core of wireless sensor network is developing a wireless sensor routing protocols. The routing protocol of wireless sensor has been a hot topic in this direction, because the first is WSN's routing protocols should not be the copy of other routing protocols various which existing now but is a whole new protocol for WSN characteristics; the second is the performance of routing protocol will affect the final application results from many aspects [1-2].

The capacity of battery used in sensor nodes is mostly limited, then, that requires the use of battery power effectively to ensure the longevity of sensor networks. In the case of conventional sensor network protocol, to remedy this situation is generally determined to increase the number of nodes. Only the active node uses the power, and conducted a series of other unwanted activity node switch off electricity to save energy. But it is not feasible to the reliability requirements of emergency rescue system[3]. For this reason, based on heuristic algorithms, this paper presents a selection mutually exclusive rule, which can be used to achieve the target detection of full-network sensors coverage[4]. This method can achieve the node configuration strategy to the target or the detection areas, ultimately achieve the optimal allocation method further control energy. By obtaining the maximum cardinal number of set of mutually exclusive, that can better extend the life of the network and enables the configuration optimization [5-6].

In order to getting the life of the sensor network, this paper especially defines the maintained time of the sensor network that is the first time which the network can't cover all the objectives or specific area[7]. Since the organization sensor network nodes into mutually exclusive groups, each group can completely cover the target, so that the life of the sensor network can be extended. As long as there is a group at any time and corresponding activities or can be taken off the sensor nodes so that the network can be maintained for longer life cycles.

II. SENSOR NODES ARRANGEMENTS AND COVERAGE AREA DESCRIPTION

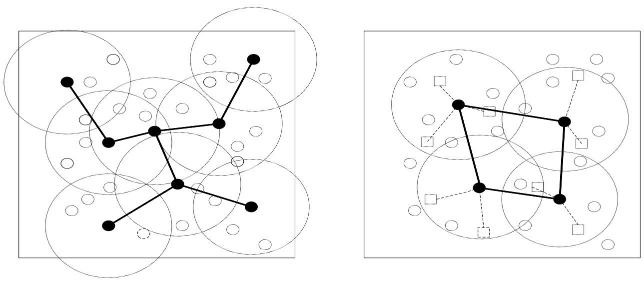
A group sensor nodes covering with randomly arranged can be shown in Figure 1, In the figure it is specified a coverage area of a square, a circle represents a node disposed corresponding to each sensor coverage area; Corresponding to a coverage group node that composed by random arrangement of sensor nodes (Square node) as shown in Figure 2.Each node in the illustrated request by at least one sensor node sensing covered to obtain information, thereby obtaining a set of sensors connected to each structure (black nodes)[8].In this paper, the conventional processing method is used, which the probability that the detection of the target sensor from the different direction is the same and the opportunity that found the sensing target from different directions are also same. In this paper, a circular area to represent the range of detection, but it is not limited to a circular area. As long as it is not within the sensor coverage, this article will consider it as a connected supply coverage problems[9]. To this end, the area where the first mathematical description of the form of defined coverage issues:

Given a monitored area A and a group of sensor nodes S, the nodes are divided into mutually exclusive subsets of the sensor $C_i = \{s_{i1}, s_{i2}, \cdots\cdots, s_{im},\}$,

$i = 1, 2, \cdots\cdots, n$, where a subset C_i and a coverage area A, and the total number of subsets is maximized.

In order to solve the coverage problem, this problem is transformed into solving the problem fixed node coverage area in the specific implementation process. Firstly, the area A is divided into a set of domains $\{a_1, a_2, \cdots\cdots, a_m,\}$, then the perception of the target area of each mutually exclusive can be regarded as arranged in a separate location.

The model consisted by anthropogenic influences weather radar vehicle communications system includes a considerable number of nodes which be remotely arranged; and includes a system which consisted by central data collection nodes. When the sensor information data are obtained, these data will experience encapsulation process and technology encryption by wireless sensor network element or a central node and at the last that will be transferred into system. At the same time, all type sensors have positioning capability (such as GPS function).



(a) Regional coverage (b) Fixed point coverage

FIGURE I. THE DESCRIPTION ILLUSTRATION OF NODE COVERAGE AREA.

Because the configuration in the Quantity field sensor is typically more than the optimum number of the sensor is configured, so there is need an effective way to achieve energy scheduling activities to ensure a smooth transition of sensor nodes in the active state and a low-power states. The realization of ideas of this method proposed in this model as following: First, the area of the sensor component is divided into disjoint subsets which each group can independently perform the required tasks, and then wake up each sub-set can transfer to a round robin manner. Then only a small portion of the active node is active, other nodes are in a sleep state; that will increase the survival time of power control, with the increasing of the number of awakening subsets. Therefore, the purpose of this method is to find the maximum number of subset, and then determine the degree of energy dissipation. In the specific implementation process, the system sensor is divided into disjoint dominating set and every advantage sets can be repeated to cover different areas[10]. If you just open a set of mutually exclusive node information at any time, you can get the consumption of less energy at the cost of less energy, also helps to improve the life time limit of sensor network, which is the core of the exclusion set covering algorithm; therefore, the algorithm for solving can be constructed corresponding to the maximum disjoint exclusive sets.

III. SOLVING ALGORITHM FOR THE MAXIMUM DISJOINT SETS OF MUTUALLY EXCLUSIVE PROBLEM

The structure diagram shown in Figure 4.6, suppose given a set of sensor nodes S and the sensing range r to form an undirected graph $G=(V,E)$, its meaning for each sensor to create a point, only when the interaction of s_i and s_j within each other's perception and there will be an edge between s_i and s_j.With the assumption that the sensing range of each sensor is same, the derived graph G is an undirected graph, in particular to a unit disk graph. Furthermore, if sensor nodes have different sensing range were required, you can put the undirected graph for the further development of the directed graph. So only when the A covered B there will only exists a directed edge (v_i, v_j).

Therefore, the problem solving for disjoint set of mutually exclusive advantage as following:

Set the dominant set is a subset of $V' \subseteq V$, each member of V is belongs to V' and is connected to a specific node of V'. When $V_i \cap V_j = \varnothing$, two mutually exclusive advantage sets V_i and V_i is not intersect.

At the same time, in the process of solving the max impaled is joint sets of mutually exclusive advantage in the figure $G=(V,E)$, this paper uses the polynomial time algorithm. The algorithm will be divided into two stages, the first is using sequence colorization algorithm to color all vertex of G; then based on this color, which further search in the area of disjoint set of mutually exclusive advantage.

First State algorithm Flow:

Step 1: Given all vertices of a sequence

Step 2: Given an order of a sequence, there is beginning to color every vertex sequentially until it does not appear the smallest possible color from its adjacent vertices.

Using colorization algorithm to color the serial, each Figure G has up to $\Delta(G)+1$ colors; Regardless of the order of the selected vertices, where $\Delta(G)$ represents the maximum vertex degree of G.

Theorem: the colorization algorithm was used to generate the color, when every vertex with $i>1$ color, there is connected to an adjacent nodes with i>1color, which is $\forall j<i$.

Proof: There must exist $k<i$ and no neighboring vertices V with k color by using the contradictory assumption. The coloring process of Step 2) can be got that vertex v can

be only assigned k color. That is Contradiction with the above hypothesis.

Thus there is an inference that all vertices with 1color form an advantage set.

From the above theorem, you can conclude that all vertexes with >1 color have at least one neighbor with $=1$color.

In order to combine the practical software needs and improve the computational efficiency, this paper uses a new way to calculate the large number of disjoint sets of mutually exclusive advantages, specific as follows 2 stage process of algorithm. Detailed algorithm process is as follows.

Stage 2 algorithm process:

Step 1: Regarding to $G=(V,E)$, taking apex depression as the criterion, uses the form of table to sort the apex.

Step 2: Calculation of vertex color, using the algorithm flow in stage 1.

Step 3: Set all same color vertexes to $D_1 =$ and the initial value is k=1.

Simultaneously $colors$ is the number of color used by in stage 1 in $\max = \min imum(d+1, colors)$ formula. The number of colors is same as the number ofneighboring side and d is the smallest apex in Figure G.

Step 4: $while \quad k < \max$; the all colors in $D_{k+1} =$ are the number of vertexes in $k+1$.

Step 5: Using recursive language for each color i =1, ...k,inspects each color i from B Apex.If only the vertex v is not been colored by $k+1$, this case should be distinguished: 1) IF vertex v has a neighbor which its color is more than $k+1$, then the maximum color should be selected and colored with $k+1$. 2) If vertex v has no neighbor which color is more than $k+1$, that should be turn to step 9 and exist loop.

Step 6: end for

Step 7: k++

Step 8: end while

Step 9: return k and the set of disjoint advantage: D1 ，D2，……，Dk

Step 10: end

According to the above algorithm processes, the set of maximum disjoint exclusive advantage has a limit of $d+1$ and d is the minimum vertex degree of G.

The proposed algorithm initial uses in the first stage 1 to finish the each vertex color content; then consider starting from minimum color loop through the query, find a color has the same vertex set and to making judgments about whether it will form a set of advantages.

After obtaining a judgment requiring inspection of small colored vertex, the main objective is to discover whether the advantage is taken up by existing set D_{k+1} (step 5 above). If D_{k+1} is not more advantage than vertex v (to get the color value), I looked for which one does not belong to a neighbor of $D_1, D_2, \cdots\cdots, D_k$, and put it into $k+1$, at the last, recolor it.

In the above algorithm process, if can't find the desired neighbor u, it means that in this case D_{k+1} construction fails, the algorithm needs to set the process back to the k advantage. Needs to pay attention specially, if this time apex v has not been occupied by D_{k+1} the superiority, then in the entire process, it will be impossible to been color by any $D_i\,(i > k+1)$.

If further considering the subsequent monitoring control application, then the coloring process for all vertices in the construction of dominant set, all vertices are should be an important part of the superior set. When using the algorithms at the stage 2 to analyze, there may have only one remaining vertices, then at this point will not be forming another new set of advantages. In fact, for such vertices can be joined by other algorithms to make its have the advantage of concentration, specific algorithm including: 1) check the remaining vertices on the scheduled but not yet fully covered area of contribution degree, according to the size of contribution degree of decision placed in the dominant set. 2) Taking into account its neighbor nodes of the benefits of the level of convenience, the minimum number of vertices of the benefits.

IV. EXAMPLE ANALYSIS

This section will evaluate the performance advantages of disjoint collection algorithm by analyzing examples. The use of simulation object is a static network; sensor nodes are randomly distributed among the area's range is 1000m * 1000m region. Assume that all sensors in the transmission network are equal. For the small network, a plurality of search algorithm and the method are listed in Table 1, in order to obtain the best performance results.

TABLE I. NODES RANDOMLY DEPLOYED NETWORK DISJOINT DOMINATING SET NUMBER.

Transmission range/ m	Group lift value	Calculated value
200	2	2
400	3	3
600	4	4
800	4	4
1000	5	4
1200	5	5
1400	6	5
1600	6	6
1800	6	6
2000	7	7
2200	7	7

In table 1, changing the sensor nodes, you can achieve transmission ranges from 200m to 2200m. In the figure, the minimum figure is found in the most significant advantage of the interactive exclusive sets $+1$, which is an upper limit, because each node has the maximum edge $\Delta(G)+1$ which does not intersect the collection. It can be seen that the actual number of disjoint will increase with increasing connectivity graph. This is because the minimum annual increased, and each edge settings require less nodes. For this small number of nodes, the difference of the best optimization methods and the way this paper presented is very small.

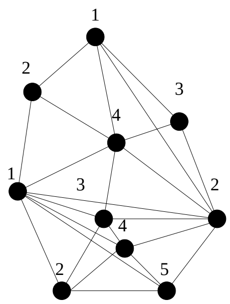


FIGURE II. THE SETTLEMENT RESULTS FOR STEP 2.

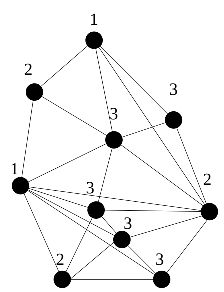


FIGURE III. THE OUTPUT OF THREE DISJOINT DOMINATING SET.

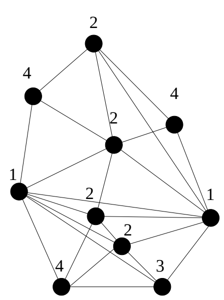


FIGURE IV. A GROUP OF MAXIMUM DISJOINT DOMINATING SET ALGORITHM FOR SOLVING THE.

V. CONCLUSION

Figure 2 to figure 4 shows a 10 node to realize the layout of the test result signal, transmission range is 2000 meters.

Figure 2 is a graph coloring obtained by step 2 in the process through the implementation of phase 2 algorithms, using 5 colors, from 1 mark to 5.

Figure 3 is the output of three disjoint dominating set in the stage 2 algorithm processes.

Figure 4 is just four disjoint exclusive advantage sets which obtained by traverse all combinations and exhaustive search. In figure 2 and figure 3, shown in figure for the number of nodes in the same color together belongs to a set of disjoint incompatible advantages.

The results showed that: in this paper, a multi sensor node energy arrangement and covering algorithm, this algorithm can solve the problem of sensor configuration in a small range. If provides the basis for all subsequent target coverage algorithm, this paper also gives the effective example analysis.

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