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Comparison of Efficient Algorithms which guarantee Coverage and maximize Network Lifetime of Wireless Sensor Networks

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Abstract: *Wireless sensor network is a growing area forresearch and development. In this paper, I provide thetheoretical analysis of algorithms that solves the problem ofnetwork coverage and maximize the network lifetime. Coverage and maximizing the lifetime of wireless sensornetworks in parallel is a challenging task. The basic idea isthat a sensor node can be duty cycled when required tomaximize lifetime. Coverage in wireless sensor networks isusually defined as a measure of how well and how long thesensors are able to observe the environmental space. Toaddress this kind of problem, we take a representativeperformance comparison of Ant-Colony-based Schedulingalgorithm [15], Centralized Truncated Greedy Algorithm [13]and Distributed Energy Efficient Clustering Algorithm toGuarantee Coverage [14]. We analyse the sensor issues andcomparison of coverage algorithms. This comparison revealsthe important features that need to be taken intoconsideration while designing coverage algorithms and solvesthe problem of coverage and maximize lifetime.*

Keywords: *Clustering, Coverage, Energy Consumption,Network Lifetime, Wireless Sensor Network.*

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I. Introduction

A wireless sensor network (WSN) is distributed autonomous sensors to monitor physical or environmental conditions like pressure, sound and temperature, still more. Sensor nodes cooperatively pass their data through the nearest neighbor to a sink (Figure 1) then to a main location.WSN applications are traffic monitoring, relief from disaster operations, environmental conditions, intelligent buildings, machine monitoring, medicine and health care.

A wireless sensor network consists of a collection of wireless sensor nodes. These nodes will be very small insize. Battery present in the sensor supplies the power to sensor nodes with limited energy.

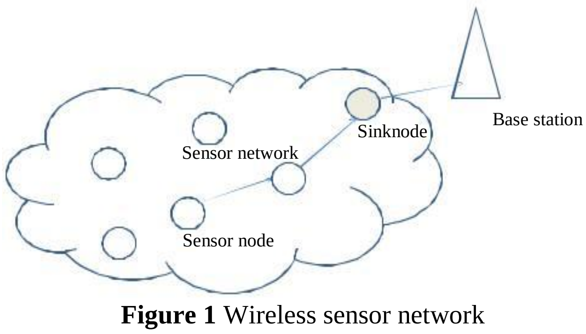

Figure 1 Wireless sensor network

Coverage is important for a sensor network tomaintain connectivity. Connectivity can be defined as of the sensor nodes to sense the environment andshare the information through the network to reach the datasink (Figure 1). One of the most active research fields inwireless sensor networks is that of coverage. Coverage isusually interpreted as how well a sensor network willmonitor a quantity in a particular field of interest liketemperature, pressure, sound, etc. Hence, Coverage isconsidered as a measure of quality of service.Designing efficient algorithm becomes veryimportant for extending the lifetime of sensor nodes andmaximizing network coverage [1, 2]. Coverage is also oneof the most important design goals in many applications ofWSNs. A good coverage should minimize the overlapamong the ranges of the clusters and cover all the sensorsdeployed within the monitored region [3]. WSNs arewidely used in a variety of application scenarios such assurveillance and environment monitoring. In all thesescenarios, a fundamental concern is the quality ofsensing, which is often referred to as coverage andquantifies the collected information about the region ofinterest (ROI) [4]. The goal of maximizing the lifetime if anetwork is equivalent to finding the lowest possibletransmission power levels for the nodes that suffice tomake all of the network connected to the sink[5]. Theexisting methods for prolonging the lifetime of WSNsfocus on the issues of device placements [6], dataprocessing [7], routing [8] and topological management [9].Only few works focus on coverage issues in WSN.The paper is organized as follows: In chapter I, we addressmany of the issues that factor into how coverage isdetermined and guaranteed. In Chapter II, related work. InChapter III, we cover few algorithms to coverage anddiscuss how these have been integrated by researchers intotheir own methods. In Chapter IV, deals with thecomparison of these various works. In Chapter V, wediscuss the observations made from the work. Finally inchapter six, we give the conclusion of this paper. At the endof the paper is a list of references.

II. Related Works

We summarize the related works regardingcoverage, clustering and network lifetime maximization.Cluster heads are elected following a three way messageexchange between each sensor and its neighbors [10].Many scheduling algorithms have been proposed to solvethe Energy efficient coverage (EEC) problem of WSNs.The EEC problem has been converted into a binary integerprogramming problem so that a greedy algorithm could beapplied [11]. “Energy-Efficient Protocol for Deterministicand Probabilistic Coverage in Sensor Networks” [12]introduces the Probabilistic Coverage Protocol (PCP)which provides connected coverage for heterogeneous andhomogeneous sensor networks. Generating a sequence ofoptimal connected covers by repeating the same methodsmay not lead to lifetime maximization. Maximizing thenumber of connected covers is a more direct way tomaximize the network lifetime. The problem of finding themaximum number of connected covers is difficult becauseeach connected cover must fulfill sensing coverage andnetwork connectivity simultaneously. Its sub problem ofmaximizing the number of subsets that fulfill sensingcoverage is already in the non-deterministic polynomialtime (NP) complete complexity class [16]. Many methodsfocus on solving the above sub problem but ignore the issueof connectivity. [17] Considering joint coverage andconnectivity problem, and indicated that full coverage of aconvex region implies connectivity if the communicationrange is at least two times of sensing range. They also gavea set of optimality conditions for scheduling sensor nodes,by which a distributed algorithm was proposed. In [18], theauthors propose an addressing protocol for cluster-basedsensor networks. To prevent collisions, the nodes within acluster are assigned different local IDs. Global IDs areobtained by putting together the local IDs and the IDs ofthe cluster heads. However, this solution has a greatincrement in energy cost in case of large sensor networks.Our algorithm, in contrast, assigns local unique IDs to thenodes in each cluster, and does not have increased energycost when the size of the network increases.

III. Coverage Algorithms

3.1. Ant-colony-based scheduling algorithm. (ACB-SA)

3.1.1. Methodology

The Ant colony optimization (ACO) algorithm is anatural metaphor algorithm based on the behavior realants. While moving, ants that find food deposit pheromoneson the way to their nests; the other ants then follow thesedeposited pheromones. Although pheromones evaporate astime passes, they open up new possibilities as antscooperate to choose a path heavily laden with pheromones.In this way, ants can search for the shortest path from theirnest to a food source with only pheromone information.The performance of the ACO algorithm is determined byhow it initializes the pheromone field and how it makes theconstruction graph.

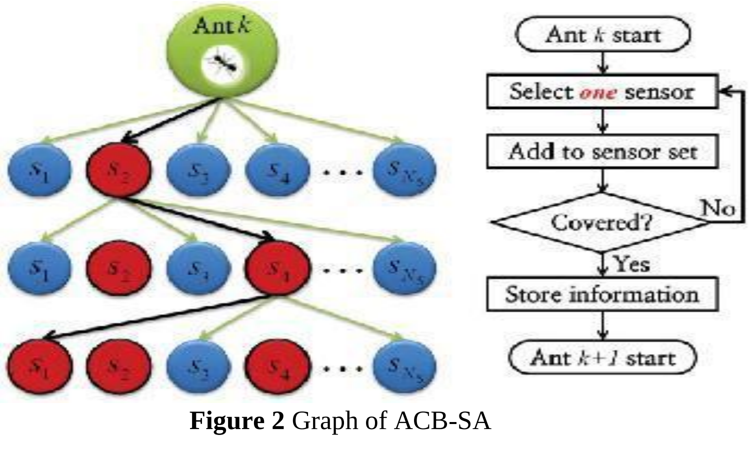

Figure 2 Graph of ACB-SA

When most ACO algorithms are applied todifferent problems, these are modified to improveperformance and reflect the characteristics of theproblem. N randomly selected sensors by ant k areevaluated as to whether they cover all point of interest(PoIs) or not. If the selected sensor set covers all PoIs, thenit is stored for the pheromone update. Otherwise, these setsare thrown away, and then the next ant (i.e., ant k + 1)starts his travel. In the ACB-SA, however, the ant k addssensors one at a time while evaluating selections aftereach addition. Thus, the ant finds the solution until theselected sensor set cover all PoIs, adding one sensor everytime. Figure 2 shows this process. Thus, to improve theperformance (mainly lifetime) of the ACB-SA, we appliedthe new initialization method for the pheromone field andthe modified construction graph, unlike the conventionalACO algorithm.Ant-colony-based Scheduling algorithm has bettercoverage performance, longer lifetime and improves energysavings in the WSN. ACB-SA solves the energy efficientcoverage (EEC) problem by random selection ofparameters for the probabilistic sensor detection model.

3.1.2. Limitations

- Introduced only for Homogeneous type of network.
- Network connectivity is not considered.

3.2. Distributed energy efficient clustering algorithm (DEECIC)

3.2.1. Methodology

DEECIC, a distributed energy-efficient clustering approach with improved coverage for wireless sensor networks. DEECIC aims at selecting the smallest set of nodes with more neighbors as the cluster heads to cover the whole network, and assigning unique IDs to each node based on local information. A node in DEECIC can have four possible states: cluster head, 1-hop member node (an immediate neighbor of a cluster head), 2-hop member node (an immediate neighbor of a 1-hop member node) and unclustered node (not a member of any cluster). Clustering model of DEECIC depends on the cluster formation phase and cluster migration phase. The node can relay its data within 2 hops to its cluster head. During the cluster head migration phase, both the residual energy and the density of the sensor nodes are considered when determining the best candidates of cluster heads. Our clustering scheme in sensor networks is directed by two fundamental requirements: energy conservation and coverage preservation. DEECIC does not require a strict time synchronization mechanism. The node in the network makes decisions independently according to its own schedule. Thus DEECIC prolongs network lifetime, and improves the quality of coverage in comparison with LEACH, PEGASIS and the Highest-Degree algorithm.

3.2.2. Limitations

- Sensor node should reach the cluster head in two hops.
- More energy is utilized
- As the sensor information should reach the cluster head in two hops it will not support a large scale Wireless sensor network.

3.3. Truncated greedy algorithm (TGA)

3.3.1. Methodology

The coverage problem in wireless sensor networks are typically temporal and spatial correlations among the data sensed by different sensor nodes, we exploit such data correlations and leverage prediction to prolong the network lifetime. The issue has been formulated as a minimum weight submodular set cover (MWSSC) problem. We proposed a truncated greedy algorithm with a theoretical performance guarantee to solve it. We prove the performance guarantee of TGA in terms of the ratio of aggregate weight obtained by TGA to that by the optimal algorithm. We modified TGA into a distributed algorithm, DTGA, and proved that these two algorithms obtain the same set cover. Distributed truncated greedy algorithm (DTGA) obtains the same set of submodular set cover for minimum weight submodular set cover problem. At the beginning of each time slot, DGTA is executed to select a submodular set cover from all functional sensor nodes. The selected nodes are activated in the current slot, while other nodes can be turned off. This helps to extend the network lifetime. TGA is a centralized algorithm. As WSN supports Decentralized, DTGA is proposed.

3.3.2. Limitations

- Network connectivity is not considered.

IV. Comparison Of Coverage

The algorithms are compared on the following table with respect to the work done, methodology and the limitations.

Table I : Comparison of coverage algorithms

S. No	Title	Author	Work	Method	Limitations
1	ACB-SA for energy-efficient coverage of WSN	Joon-woo Lee, Ju-Jang Lee	1. Energy efficient 2. Solves energy efficient coverage (EEC) problem	ACB-SA	1. Introduced only for Homogeneous sensor network 2. Connectivity is not considered
2	DEECIC with improved coverage in WSN	Zhixin Liu, Qingchao Zheng et al	1. Prolong network lifetime 2. Improve network coverage	DEECIC	1. The sensor node can relay its data within 2 hops to its cluster head. 2. Does not support large scale network
3	Leveraging Prediction to improve coverage of WSN	Shibo He, Jiming Chen et al	1. Less cost 2. More energy 3. Preserve Coverage	TGA, DTGA	1. Network Connectivity is not considered

DEECIC aims at clustering with the least number of cluster heads to cover the whole network and assigning a unique ID to each node based on local information. In addition, DEECIC periodically updates cluster heads according to the joint information of nodes residual energy and distribution. Leveraging Prediction in WSN prove the performance guarantee of TGA in terms of the ratio of aggregate weight obtained by TGA to that by the optimal algorithm. Considering the decentralization nature of WSNs, a distributed version of TGA, denoted as DTGA, which can obtain the same solution as TGA. ACO-based approach that can maximize the lifetime of heterogeneous WSNs. The ACB-SA is based on finding the maximum number of disjoint connected covers that satisfy both sensing coverage and network connectivity. A construction graph is designed with each vertex denoting the assignment of a device in a subset. Based on pheromone and heuristic information, the ants seek an optimal path on the construction graph to maximize the number of connected covers. Thus the above algorithms promise to prolong the network lifetime and improve network coverage effectively.

V. Observations Made

From the above comparison the following observations are made

- Algorithms, Introduced only for Homogeneous type of networks.
- Network connectivity in large network is not considered.
- Sensor node cannot reach the cluster head in two hops when we go for a maximized network.
- Does not support large network

VI. Conclusion

In this paper, comparisons of efficient coverage algorithms are discussed with the objective of improving coverage and to maximize the network lifetime. Comparison made on three algorithms. All the three algorithms are identified to operate more efficiently than previous techniques and provide increased coverage and network lifetime. DEECIC increases network lifetime and improves the quality of coverage in comparison with LEACH and the Highest-Degree algorithms. ACB-SA is an efficient method which prolongs the lifetime and to solve the EEC problem in WSNs. TGA and DTGA solves the coverage problem in Centralized and Decentralized nature of WSN. Thus the above algorithms enlarge the lifetime of sensor network and provide guaranteed coverage.

References

[1]. K.Romer, F. Mattern, and E. Zurich, “The design space of wireless sensor networks,” IEEE Wireless Commun., vol. 11, no. 6, pp. 54–61, Dec. 2004.

[2]. T. D. Raty, “Survey on contemporary remote surveillance systems for public safety,” IEEE Trans. Syst., Man, Cybern., Part C, vol. 40, no. 5, pp. 493–515, Sep. 2010.

[3]. S. Yi, J. Heo, Y. Cho, PEACH: power- efficient and adaptive clustering hierarchy protocol for wireless sensor networks, Computer Communications 30 (14–15) (2007) 2842–2852.

[4]. X. Li, H. Frey, N. Santoro, and I. Stojmenovic, “Strictly Localized Sensor Self-Deployment for Optimal Focused Coverage,” IEEE Trans. Mobile Computing, To Appear, 2011.

[5]. YS Yun et al, “Maximizing the lifetime of WSN with mobiles in delay tolerant applications”, IEEE Trans. Mobile Computing, 2010.

[6]. C.-Y. Chang, J.-P. Sheu, Y.-C. Chen, and S.- W. Chang, “An obstacle-free and power-efficient deployment algorithm for wireless sensor networks,” IEEE Trans. Syst., Man, Cybern., Part A, vol. 39, no. 4, pp. 795– 806, Jul.2009.

[7]. F. Marcelloni and M. Vecchio, “A simple algorithm for data compression in wireless sensor networks,” IEEE Commun. Lett., vol. 12, no. 6, pp. 411– 413, Jun. 2008.

[8]. S. Yang, H. Cheng, and F. Wang, “Genetic algorithms with immigrants and memory schemes for dynamic shortest path routing problems in mobile Ad Hoc networks,” IEEE Trans. Syst., Man, Cybern., Part C, vol. 40, no. 1, pp. 52–63, Jan. 2010.
[9]. H. Chen, C. K. Tse, and J. Feng, “Impact of topology on performance and energy efficiency in wireless sensor networks for source extraction,” IEEE Trans. Parallel Distrib. Syst., vol. 20, no. 6, pp. 886–897, Jun. 2009.
[10]. A. Chamam, S. Pierre, A distributed energy- efficient clustering protocol for Wireless sensor networks, Computers & Electrical Engineering 36 (2) (2010) 303– 312.
[11]. Í. K. Altínel, N. Aras, E. Güney, and C. Ersoy, “Binary integer programming formulation and heuristics for differentiated coverage in heterogeneous sensor networks,” Comput. Netw., vol. 52, no. 12, pp.2419–2431, Aug. 2008.
[12]. M. Hefeeda, “Energy-Efficient Protocol for Deterministic and Probabilistic Coverage in Sensor Networks”, IEEE Transactions On Parallel And Distributed Systems,2009.
[13]. Shibo He et al,”Leveraging Prediction to improve the coverage of wireless sensor networks”, IEEE Transactions on Parallel and Distributed Systems.,vol 23,April 2012.
[14]. Zhixin Liu et al, “A distribued energy afficient clustering algorithm with improved coverage in wireless sensor networks”, Future generation computer systems, 2011.
[15]. Joon-Woo Lee et al,”Ant-colony-based scheduling algorithm for energy efficient coverage of WSN”, IEEE sensors journal, vol 12, Oct 2012
[16]. M. Cardei and D.-Z. Zhang, “Improving wireless sensor network lifetime through power aware organization,” Wireless Networks, vol. 11, no. 3, pp. 333– 340, May 2005.
[17]. H. Zhang and J. Hou, “Maintaining Sensing Coverage and Connectivity in Large Sensor Networks,” Ad hoc and Sensor Wireless Networks, vol. 1, nos. 1/2, pp. 89-124, 2005
[18]. H. Liu, X.H. Jia, P.J. Wan, X.X. Liu, F. Yao, A distributed and efficient flooding scheme using 1- hop information in mobile ad hoc networks, IEEE Transactions on Parallel and Distributed Systems 18 (5) (2007) 1–14.
[19]. J.-H. Lee, T.-K. Kwon, and J.-S. Song, “Group connectivity model for industrial wireless sensornetworks,” IEEE Trans. Ind. Electron., vol. 57, no. 5, pp. 1835–1844, May 2010.
[20]. J. Yick, B. Mukherjee, and D. Ghosal, “Wireless sensor network survey,”Comput. Netw., vol. 52, no. 12, pp. 2292–2330, Aug. 2008.
[21]. V. C. Gungor and G. P. Hancke, “Industrial wireless sensor networks: Challenges, design principles, and technical approaches,” IEEE Trans. Ind. Electron., vol. 56, no. 10, pp. 4258–4265, Oct. 2009.
[22]. J.-Y. Heo, J.-M. Hong, and Y.-K. Cho, “EARQ: Energy aware routing for real-time and reliable communication in wireless industrial sensor networks,” IEEE Trans. Ind. Inf., vol. 5, no. 1, pp. 3–11, Feb. 2009.
[23]. D. Tian and N. D. Georganas, “Connectivity maintenance and coverage preservation in wireless sensor networks,” J. Ad Hoc Netw., vol. 3, no. 6, pp. 744–761, Nov. 2005.

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