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A Survey on Sensor Node Placement based on TPSM Algorithm for Energy Efficient WSN

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Abstract: Wireless sensor network is built of autonomous 'nodes', from a few to several hundred, where each node is connected to one sensor. Sensor-node is a node in a wireless sensor network that is capable of performing sensing information, processing and communicating with other connected nodes in the network. Sensor deployment is the major concern, when considering the network coverage area and life-time of network. So with this by using bio-inspired optimization behavior techniques are called as Territorial Predator Scent Marking Algorithm (TPSMA) is used for placement of sensor node schemes in terms of coverage ratio, network life time by this energy efficient network can be achieved. This is based on the scent marking behavior, predator will scent-mark the area due to certain factors such as food resources. Sensor node will identify its monitored location based on their marked territories that imitate the scent-matching behavior in TPSMA. The performance of the proposed technique improved and better as compare to other Swarm Intelligence technique. WSN deployed with the proposed sensor node placement scheme consumes lower energy and is expected to provide longer lifetime. In this paper we focus on surveying various sensor node placements that were discovered till now and their uses to WSN systems. At the end of this paper we highlighted future work of this paper.

Key Words: Territorial Predator Scent Marking Algorithm, SI, WSN, Sensor nodes etc.

1. INTRODUCTION

Spatially distributed autonomous sensor, which communicate wirelessly, form a Wireless Sensor Network (WSN). This network monitors physical or environmental conditions such as temperature, pressure, sound and pass the data through the network to the location. A central gateway is called high energy communication node that collects data from all sensors and sends them to the central computer, where they are processed. The topology of wireless sensor network can vary from star network to advanced multihop wireless mesh network. The propagation technique between hops of the network can be routing. Main aim is to minimize the sensors and energy consumption of the network. Wireless sensors are highly distributed networks of small, light weight wireless nodes. A node does the function sensing, processing and communication. Applications are constant monitoring and detection of specific events. Military, battle field surveillance, home appliances and patient monitoring.

The Swarm intelligence is emergent collective intelligence of groups of small agents. It is local interaction of many simple agents to achieve a global goal. Swarm intelligence (SI) is the collective behavior of decentralized, self-organized systems, natural or artificial. The concept is employed in work on artificial intelligence. The expression was introduced by Gerardo Beni and Jing Wang in 1989. The SI algorithms have characteristics are of capabilities of self organizing systems, adaptation to the changing conditions, self healing and local decision making. Using swarm intelligence we can achieve more throughput, data transmission and average power efficiency. Territorial predator such as tigers, bears, and dogs can be defined as predators that consistently defend a specific area against animals from other species. The territory is based on certain factor such as food resources. Most territorial predators use scent marking to indicate the boundaries of their territories which are also playing a role in territorial maintenance and as information sites for other members of the population [13].

Sensor Node measure physical data of parameter to be monitored. In wireless sensor network, all data collected by sensor are forwarded to a sink node has a great impact on energy consumption and lifetime of WSNs. Node consists of component controller , memory ,power source , sensor, transceiver . More energy required for data communication than any other process. Power is stored in batteries or capacitors.

2. DISTRUBUTED SENSOR NETWORK

If a centralized architecture is used in sensor network. And if central node fails, then entire network will collapse, however the reliability of the sensor network can be increased by using distributed control architecture. Distributed control is used in WSNs for the following reasons –

1. Sensor Nodes are prone to failure.
2. Better collection of data.
3. To provide nodes with backup in case of failure of central node.

We are using different protocols and algorithms need to address the following issues–1.Life time maximization. 2. Robustness and fault tolerance and 3. Self Configuration. Position of nodes affects different parameters of the WSNs. The most important parameters, which have

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been investigated in literature, are power consumption, Network coverage, Network life time, network connectivity. Several algorithms have been proposed for optimizing there parameters. Sensors are classified into two categories active sensor and passive sensor. Active sensors actively probe the environment. Example radar sensor, they need continuous energy from power source. Passive sensor senses the data without actually manipulating the environment by active probing and self powered.

3. BRIEF INTRODUCTION OF TPSM ALGORITM

Optimum sensor node placement in a monitored area is needed for cost-effective deployment. The positions of sensor nodes must be able to provide maximum coverage with longer lifetimes. This paper proposed a sensor node placement technique that utilizes a new biologically inspired optimization technique that imitates the behaviour of territorial predators in marking their territories with their odours, known as territorial predator scent marking algorithm (TPSMA).The TPSMA deployed in this paper uses the maximum coverage objective function. A performance study has been carried out by comparing the performance of the proposed technique with the mini max and lexicographic mini max (lexmin) sensor node placement schemes in terms of coverage ratio and uniformity. Uniformity is a performance metric that can be used to estimate a WSN lifetime. Simulation results show that the WSN deployed with the proposed sensor node placement scheme outperforms the other two schemes with larger coverage ratio and is expected to provide as long lifetime as possible.

Advantages:

1. Balanced time delay.
2. No Interference.
3. Coverage area is enhanced.

One of the ways in provisioning maximum coverage with longer lifetime is through the use of some sort of wireless sensor network (WSN) deployment mechanism. This can be done by utilizing an effective planning mechanism in arranging the limited number of sensor nodes. WSN for target monitoring applications such as landslide monitoring, forest fire detection and precision agriculture can be implemented with a fixed number of sensor nodes that are deployed to monitor one or more locations within a monitored area. For cost-effective deployment, it is critically important to determine optimal locations for these sensor nodes. The locations of the sensor nodes strongly affect the energy consumption, operational lifetime, and sensing coverage. Thus, careful sensor node placement is needed. Romoozi et al. stated that there is a trade-off between energy consumption of sensor nodes and network coverage. Closer sensor nodes will reduce the energy consumption but the network coverage will become smaller. This scenario has attracted numerous research works on WSN sensor node deployment.

4. OVERVIEW ON VARIOUS SENSOR NODE PLACEMENT TECHNIQUES

4.1 Genetic Algorithm for Energy Efficient and Coverage-Preserved Positioning in Wireless Sensor Networks

Romoozi, M. et al [1] invented designing sensor networks. This paper brings a new idea for the positioning of nodes in a wireless sensor network. The sensors communicate with each other to transmit their data to a high energy communication node which acts as an interface between data processing unit and sensors. Optimization of sensor locations is essential to provide communication for a longer duration. An energy efficient layout with good coverage based on Genetic algorithm is proposed here. During the process of optimization, sensors move to form a uniformly distributed network. The two objectives taken into consideration are coverage and lifetime. Basically a set of network layouts are obtained. The simulation results also exhibit improvement of performance with increase in number of generations in the algorithm.

4.2 Energy Aware Node Placement Algorithm for Wireless Sensor Network

Kirankumar Y et al [2] designed a wireless sensor communication technology allows random participation of sensor nodes with particular applications to take part in the network, which results in most of the uncovered simulation area, where fewer nodes are located at far distances. The drawback of such network would be, additional energy is spent by the nodes located in a pattern of dense location, using more number of nodes for a smaller distance of communication adversely in a region with less number of nodes, additional energy is again spent by the source node in order to transmit a packet to neighbors there by transmitting the packet to reach the destination. The proposed work is intended to develop Energy Efficient Node Placement Algorithm (EENPA) in order to place the sensor node efficiently in simulated area, where all the nodes are equally located on a radial path to cover maximum area at equidistance. The total energy consumed by each node compared to random placement of nodes is less by having equal burden on fewer nodes of far location, having distributed the nodes in whole of the simulation area. There by calculating the network lifetime which also proves to be efficient as compared to random placement of nodes, hence increasing the network lifetime too. Simulation is been carried out and results are obtained on per with random placement of nodes with EENP algorithm. Simulation results shows that with the help of node placement algorithm energy consumption of nodes with proposed algorithm of node optimization using circular deployment are less compared to random deployment of node, this definitely help to increase the network lifetime. Work can be extended to compare the network lifetime by placing the nodes in triangular as well as hexagonal pattern. Best pattern then can be evaluated.

4.3 Sensor Placement for maximizing Life Time per unit cost

Yunxia Chen et.al [3] discovered the Life time per unit cost, defined as the network lifetime divided by the number of sensors deployed in the network, can be used to measure the utilization efficiency of sensors in a wireless sensor network (WSN). Analyzing the lifetime per unit cost of a linear WSN, we find that deploying either an extremely large or an extremely small number of sensors is inefficient in terms of lifetime per unit cost. We thus seek answers to the following questions: how many sensors should be deployed and how to deploy them to maximize the lifetime per unit cost. Numerical and simulation results are provided to study the optimal sensor placement and the optimal number of deployed sensors. In this paper, we analyzed the lifetime per unit cost of an event-driven linear WSN. We found that deploying either an extremely large or an extremely small number of sensors is inefficient in terms of lifetime per unit cost. We thus optimize the number of sensors to be deployed and their placement for maximizing lifetime per unit cost. We found that the last sensor should be placed as close to the gateway node as possible to reduce the reporting energy consumption. As the path loss exponent increases, the distance between adjacent sensors approaches uniform. We also found that the optimal number of deployed sensors increases with the event arrival rate and decreases with the sensing power consumption.

4.4 Dynamic sink node placement using PSO

R Alageswarm et al [4] explained as the energy available in sensor nodes used in WSN is limited, the primary focus of WSN applications is to maximize the network life time by using the energy efficiently. Hence making a good use of energy is important in WSN application.There are technique to utilize the energy in an efficient way. One such technique is to place the sink node is by Particle Swarm Optimization. The initial constraints in finding optimal Base-Station locations in two tiered wireless sensor networks using PSO are relaxed by application node dynamically on Euclidean distance and probability communication between the nodes and sink through the application nodes using query-driven model of WSN. PSO is used to extend the life time of the application. In this finding the ant optimized location for sink node using PSO.

4.5 Greedy routing algorithm for WSNs

Luis Daniel Samper Escalante et al [5] presented on energy consumption is crucial. Routing plays a very high role for energy optimization, as taking less hop numbers usually leads to a better performance. And is inspired by the work in the field of swarm intelligence. Based on the idea that transmission consumes more energy than processing the routing algorithm avoids this by only sending updated to neighbors, when a critical event occurs(e.g the nodes energy dropping to zero) with the objective that this type of events do not impact negatively in the network. The selection of a path is based on the neighbor with fewer hops and less pheromone concentration, to avoid overusing of a route, all this being evaluated by each nodes own processing. This proposed routing algorithm addresses three critical problems in WSN's first one optimized use of energy, second one selection of the best path to transmit a packet and third one exhaustion of shorter paths, all at the same time. Generally for packet transmission the shortest path is preferred, but by this approach few nodes will exhaust their energy. And the others will be barely used, reducing the coverage area of the WSN and impacting negatively on its performance and lifetime [12]. And "Maximum life time routing in WSN". By studying the behavior of ant colony [13], it is clear that pheromone plays an important role for its society describing paths that have been used frequently when searching for food. Implementing this behavior into the WSN nodes will helps to prevent overusing paths by checking initially the pheromone concentration path has and thus avoiding the creation of isolated islands in the WSNs. As choosing the shortest path will exhaust prematurely the nodes, and choosing the longest will create undesirable long delays. So both extremities are not optional and middle solution is required for routing purposes. That's main reason why reason why pheromones are addressed the problem.
In this algorithm, pheromone concentration measures the number of times traffic has passed through a node, and hence is used to calculate the energy content of that node, since the estimated remaining energy of a node is proposional to inverse of pheromone concentration. This guarantees that the n it's pheromone or energy algorithm will always have another options to route the packets , which depends upon it's pheromone is to prolonging lifetime of WSN, which takes less hop numbers into consideration, Choosing the nodes with less pheromone concentration. Which kernel idea is taking less hop numbers into consideration, choosing the nodes with less pheromone concentration as next hop to avoid some nodes' prematurely deplete their energy because of overuse of short routes, with the aim of balancing global energy consumption.

4.6 Routing based on sensor grouping for energy efficient

Ammar Hawbani et al [6] proposed the wireless network system due to the limited communication range of WSN, the sensor is unable to establish direct connection to the data collection station, therefore the collaborative work of nodes is highly necessary. The data routing is one of the most fundamental processes exploring how to transmit data from the sensing field to the data collection station via the least possible number of intermediate nodes. This paper addresses the problem of data routing based on the sensors grouping; it provides a deep insight on how to divide the sensors of a

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network into separate independent groups, and how to organize these independent groups in order to make them work collaboratively and accomplish the process of data routing within the network. We have proposed an algorithm where the source group forwards a packet to one neighbor only and there is no need of flooding or forwarding packets to all neighbors. The grouping adaptive routing saves more power there-fore, ends up maximizing the lifetime of the wireless sensor network.

4.7 Particle swarm clustering algorithm and inter-cluster routing algorithm

Xia Li et al [7] is introduced Wireless sensor network (WSN) hierarchical routing protocols meet the efficient communication of a large-scale network. However, many of them cannot guarantee the optimum choice of the cluster heads because of the lack of comprehensive consideration of the remaining energy of nodes, the distribution within a cluster and the distribution among clusters in the process of choosing the cluster heads. Energy efficient routing protocol based on particle swarm clustering algorithm and inter-cluster routing algorithm for WSN, which makes improvements mainly in the following two aspects. First, network clustering is a kind of NP problem to optimize the network topology partitioning, particle swarm algorithm can effectively solve this problem. However, the convergence speed of the particle swarm algorithm is slow. To address the issue above, we introduce an adaptive inertia weight based on different dimensions to accelerate the convergence speed of the particles. Based on the improved particle swarm optimization (PSO) we present a particle swarm clustering algorithm which considers the remaining energy of nodes, the distribution within a cluster and the Distribution among clusters. Second, an inter-cluster routing algorithm combining single-hop with multi-hop is designed to avoid long distance communication between the cluster head and the sink node, which at the same time adopts the "threshold detection" mechanism to relief the load of the cluster heads near the sink node. Finally, we combine the improved particle swarm clustering algorithm with the inter-cluster routing algorithm to form an adaptive energy-efficient clustering routing protocol, referred to as AECRP. The protocol can balance the energy consumption of the network and prolong the life time of the network.

4.8 Multi-objective Optimization (MOO) Approach for Sensor Node Placement

Husna Zainol Abidin et al [8] proposed position sensor nodes in a Wireless Sensor Network (WSN) to be able to provide maximum coverage with minimum energy consumption. However, these two aspects are contradicting and quite impossible to solve the placement problem with a single optimal decision.

Thus, Multi-objective Optimization (MOO) approach is needed to facilitate this. This paper studies the performance of a WSN sensor node placement problem solved with a new biologically inspired optimization technique that imitates the behavior of territorial predators in marking their territories with their odors known as Territorial Predator Scent Marking Algorithm (TPSMA). The simulation study is done for a single objective and multi-objective approaches. The MOO approach of TPSMA (MOTPSMA) deployed in this paper uses the minimum energy consumption and maximum coverage as the objective functions while the single objective approach TPSMA only considers maximum coverage. The performance of both approaches is then compared in terms of coverage ratio and total energy consumption. Simulation results show that the WSN deployed with the MOTPSMA is able to reduce the energy consumption although the coverage ratio is slightly lower than single approach TPSMA which only focuses on maximizing the coverage. Multi-objective optimization is needed for sensor node placement because the problem requires optimal decisions due to the presence of tradeoffs between two conflicting objectives that are coverage and energy consumption. The simulation results clearly show that as a whole, TPSMA outperforms MOTPSMA in terms of coverage because the objective of TPSMA is to get the maximum coverage only unlike MOTPSMA which also considered energy consumption. Even though the coverage given by MOTPSMA is slightly lower than TPSMA, the coverage given by MOTPSMA is considerably acceptable as it also needs around 10 sensor nodes in order to get at least 95% coverage. It can be seen that MOTPSMA is able to reduce the energy consumption of the network because one of the objectives of MOTPSMA is to get the minimum energy consumption.

4.9 A Distributed Self Spreading Algorithm

Nojeong Heo et al [9] invented Sensor deployment is an important problem in mobile wireless sensor networks. This paper presents a distributed self deployment algorithm for mobile sensors. Performance metrics to evaluate algorithm performance are coverage, uniformity, time and distance traveled till the algorithm converges. Our algorithm is compared with a simulated annealing based algorithm for deployment and is shown to exhibit excellent performance. Sensor coverage problem for the deployment of wireless sensor networks here. A region of interest needs to be covered by a given number of nodes with limited sensing and communication range. We start with a "random" distribution of the nodes over the region of interest. Though many scenarios adopt random deployment because of practical reasons such as deployment cost and time, random deployment may not provide a uniform distribution which is desirable for a longer system life time over the region of interest. In this paper, we propose a distributed algorithm for the deployment of mobile nodes to improve an irregular initial deployment of nodes. After going through the algorithm, the area of interest is covered by uniformly distributed nodes. While developing the algorithm, one should consider factors such as density of nodes, memory constraints, localization errors, and scalability of mobile nodes. Through the requirement of mobility and locationing ability of nodes, this algorithm provides a way to avoid expensive redeployment process. This post deployment idea will be more useful especially when a large fraction of nodes are destroyed or broken during deployment or in a hostile situation, where initial distribution is quite uneven and when redeployment is too costly or too risky. The performance of the algorithm is determined by the percentage of region covered, by computational/deployment time, by the mean distance that is required for the deployment, and by the uniformity of the networks.

4.10 The divide-and-conquer deployment based on triangles

L. C. Shiu et al [10] in order to monitor environmental conditions, a large quality of static sensors normally are deployed randomly in large monitored area. Obviously, there are coverage holes distributed over the monitored area, and the coverage hole can be polygonal. Each coverage hole is evaluated collaboratively by static sensors surrounding the hole, while all coverage holes are evaluated in parallel. Because a polygon can be divided triangularly, exactly how to deploy sensors on a triangle is a priority. Three static sensors are located individually on the three nodes of triangles following random deployment. This work presents a novel divide-and-conquer deployment algorithm based on the triangular form that is executed on the three static sensors. The triangle can be cut into smaller ones that contain at least one interior angle equal to 60°. The small triangles with a 60° angle can be ensured full coverage, while the remaining area is still a triangle. The cutting is repeated until the triangle is sufficiently small so that the sensors on the three nodes can fully cover the area. Ultimately, the coverage hole of a triangle can be full coverage. Moreover, the *x -y* coordinates of each deployed sensor can be deduced. The proposed algorithm can conquer the coverage hole of each triangle of the polygon. The number of sensors and *x- y* coordinates of all sensors deployed in the coverage hole of the polygon can be evaluated as well.

4.11 Energy-Efficient Communication Protocol for Wireless Micro sensor Networks

Wendi Rabiner Heinzelman et al [11] developed the Wireless distributed micro sensor systems will enable the reliable monitoring of a variety of environments for both civil and military applications. In this paper they look at communication protocols, which can have significant impact on the overall energy dissipation of these networks. Based on our findings that the conventional protocols of direct transmission, minimum-transmission-energy, multihop routing, and static clustering may not be optimal for sensor networks, we propose LEACH (Low-Energy Adaptive Clustering Hierarchy), a clustering-based protocol that utilizes randomized rotation of local cluster base stations(cluster-heads) to evenly distribute the energy load among the sensors in the network. LEACH uses localized coordination to enable scalability and robustness for dynamic networks, and incorporates data fusion into the routing protocol to reduce the amount of information that must be transmitted to the base station. Simulations show that LEACH can achieve as much as a factor of 8 reductions in energy dissipation compared with conventional routing protocols. In addition, LEACH is able to distribute energy dissipation evenly throughout the sensors, doubling the useful system lifetime for the networks we simulated. Distributing the energy among the nodes in the network is effective in reducing energy dissipation from a global perspective and enhancing system lifetime.

FUTURE WORK

In future we would like to extend the work by using LEACH protocol for energy efficient TPSM algorithm Wireless Sensor Network. We will carry out simulations and find out based on results.

CONCLUSION

A sensor node placement scheme based on TPSM has been proposed in order to ensure maximum coverage area and energy efficient, maximum life time of wireless sensor network .This performance is compared with minmax and lexmin schemes. This network model consists of several equal widths monitored locations. In this we have used to adapt the swarm intelligence technique for optimization of coverage and sensor node life time in wireless sensor network and Position if each sensor node can be determined by the algorithm. Design of network should be self organized functionality to dynamically adapt to its environment. By using node scheduling scheme, proper protocol and efficiently utilizing node scheduling scheme using TPSM algorithm can save power.

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