ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 4, April 2015

Analysis of Energy Efficiency and Data Density in WSN

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ABSTRACT: In Wireless Sensor Networks, the sensor nodes are capable of collecting, sensing and gathering data from environment. In data aggregation process it aggregates all sensor nodes data with least amount energy utilization and sends its data to the destination. The main goal of data aggregation algorithms is to gather and collect data in an energy efficient manner so that network lifetime is improved. A new algorithm which focuses on energy capable data transmission between all the source nodes and the sink node. The new concept of 'Distance Metric' mechanism is proposed routing protocol for dynamic energy efficiency and shortest path for the data transmission is found to be highly advantageous.

KEYWORDS: Wireless sensor networks, Data Density, Data Aggregation, Clustering method,

I. INTRODUCTION

The recent developments of wireless sensor network (WSN) have enabled low power sensor nodes which are capable of sensing, processing and transmitting sensed data from sensing environment such as observation fields [6]. Data aggregation is the method of gathering and aggregating the required data. Aggregating data is considered as one of the crucial processing measures for energy reduction. In WSN, aggregating data is an efficient mode to accumulate the insufficient resources. The major purpose of data aggregation algorithm is to collect and aggregate data in disciplined way so that network duration is also enhanced [3]. The main goal of a WSN is reliably detecting and accurately evaluating the proceedings in the monitored area with collected data.

A WSN composed of self-organized wireless sensor nodes scattered in a monitored area collects, processes and transmits data acquired from the physical atmosphere [1],[2]. The main goal of a WSN is constantly detecting a precisely evaluating the events in the monitored area with the collected data. For this purpose, sensor nodes should be deployed closely. However, this will cause overlapping of sensor nodes' sensing areas and the spatial idleness of adjacent sensor nodes' data [6],[8]. If every sensor node transmits collected data to the sink node, the sensor nodes will use a large quantity of energy. To reduce the amount of transmitted data in a WSN, a great number of correlation based data aggregation methods have been studied in the literature [6].

According to the level of sampled data in data aggregation approach, data aggregation methods are grouped into three classes: data level aggregation, feature level of aggregation and decision level aggregation [12]. Also, based on the aggregation strategy, we can split the data aggregation methods into three types: in-network query type [5],[13], data compression type[6],[14] and representative type [7],[9],[15]. It will acquire a long time to obtain a reply from WSN in the first type. The second type is of limited usefulness as it is too difficult. The third type is perceptive to the correlation measurement for sensor nodes. The major objective of the representative type is selecting a representative sensor node in the neighborhood and sending its observation to the sink node. Therefore, the relative error between a representative data and its correlated data is a considerable index for evaluating the represented performance.

In the study of data aggregation methods, the spatial correlation model between sensor nodes' data is an main establishment that relates to the precision of aggregated data and energy utilization of sensor nodes[11].The energy effectiveness of the DDCD clustering method is not always the uppermost in data transmitting process. While in the clustering process, the DDCD clustering method is an energy efficient one. The main goal of data aggregation algorithms is to gather and aggregate data in an energy efficient manner so that network lifetime is enhanced. Wireless sensor networks (WSN) offer an progressively more attractive method of data gathering in distributed system architectures and dynamic access via WSN.

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II. RELATED WORK

A. *Optimized clustering technique:*

Jinhui yuan,et.al.[3]proposed optimized clustering technique based on spatial-correlation, which estimates spatial-correlation between the nodes by reading the nodes at an interval times. It can reduce communication sent in the networks a lot and get estimated results with lesser average relative error. It avoids the effect of unpredicted data on the consequences. Proposed two algorithms CC(clusters construction) and KCC(k-hop clusters construction),which construct clusters based on Spatial-correlation according to readings of nodes at interval times and thus clusters can show variability of data in this period of time.

CC may cause some clusters containing too many nodes, and the hop count among the nodes in the cluster may be too much so as to spatial-correlation between the nodes in clusters will be weak [2]. Therefore proposed for improved clusters construction algorithm KCC. Use the average relative error results and energy consumption as metrics for evaluation of performance and the total communication cost as criteria of energy consumption. When it compares average relative error of different clusters construction algorithms this error will be low. It shows that these methods are more efficient than other methods. Also see that error of other algorithms is larger as time goes on and error of KCC is not. It shows that spatial correlation of nodes in clustering more reliable when max hop count of clusters is restricted.

B. *α-LS algorithm:*

Yajie Ma.et.al.[4] proposed an α -local spatial clustering algorithm for sensor networks. By evaluating the spatial connection between data gathered by multiple sensors, the algorithm forms a commanding set as the sensor network strength, used to recognize the data aggregation.

This algorithm is useful for applications such as environmental surveillance where the sensors are always distributed in very high density. Discussed time and message complexities of algorithm with analysis of size of aggregated networks. The trial consequences show that the aggregated network can provide the environmental information in very high accuracy in comparison with the original network. Result of average percentage membership match (APMM) of α-LS clustering is high other algorithms are less which is much lower than APMM of this algorithm. Therefore algorithm has better accuracy performance in data description/summarization.

C. *Energy-aware spatial correlation:*

Ghalib A. Shah. et.al.[5] explains an energy-based spatial correlation model on a clustering protocol. In this approach, only the cluster-heads are accountable of exploiting spatial correlation nodes as well, since energy preservation is a key matter for their member nodes and selecting the suitable associate nodes to stay energetic. The correlation is based on the distortion tolerance and the remaining energy of associate nodes[10]. However, it provides predictable head divides its clustered region into connection regions and selects a core node in each correlation region which is closer to the center of correlation region and has the higher remaining energy.

The non-core sensor nodes remain inactive until the energy of active nodes go down to some threshold value. Consists of the event readings distortion, number of active nodes, average packet delay and energy expenditure. When the concentration of nodes is high the wireless channel is contended by high number of nodes that result in great communication interruption. Average packet delay is larger than at lower densities. Simulation results prove that the required reporting rate can be achieved with less number of nodes by exploiting spatial correlation and finally conserves the nodes energy. Similarly delivery ratio is improved by increasing the threshold value.

D. *Coverage in Wireless Sensor Networks: A Survey*

Wireless sensor networks are a rapidly rising area for research and commercial development. Wireless sensor networks are used to monitor a given field of interest for changes in the environment. They are very useful for military, ecological, and technical applications to name a few. One of the most active areas of explore in wireless sensor networks is that of coverage[6]. Coverage in wireless sensor networks is usually defined as a measure of how well and for how extensive the sensors are able to observe the physical space. In this paper, they take a representative survey of the current work that has been done in this area. Define several terms and concepts and then show how they are being utilized in various research works.

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III. Clustering Method Description

A. *Data Density Correlation Degree*

In a WSN, if a certain number of neighboring sensor nodes' data are close to a sensor node's data, this sensor node can represent its neighbours in the data domain. This representative sensor node is called the core sensor node.

Definition 1: Core sensor node. Let us consider sensor node v has n neighbouring sensor nodes. They are respectively v 1 , v 2 . . . v n . The data object of v is D. It's neighbouring sensor nodes' data objects are respectively D1 , D2 . . . Dn . If there are N data objects in D1, D2 , . . ., Dn whose distances to D are less than ε and min Pts ≤ N ≤ n then the sensor node v is called the core sensor node. Where min Pts is the amount threshold, ε is the data threshold. Instinctively, the larger the N is, the improved representative the sensor node v is to those sensor nodes whose data objects are in ε-neighbourhood of D. Meanwhile, high interest of the data objects in the ε-neighbourhood of D implies that sensor node v has a high spatial correlation between it and these sensor nodes. Therefore, to determine the representation degree of v to those sensor nodes whose data objects are in ε-neighbourhood of D in quantity, we proposed the data density correlation degree as shown in definition 2.

Definition 2: Data density correlation degree. Let sensor node v has n neighboring sensor nodes which are inside the cycle of the communication radius of v. They are v 1 , v 2 . . .v n , respectively. The data object of v is D, and its neighbouring sensor nodes' data respectively D1 , D2 . . . Dn. Among these n data objects, there are N data objects whose distance to D is not as much of than ε, and min Pts ≤ N ≤ n. After that the data density correlation degree of sensor node v to the sensor node whose data objects are in ε-neighbourhood of D is as follows.

$$\mathrm{Sim}(V_1) = a_1\left(1-\frac{1}{\exp(\mathrm{N}-\mathrm{minPts})}\right) + a_2\left(1-\frac{\mathrm{d}\Delta}{\epsilon}\right) + a_3\left(1-\frac{\mathrm{d}}{\epsilon}\right)$$

Where min Pts is the amount threshold, ε is data threshold. dΔ is the distance between D and the data centre of the data objects which are in the ε neighbourhood of D. d is the average distance between the N data objects and D. a1+a2+a3=1.

If the data density correlation degree of sensor node v is $\mathrm{Sim}(V_1)$ defined by Eq.1,then we can obtain the properties of $\mathrm{Sim}(V_1)$ as.

1) $\mathrm{Sim}(V_1)$ increases with the increase of N, the amount of data objects which are in the ε-neighbourhood of D;
2) $\mathrm{Sim}(V_1)$ increases with the increases with decreases of dΔ, the distance between D and the data centre of the data objects which are in the ε-neighbourhood of D;
3) $\mathrm{Sim}(V_1)$ increases with the decreases of d, the typical distance between D and those data objects which are in the ε-neighbourhood of D;
4) $\mathrm{Sim}(V_1) \epsilon [0,1]$.

These properties are consistent with our intuitiveness. In definition 2, the data threshold ε guarantees that $\mathrm{Sim}(V_1)$ will not be impacted by unrelated data. The amount threshold min Pts is the minimum amount for sensor node v to represent some sensor nodes. In order to exhibit the potency of data density degree defined by Eq.1. It includes three procedures: the Sensor type calculation (STC), Local cluster construction(LCC), Global representative sensor node selection(GRS).

IV. Approach

We propose a protocol Dynamic Energy Efficient Latency Improving Protocol (DEELIP), with a concept of distance metric, which reduces the overhead network traffic ensuring in the improvement of energy and latency than the DDCD method. In proposed protocol, to reduce the transmission delay, we have considered a new concept of the 'Distance Metric' (DM) instead of 'hop count (h)'. Here, the distance means the air distance between sink to particular sensor node. We have understood that the sensors are indiscriminately deployed on the field, so that the data transmission between any nodes to sink node may take quite a lot of paths with dissimilar distance level since the distances between nodes are not equal. The total path distances from sensor nodes to sink node are intended by adding all distances between nodes in that routing path. Actual data transferred only after confirming the shortest path. Since the path is the shortest, the transmission time can reduce and so that delay can be minimized.

In Proposed 'DEELIP' protocol,

- Any sink to the other node for hop level constraint, it calculates the distance between nodes and also updates the distance between the sink to that node.
- The sink node sent their fresh position in announcement message to all nodes.

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- At hop level one, it will update this between sink to their node, so the sink node has to send their fresh one position in our publication message.
- Since all nodes sends the message at a time and updates their routing tables at a time, it reduces the broadcast delay
- This is the pioneering way of reducing overheads on packet traffic so as to finally decrease the transmission delay.

V. CONCLUSION

The main contributions of this paper are introduction of data density correlation degree (DDCD) clustering method. The DDCD clustering method concentrates on the well-organized clustering process only on the data precision during data broadcast process and does not consider the energy efficient way of data transmitting process and there exists a time setback also. Hence to overcome drawbacks in the existing model, we proposed a DEELIP protocol which is the novel way of dropping the transmission delay and increases energy efficiency

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