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IMPACT OF BOUNDARY EFFECT ON COVERAGE FRACTION IN WIRELESS SENSOR NETWORK

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Abstract: The length of a network is the significant issue in wireless sensor network (WSN).This issue can be explained by watching the less number of the knob vivacious at the specific time. The sensors from the dynamic sets are checking all objectives and at risk to transmit the information to the base station and remaining hubs are in rest mode. This paper discusses several relevant algorithms - Modified K-Means, PSO algorithmand AOMDV utilized as a part of wireless sensor networks.The Modified K-Means is utilized to coverage the area, AOMDV used for multipath routing and PSO is utilized to locate the optimal path.

Keywords: wireless sensor networks, information, algorithm, development

1. INTRODUCTION

Recent years have seen huge advancement in wireless sensor networks due to reduction in development costs and spontaneity in hardware manufacturing. Past two to three decades have been marked with quick use of wireless sensor networks in an assortment of fields. Now wireless sensor networks are used in military shadowing, habitat monitoring, seismic activity surveillance and in indoor applications. These wireless sensors have provided us tool to monitor an area of interest remotely. All one is supposed to do deploy these sensors, aerially or manually, and then these sensors which form the junctions of the network gather information from the area under investigation.

The information thus obtained is transfer back to the "main server" or "base station" where the information is processed. The base server is sometimes connected to Internet which then relays the organized information via satellite to the main station or control center for further processing and analysis. Very little or no processing is done while data is transferred from junctions.

Sensor junctions who compose the wireless network are autonomous junctions with a microcontroller, one or more sensors, a transceiver, actuators and a battery for power supply. These junctions, sometimes also referred motes. These sensors have very little memory and perform little amount of processing with the data obtained. Now apart from monitoring, collecting and transmitting data from one junction to another and to the base station moreover the processing unit regulates and controls functionality of other components of the sensor junction.. Nevertheless the memory operation is an overhead too. This is because the sensors are provided with a battery which often is non-replaceable. Thus increase in processing would implicit more energy is being consumed and hence sensor lifetime would decrease thereby affecting the lifetime of the network. As mentioned earlier the relaying of data is done by following a certain transmission protocol. However this facility is achieved by the transmission unit of the sensor. Usually the sensor has a transceiver that can act as both transmitter and a receiver.

The transmitter and the receiver hardware both are not kept separate in order to save space and energy. These days, sensors can communicate through transmission media ranging from huge electromagnetic spectrum.

A wireless sensor network is to be found in one of the two ways: intended and unintended. In the planned method of deployment a specific number of sensors are placed in strategic points in predetermined manner.

Here it should be noted that the area to be monitored can be accessed physically, thus the cost is not a factor under such conditions. These junctions are placed using a predetermined algorithm such that the area to be covered is maximized placing less overhead on transmission and battery thereby increasing the network lifetime.

The wireless sensor network countenance various issues one of which includes coverage of the given area under limited energy. This problem of maximizing the network lifetime while following the coverage and energy parameters or limitation is known as the Target Coverage Problem in Wireless Sensor Networks.

As the sensor junctions are battery driven so they have limited energy too and hence the main challenge becomes maximizing the coverage area and also protecting a prolonged network lifetime. The work has been done to address this problem but mainly as the challenge by default contain time constraint; hence the problem becomes time dependent, which in turn is non-polynomial in nature. Now even non-linear problems belong to the NP-Hard class thus only a few heuristics have been suggested to address the Target Coverage Problem if not in optimal, then near optimal or suboptimal time. One of such algorithm is discusses in further section which is used as a baseline against our proposed algorithm.

2. MODIFIED K-MEANS

This paper presents a data clustering approach using modified K-Means algorithm based on the improvement of the sensitivity of initial center of clusters. This algorithm partitions the whole space into different segments and calculates the frequency of data point in each segment. The segment which shows maximum frequency of data point will have the maximum probability to contain the centroid of cluster. The number of cluster's centroid (k) will be provided by the user in the same manner like the traditional K-mean algorithm and the number of division will be k*k (`k' vertically as well as `k' horizontally). If the highest frequency of data point is same in different segments and the upper bound of segment crosses the threshold `k' then merging of different segments become mandatory and then take the highest k segment for calculating the initial centroid of clusters. In this paper we also define a threshold distance for each cluster's centroid to compare the distance between data point and cluster's centroid with this threshold distance through which we can minimize the computational effort during calculation of distance between data point and cluster's centroid. It is shown that how the modified k-mean algorithm will decrease the complexity & the effort of numerical calculation, maintaining the easiness of implementing the k-mean algorithm. It assigns the data point to their appropriate class or cluster more effectively.

We have presented a modified k-means algorithm which eliminates the problem of generation of empty clusters (with some exceptions). Here, the basic structure of the original k-means is preserved along with all its necessary characteristics. A new center vector computation strategy enables us to redefine the clustering process and to reach our goal. The modified algorithm is found to work very satisfactorily, with some conditional exceptions which are very rare in practice.

Modified approach K-mean algorithm:

The K-mean algorithm is a popular clustering algorithm and has its application in data mining, image segmentation, bioinformatics and many other fields. This algorithm works well with small datasets. In this paper we proposed an algorithm that works well with large datasets. Modified k-mean algorithm avoids getting into locally optimal solution in some degree, and reduces the adoption of cluster -error criterion.

Algorithm: Modified approach (S, k), S={x1,x2,…,xn }

Input: The number of clusters k1 (k1> k) and a dataset containing n objects(Xij+).

Output: A set of k clusters (Cij) that minimize the Cluster -error criterion.

Algorithm

1. Compute the distance between each data point and all other data- points in the set D

2. Find the closest pair of data points from the set D and form a data-point set Am (1<= p <= k+1) which contains these two data- points, Delete these two data points from the set D

3. Find the data point in D that is closest to the data point set Ap, Add it to Ap and delete it from D

4. Repeat step 4 until the number of data points in Am reaches (n/k)

5. If p<k+1, then p = p+1, find another pair of data points from D between which the distance is the shortest, form another data-point set Ap and delete them from D, Go to step 4.

3. PSO ALGORITHM

Particle swarm optimization was introduced by Kennedy and Eberhart (1995). It has roots in the simulation of social behaviors using tools and ideas taken from computer graphics and social psychology research.

The goal of the algorithm is to have all the particles locate the optima in a multi-dimensional hyper-volume. This is achieved by assigning initially random positions to all particles in the space and small initial random velocities. The algorithm is executed like a simulation, advancing the position of each particle in turn based on its velocity, the best known global position in the problem space and the best position known to a particle. The objective function is sampled after each position update. Over time, through a combination of exploration and exploitation of known good positions in the search space, the particles cluster or converge together around optima, or several optima.

3.1. Algorithm Outline

The particle swarm algorithm begins by creating the initial particles, and assigning them initial velocities.

- It evaluates the objective function at each particle location, and determines the best (lowest) function value and the best location.
- It chooses new velocities, based on the current velocity, the particles' individual best locations, and the best locations of their neighbors.
- It then iteratively updates the particle locations (the new location is the old one plus the velocity, modified to keep particles within bounds), velocities, and neighbors.
- Iterations proceed until the algorithm reaches a stopping criterion.

3.2. The algorithm

As stated before, PSO simulates the behaviours of bird flocking. Suppose the following scenario: a group of birds are randomly searching food in an area. There is only one piece of food in the area being searched. All the birds do not know where the food is. But they know how far the food is in each iteration. So what's the best strategy to find the food? The effective one is to follow the bird which is nearest to the food.

PSO learned from the scenario and used it to solve the optimization problems. In PSO, each single solution is a "bird" in the search space. We call it "particle". All of particles have fitness values which are evaluated by the fitness function to be optimized, and have velocities which direct the flying of the particles. The particles fly through the problem space by following the current optimum particles.

PSO is initialized with a group of random particles (solutions) and then searches for optima by updating generations. In every iteration, each particle is updated by following two "best" values. The first one is the best solution (fitness) it has achieved so far. (The fitness value is also stored.) This value is called pbest. Another "best" value that is tracked by the particle swarm optimizer is the best value, obtained so far by any particle in the population. This best value is a global best and called gbest. When a particle takes part of the population as its topological neighbors, the best value is a local best and is called lbest.

The pseudo code of the PSO is as follows

```
for each particle
    Initialize particle
END

Do

    For each particle
        Calculate fitness value
        If the fitness value is better than the best fitness value (pBest) in history
set current value as the new pBest
    End
    Choose the particle with the best fitness value of all the particles as the gBest
    For each particle
        Calculate particle velocity according equation (a)
        Update particle position according equation (b)
    End

While maximum iterations or minimum error criteria is not attained
```

Particles' velocities on each dimension are clamped to a maximum velocity Vmax. If the sum of accelerations would cause the velocity on that dimension to exceed Vmax, which is a parameter specified by the user. Then the velocity on that dimension is limited to Vmax.

4. RELATED WORK

SunanditaDebnath, Ashraf Hossain [1], Sensing coverage or coverage fraction is a critical performance merits of the quality of service (QoS) offered by a Wireless sensor network (WSN). The coverage performance of a sensor network strongly depends on how efficiently the nodes are deployed in the field of interest. Boundary effect plays a significant role on the node deployment planning. In this paper, we investigate the impact of boundary effect on network coverage fraction for probabilistic sensing model. Furthermore, we have studied how the multiple deployment schemes enhance the network coverage.

Ashraf HossainRashmita Mishra [2], Coverage and connectivity both are important in wireless sensor network (WSN). Coverage means how well an area of interest is being monitored by the deployed network. It depends on sensing model that has been used to design the network model. Connectivity ensures the establishment of a wireless link between two nodes. A link model studies the connectivity between two nodes. The probability of establishing a wireless link between two nodes is a probabilistic phenomenon. The connectivity between two nodes plays an important role in the determination of network connectivity. In this paper, we investigate the impact of sensing model of nodes on the network coverage. Also, we investigate the dependency of the connectivity and coverage on the shadow fading parameters. It has been observed that shadowing effect reduces the network coverage while it enhances connectivity in a multi-hop wireless network.

Ashraf Hossain, Member, IACSIT [3], Network coverage is important in wireless sensor network. It depends on node deployment strategy. Boundary effect in node deployment plays an important role in network coverage. In this paper, we present the impact of boundary effect on node coverage success probability and coverage fraction. This result will be useful in studying information generation, collection and forwarding in a wireless sensor network. It has been found the boundary effect can be ignored when node sensing area of a node is much smaller than the area of interest.

Anwar Saipulla, Cedric Westphal, Benyuan Liu, Jie Wang [4], Barrier coverage of wireless sensor networks has been studied intensively in recent years under the assumption that sensors are deployed uniformly at random in a large area (Poisson point process model). However, when sensors are deployed along a line (e.g., sensors are dropped from an aircraft along a given path), they would be distributed along the line with random off-sets due to wind and other environmental factors. It is important to study the barrier coverage of such line-based deployment strategy as it represents a more realistic sensor placement model than the Poisson point process model. This paper presents the first set of results in this direction. In particular, we establish a tight lower-bound for the existence of barrier coverage under line-based deployments. Our results show that the barrier coverage of the line-based deployments significantly outperforms that of the Poisson model when the random offsets are relatively small compared to the sensor’s sensing range. We then study sensor deployments along multiple lines and show how barrier coverage is affected by the distance between adjacent lines and the random offsets of sensors. These results demonstrate that sensor deployment strategies have direct impact on the barrier coverage of wireless sensor networks. Different deployment strategies may result in significantly different barrier coverage. Therefore, in the planning and deployment of wireless sensor networks, the coverage goal and possible sensor deployment strategies must be carefully and jointly considered. The results obtained in this paper will provide important guidelines to the deployment and performance of wireless sensor networks for barrier coverage.

Xiu Deng, Jiguo Yu, Dongxiao Yu, and Congcong Chen [5], Area coverage is one of the key issues for wireless sensor networks. It aims at selecting a minimum number of sensor nodes to cover the whole sensing region and maximizing the lifetime of the network. In this paper, we discuss the energy-efficient area coverage problem considering boundary effects in a new perspective that is, transforming the area coverage problem to the target coverage problem and then achieving full area coverage by covering all the targets in the converted target coverage problem. Thus, the cover-age of every point in the sensing region is transformed to the coverage of a fraction of targets. Two schemes for the converted target coverage are proposed, which can generate cover sets covering all the targets. The network constructed by sensor nodes in the cover set is proved to be connected. Compared with the previous algorithms, simulation results show that the proposed algorithm can prolong the lifetime of the network.

RajaramPichamuthu, PrakasamPeriasamy [6], A wireless sensor network (WSN) is spatially distributing independent sensors to monitor physical and environmental characteristics such as temperature, sound, pressure and also provides different applications such as battlefield inspection and biological detection. The Constrained Motion and Sensor (CMS) Model represents the features and explain k-step reach ability testing to describe the states. The description and calculation based on CMS model does not solve the problem in mobile robots. The ADD framework based on monitoring radio measurements creates a threshold. But the methods are not effective in dynamic coverage of complex environment. In this paper, a Localized Coverage based on Shape and Area Detection (LCSAD) Framework is developed to increase the dynamic coverage using mobile robots. To facilitate the measurement in mobile robots, two algorithms are designed to identify the coverage area, (i.e.,) the area of a coverage hole or not. The two algorithms are Localized Geometric Voronoi Hexagon (LGVH) and Acquaintance Area Hexagon (AAH). LGVH senses all the shapes and it is simple to show all the boundary area nodes. AAH based algorithm simply takes directional information by locating the area of local and global convex points of coverage area. Both these algorithms are applied to WSN of random topologies. The simulation result shows that the proposed LCSAD framework attains minimal energy utilization, lesser waiting time, and also achieves higher scalability, throughput, delivery rate and 8% maximal coverage connectivity in sensor network compared to state-of-art works.

MihaelaCardei and Jie Wu [7], Wireless sensor networks constitute the platform of a broad range of applications related to national security, surveillance, military, health care, and environmental monitoring. The sensor coverage problem has received increased attention recently, being considerably driven by recent advances in affordable and efficient integrated electronic devices. This problem is centered around a fundamental question: How well do the sensors observe the physical space? The coverage concept is subject to a wide range of interpretations due to a variety of sensors and their applications. Different coverage formulations have been proposed, based on the subject to be covered (area versus discrete points) and sensor deployment mechanism (random versus deterministic) as well as on other wireless sensor network properties (e.g. network connectivity and minimum energy consumption). In this article, we survey recent contributions addressing energy efficient coverage problems in the context of static wireless sensor networks. We present various coverage formulations, their assumptions, as well as an overview of the solutions proposed.

Junkun Li, Jiming Chen, Shibo He, Tian He, Yu Gu, Youxian Sun [8], In wireless sensor networks (WSNs), trap coverage has recently been proposed to tradeoff between the availability of sensor nodes and sensing performance. It offers an efficient framework to tackle the challenge of limited resources in large scale sensor networks. Currently, existing works only studied the theoretical foundation of how to decide the deployment density of sensors to ensure the desired degree of trap coverage. However, the practical issues such as how to efficiently schedule sensor node to guarantee trap coverage under an arbitrary deployment is still left untouched. In this paper, we formally formulate the Minimum Weight Trap Cover Problem and prove it is an NP-hard problem. To solve the problem, we introduce a bounded approximation algorithm, called Trap Cover Optimization (TCO) to schedule the activation of sensors while satisfying specified trap coverage requirement. The performance of MinimumWeight Trap Coverage we find is proved to be at most O(ρ) times of the optimal solution, where ρ is the density of sensor nodes in the region. To evaluate our design, we perform extensive simulations to demonstrate the effectiveness of our proposed algorithm and show that our algorithm achieves at least 14% better energy efficiency than the state-of-the-art solution.

A.Dhanalakshmi, R.Malathi [9], The research work analyzes the circular area of border effect to be considered. The tradeoff between the number of sensors and their communication range we deploying a wireless network that is connected with the validate analysis through simulation experiments. Additional simulations considering sensor failures ratified that periodic sensor redeployments calculated according to the reliability of WSNs continuously connected through the network. For this applications the network not to be disconnection we use energy for this approach. Using energy efficient routing algorithm for these computations.

Paul Balister, ZizhanZhengy, Santosh Kumar, PrasunSinhay [10], Tracking of movements such as that of people, animals, vehicles, or of phenomena such as fire, can be achieved by deploying a wireless sensor network. So far only prototype systems have been deployed and hence the issue of scale has not become critical. Real-life deployments, however, will be at large scale and achieving this scale will become prohibitively expensive if we require every point in the region to be covered (i.e., fullcoverage), as has been the case in prototype deployments.

In this paper we therefore propose a new model of coverage, called Trap Coverage, that scales well with large deployment regions. A sensor network providing Trap Coverage guarantees that any moving object or phenomena can move at most a (known) displacement before it is guaranteed to be detected by the network, for any trajectory and speed. Applications aside, trap coverage generalizes the de-facto model of full coverage by allowing holes of a given maximum diameter (d). From a probabilistic analysis perspective, the trap coverage model explains the continuum between percolation (when coverage holes become finite) and full coverage (when coverage holes cease to exist).

We take first steps toward establishing a strong foundation for this new model of coverage. We derive reliable, explicit estimates for the density needed to achieve trap coverage with a given diameter when sensors are deployed randomly. We show by simulation that our analytical predictions of density are quite accurate even for small networks. Next, we investigate optimal deterministic patterns for deployment. We show that for d · 0:5552r, where r is the sensing range, the optimal deployment pattern is a triangular grid and for large d=r, the subdivided hexagonal grid is within 10% of optimal. Proving the exact optimal pattern appears to be an extremely difficult problem, related to several open problems in optimal plane packing. Finally, we propose polynomial-time algorithms to determine the level of trap coverage achieved once sensors are deployed on the ground.

Aneesh Kumar V.N., AyanaAjith [11], A wireless sensor network is commonly used to monitoring and recording special events in a geographical area with the help of number of sensors called sensor nodes. These sensor nodes are small in size, weight and portability. They are very vulnerable to various type of failures. These failures form holes in the coverage area. The four key elements that ensure coverage for WSNs are determining the boundary of RoI, detecting coverage holes and estimating their characteristics, determining the best target locations to relocate mobile nodes to repair holes, and dispatching mobile nodes to the target location while minimizing the moving and messaging cost. The coverage enhancement and hole healing is a big task in the field of wireless sensor networks. There are different methods are available for detecting holes and their boundary. Also different methods are used to enhance coverage area and whole healing. These works goes through the available methods for this purpose and differentiate their performance.

Feng Li, Jun Luo [12], Although the problem of k-area coverage has been intensively investigated for dense wireless sensor networks (WSNs), how to arrive at a k-coverage sensor deployment that optimizes certain objectives in relatively sparse WSNs still faces both theoretical and practical difficulties. In this paper, we present a practical algorithm LAACAD (Load bAlancing k-Area Coverage through Autonomous Deployment) to move sensor nodes toward k-area coverage, aiming at minimizing the maximum sensing range required by the nodes. LAACAD enables purely autonomous node deployment as it only entails localized computations. We prove the convergence of the algorithm, as well as the (local) optimality of the output. We also show that our optimization objective is closely related to other frequently considered objectives. Therefore, our practical algorithm design also contributes to the theoretical understanding of the k-area coverage problem. Finally, we use extensive simulation results both to confirm our theoretical claims and to demonstrate the efficacy of LAACAD.

A. Capone, M. Cesana, D. De Donno, I. Filippini [13], Data collected by sensors often have to be remotely delivered through multi-hop wireless paths to data sinks connected to application servers for information processing. The position of these sinks has a huge impact on the quality of the specific Wireless Sensor Network (WSN). Indeed, it may create artificial traffic bottlenecks which affect the energy efficiency and the WSN lifetime. This paper considers a heterogeneous network scenario where wireless sensors deliver data to intermediate gateways geared with a diverse wireless technology and interconnected together and to the sink. An optimization framework based on Integer Linear Programming (ILP) is developed to locate wireless gateways minimizing the overall installation cost and the energy consumption in the WSN, while accounting for multi-hop coverage between sensors and gateways, and connectivity among wireless gateways. The proposed ILP formulations are solved to optimality for medium-size instances to analyze the quality of the designed networks, and heuristic algorithms are also proposed to tackle large-scale heterogeneous scenarios.

KoenLangendoen ,NielsReijers [14], This paper studies the problem of determining the node locations in ad-hoc sensor networks. We compare three distributed localization algorithms (Ad-hoc positioning, Robust positioning, and N-hop multilateration) on a single simulation platform. The algorithms share a common, three-phase structure: (1) determine node–anchor distances, (2) compute node positions, and (3) optionally refine the positions through an iterative procedure. We present a detailed analysis comparing the various alternatives for each phase, as well as a head-to-head comparison of the complete algorithms. The main conclusion is that no single algorithm performs best; which algorithm is to be preferred depends on the conditions (range errors, connectivity, anchor fraction, etc.). In each case, however, there is significant room for improving accuracy and/or increasing coverage.

Xinbing Wang, Sihui Han, Yibo Wu, and Xiao Wang [15],In this paper, we investigate the coverage and energy consumption control in mobile heterogeneous wireless sensor networks (WSNs). By term heterogeneous, we mean that sensors in the network have various sensing radius, which is an inherent property of many applied WSNs. Two sensor deployment schemes are considered –uniform and Poisson schemes. We study the asymptotic coverage under uniform deployment scheme with i.i.d. and 1-dimensional random walk mobility model, respectively. We propose the equivalent sensing radius (ESR) for both cases and derive the critical ESR correspondingly. Our results show that the network performance largely depends on ESR. By controlling ESR, we can always promise the network achieve full coverage, regardless of the total number of sensors or the sensing radius of a single senor under random mobility patterns, which is a much easier and more general way to operate coverage control. Meanwhile, we can operate a tradeoff control between coverage performance and energy consumption by adjusting ESR. We demonstrate that 1-dimensional random walk mobility can decrease the sensing energy consumption under certain delay tolerance, though requires larger ESR. Also, we characterize the role of heterogeneity in coverage and energy performance of WSNs under these two mobility models, and present the discrepancy of the impact of heterogeneity under different models. Under the Poisson deployment scheme, we investigate dynamic k-coverage of WSNs with 2-dimensional random walk mobility model. We present the relation between network coverage and the sensing range, which indicates how coverage varies according to sensing capability. Both k-coverage at an instant and over a time interval are explored and we derive the expectation of fraction of the whole operational region that is k-covered, which also identifies the coverage improvement brought by mobility.

5. PROPOSED METHODOLOGY

We proposed the new technique which solved all the issues describe in problem statement. Main objectives of our proposed system are optimum path, target coverage, increase the life time of the network and failure detection. We introduce the novel approach in which we merge the multiple techniques called AOMDV, Modified K-Means and PSO (Particle Swarm Optimization) to find Optimum path, target coverage and failure detection in wireless sensor Network. We have proposed a System which relies on upon blend approach of using optimal path utilizing modified k-means for area coverage and AOMDV for multipath routing and afterword applying PSO for shortest path to find best result.

Step 1: The first phase applies the K-means algorithm to partition the network into k clusters.

Step 2: Next, the AOMDV algorithm for the multipath routing within each cluster obtained by the Modified K-Means.

Step 3: Finally, the PSO algorithm searches for the best CH (cluster head) within each cluster and evaluates the optimal path.

With our proposed algorithm, the clustering problem will be easily managed with less computation required and we can find optimal path, target coverage, reduce energy consumption and increase network life time with failure detection.

6. CONCLUSION

After reviewing some previously done important researches we have proposed a hypothetical working framework which depends on mixture approach of utilizing optimal path using modified k-means for area coverage and afterward apply PSO for briefest network way alongside to discover ideal outcome. In this manner the paper finishes up a framework that can illuminate the issues of WSN which are scope issue, optimum path, and vitality effective network.

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