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Performance Analysis of Tree Cluster Based Data Gathering for WSNs

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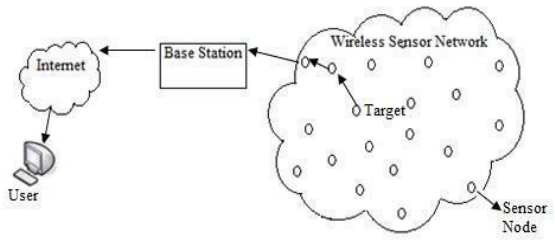
***Abstract*— Wireless sensor network (WSNs) contain many sensor devices which send their data to the base station for processing is called direct delivery. This cause to heavy traffic in network so this decreases the lifetime of the network. Wireless sensor networks have been widely applied in various industrial applications, which involve collecting a massive amount of heterogeneous sensory data. However, number of data gathering strategies for WSNs cannot avoid the hotspot problem in local or whole deployment area. network connectivity affected by the hotspot problem and decreases the network lifetime.WSN suffers from many hurdles such as small memory, low computational capability, and limited energy resources so, data gathering technique is introduced to improve the lifetime of network. Therefore to improve performance large number of protocols are introduced. Previous researchers have used such types of the cluster-based, the chain-based and the tree-based to establish their energy-efficient routing protocols. In this paper, we propose an improved version namely a tree-cluster data gathering technique which uses both cluster and tree based protocols. The simulation and comparison with other techniques shows that our TCDGT can significantly balance the load of the whole network, reduce the energy consumption, alleviate the hotspot problem and prolong the network lifetime.**

Keywords*— WSNs, sensor data collection, Energy Efficient, data gathering, Clustering, Cluster Head Selection

I. INTRODUCTION

A wireless Sensor Networks (WSN) must have of different sensor enable nodes which are distributed in an environment and use batteries as energy resource. These sensor nodes, which consist of data processing, sensing, and communicating components, result in the idea of sensor networks based on collaborative effort of a large number of nodes. A typical WSN is composed of a large number of sensor nodes, randomly circulate over the network. Signals which are picked up by all types of sensors and data acquiring, processing and transmitting them into a node called as sink node. The energy conservation of the network can be decreased by the cluster heads, cluster heads means allowing the porting of the nodes. Data gathered from the nodes are aggregated by the cluster heads. After this process, aggregated data is forwarded to the BS, but it has some problems. The major problem is energy consumption which is concentrated on the cluster heads. In order to solve this problem cluster routing is used for distribution of energy consumption with the cluster heads [1]



. Fig.1. Basic structure of WSN

The limited energy resource, such as using non-rechargeable battery supplies to each sensor node, is one of the most crucial challenges in WSNs. Many routing algorithms have been developing for WSNs. Many hierarchical routing algorithms which are proposed for only WSNs concentrated mainly on increasing the lifetime of the network by reducing the energy consumption. Data gathering would be more efficient with homogenous sensor networks. Data aggregation is the process of collecting the data from all different sensors and transmitted to the base station In this case, data aggregation is accomplished by collecting and aggregating data from a set of sensor nodes. The data which is collected that combined into a single data packet to be sent to the sink node. Certainly, this try to minimize the number of transmissions by eliminating data redundancy and thus reduce the total power and continues to provide accurate information in the face of security attacks and hardware failure. The sheer number of sensor nodes in a sensor network combined with the unique characteristics of their utilization in the network.

Clustering in WSNs is an important technique to decrease the energy consumption over these networks and thus increasing its network lifetimes. Many energy efficient protocols based on clustering and data aggregation have been studied [2].

The main goal of a sensor network is to produce, over an extended period of time, globally meaningful information from raw local data obtained by individual sensor nodes. Mainly, this objective must be achieved in the context of prolonging as much as possible the useful lifetime of the network and ensuring that the network remains mainly available operating environment (anonymity of personage

sensors, limited power resources and a possibly hostile environment), pose unique challenges to the designers of protocols. For one thing, the limited power budget at the separate sensor node level mandates the design of ultra-light weight data gathering, fusion, and communication protocols. An important guideline in this way is to perform as much local data processing at the sensor level as achievable, avoiding the transmission of raw data through the sensor network. Recent advances in hardware technology are making it plain that the biggest challenge facing the sensor network community is the development of ultra light weight communication protocols ranging from guidance, to identity organization, to network protection, to security, to data gathering and fusion, to routing, along with many others.

Most research works for wireless sensor networks often assume that the data collected by sensors are transmitted to one or several sink nodes in some specific location in the WSNs. It was identify that the sensors which is closest to the sink tend to deplete their energy budget faster than other sensors, which makes an energy hole approximately the sink. If there in an energy hole then no more data can be transmitted to that sink. Accordingly a considerate amount of energy is wasted and the network lifetime ends prematurely. Experiments in [3] showed that there is still a great amount of energy left unused after the network lifetime is over for large-scale networks, which can be as much as 90% of total initial energy. Accordingly, improving the prolonging the lifetime of networks and energy efficiency is a key problem.

A. Data collection methods in wireless sensor networks

In WSN distinct types of data collection methods are present that are mainly classified as data collection using mobile sensor nodes, data collection using mobility based approach and data collection using static sink approach. Mobility based approach is again classified into two groups they are data collection using single mobile sink and data collection using multiple mobile agents. Multiple mobile mules are also used for data collection. Path of these mobile agents can be constrained or uncontrollable. Figure 2 shows data collection methods in wireless sensor networks [3]

This paper mainly focuses on the tree-cluster based secure data gathering techniques. The data gathering of these protocols can be characterized as i) systematic collection and transmission of sensed data from multiple sensor nodes and ii) processing them at a remote location for final decision making. Data aggregation is nothing but a process of aggregating the data from different sensor nodes to eliminate redundant transmission and provide fused information to the base station. Security is an important design issue in data gathering and aggregation for wireless sensor networks. Secure data collection is a challenging task when sensors are deployed in hostile environments and are passionate to physical attacks. [4].

Multi-hop routing and Direct transmission are conventional transmission schemes for WSNs. In multi-hop networks, encoded data are transmitted and generated by any one sensor to an intermediate node, and then relayed to a sink hop by hop. In Ref. [6] they prove that in WSNs multi-hop transmission is more energy-efficient than single-hop transmission. Nevertheless, when a sink is far from the sensor area or the area is so long that most sensor nodes need numerous hops to r each the sink, considerable retransmitting energy is consumed during transmission, thereby significantly accelerating node depletion [6].

To remove the problems from existing algorithms, here we propose a Tree Cluster Based Data Gathering technique which significantly balances the load of the whole network, reduce the energy utilization, alleviate the hotspot problem and prolong the network lifetime.

II. LITERATURE SURVEY

In this section we gives brief description of different papers about cluster formation, tree construction, data collection ,data forwarding and energy consumption is carried out. In last decade, a number of studies have discussed the issues of data gathering techniques to discover the efficient path.

A. Abdullah I. Alhasanat1 (2015)

In [1], they proposed a new algorithm which focused on reducing the transmission bath between sensor nodes and cluster heads. A proper utilization and reserving of the available power resources is achieved with this technique compared to the well-known LEACH_C algorithm. The main purpose of this algorithm is to continually divide the sensor network into four partitions which are symmetrical about a centroid node. Furthermore, a set of cluster heads is defined in the middle of each partition in order to aggregate data from cluster members and transmit these data to cluster heads in the next hierarchical level.

B. Narendran. M (2014)

In [2], the main objective is to reduce the overall network overhead and energy expenditure associated with the multihop data retrieval process while also ensuring balanced energy consumption among SNs and prolonged network lifetime. The different kind algorithms are used to partition the neighboring nodes, which will sense similar sensor nodes into one cluster and wireless sensor nodes autonomously adjust control parameters after observing its environments. This is achieved through developing cluster structures which may consist of member nodes that route their measured data to their assigned cluster head (CH). In this paper various method has been reported and compared.

C. Priya V. Ujawe1 (2014)

In [3], In this paper they discus about different data aggregation techniques to improve energy efficiency in WSN. Also they have suggested modified data in network aggregation technique to solve the problem of existing DRINA. Distinct data aggregation protocols or algorithms are used for energy efficiency in WSN's by different researchers. Cluster based and in-network algorithm is widely used for low energy utilization and increase the life time of network

D. M.G.Annapoorani1 (2014)

In [4], this paper the proposed approach is designed with 3 phases (i) initialization phase (ii) packet-splitting phase (iii) forwarding phase. Before the collection of data from sensor node, the sink node broadcast the message to all sensor nodes

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in the network to form the route path from the sensor to sink. To form the route path the proposed system incorporate the method of SCF. SCF stands for Self Cantered Friendship is nothing but the tree generation method in this each node will consider itself as root node and appends the nodes that are connected to them by one hop. After the basic structure of Self Canted Friendship Tree the system shifts forward with help of Chinese Remainder Theorem for break the packets. The Chinese Remainder Theorem (CRT) is characterized by a simple modular division between the integers. Once all sub packets (called CRT components) are received correctly the sink node will recombine them using mask. When, compared to the existing data collection techniques data collection using SCF Tree with CRT based packet forwarding is found to produce the best result in terms of energy consumption, data accessibility and low communication cost.

E. Mohammad Hossein Anisi (2011)

In [5], this paper they introduce a methodology which takes the benefit of both cluster and tree structures for data gathering. In his proposed energy-efficient method, the most proper hops for data forwarding will be selected as well as the lifetime of the whole network will be maximized. They shows experimental results using the proposed method, the throughput and the lifetime of the network will be increased.

F. LIU Danpu (2013)

In [6] A transmission scheme for energy-constrained WSNs is proposed in this paper. The scheme, called MIHOP (MIMO and Multi-hop), combines cluster-based virtual MIMO and multi-hop technologies. The multi- hop mode is employed in transmitting data when the related sensors are place within a specific number of hops from the sink, and the virtual MIMO mode is used in transmitting data from the remaining sensor nodes. To calculating the optimal hop count in MIHOP they compare the energy utilization of different transmission technique and propose an algorithm. A controllable mobile sink that minimize the energy consumed in sensor transmission is also adopted for data collection.

G. Dipesh Sharma (2011)

In [7], they propose an improved version existing approaches which uses both cluster and tree based protocols. The proposed protocol improves the power consumption by improving FND. In this paper they introduce, the one new data gathering technique for wireless sensor network has been introduced. Detailed simulations of wireless sensor network environment indicate that our DGP can reduce energy utilization improve evenness of dissipated network energy and the ability of extending the life span of the network

H. Praveena. R (2015)

In [8], this paper, cluster based new data collection method is proposed. It is based on cluster topology. The mobile sensors have many benefits to gather and collect the data as compared to static sensor nodes,. The proposed data collection method has a Data Gathering Node (DGN).The DGN is made as a mobile node, which try to moves towards the cluster and collects the data and forwards to the sink. The DGN does not participate on sensing in this particular round, however, it simply gathers the data packet from the cluster and delivers it to the sink. The proposed method minimizes the energy utilization, delay and traffic. The simulation results have indicate that proposed data collection method has better performance in terms of energy consumption, end-to-end delay, and throughput and network lifetime of WSNs.

I. Chuan Zhu(2015)

In [9],this paper they propose a tree-cluster-based data-gathering algorithm (TCBDGA) for WSNs with a mobile sink. In this paper they introduce weight-based tree-construction method. Rendezvous points (RPs) are nothing but the root nodes of the constructed trees. Some nodes are selected according to their hops to root nodes and traffic load that node called as sub rendezvous points (SRPs) . RPs and SRPs are viewed as stop points of the mobile sink for data collection, and can be reselected after a certain period. The simulation and comparison with other existing algorithms show that our TCBDGA can significantly balance the load of the whole network, reduce the energy consumption, alleviate the hotspot problem, and prolong the network lifetime**.**

J. Dr. Saravana Selvam (2016)

In [10], this paper they proposed Energy Efficiency Clustering and Data aggregation for sensor Network. There are four phases: cluster head, data aggregation, cluster head selection, and maintenance. Important issued in wireless sensor network is minimize the total energy utilization requires to collect data. Proposed protocol gives improved network time period since the energy level of the nodes are considered while choosing the cluster head.

III. PROPOSED APROACH FRAMEWORK AND DESIGN

A. Problem Definition

Wireless sensor networks are very small in size, have limited processing capability and very low battery power. This restriction of low battery power makes the sensor network prone to failure so, Data Gathering is very crucial technique in Wireless Sensor networks. However, most of the data-gathering strategies for WSNs cannot avoid the hotspot problem in local or whole deployment area. hotspot problem caused the network connectivity and minimize the network lifetime. So, an improvement over the above technique would be clustering where each node sends data to cluster-head (CH) and then aggregation performed by the cluster-head on the received raw data and send it to sink.

B. Proposed System Architecture

In our system, we propose a Tree Cluster based data gathering technique (TCBDGT) which balances the energy consumption in order to reduce heavy burden around them. Proposed system also increase the network lifetime compared with other existing data gathering techniques. The flow of the system if shows in below diagram.

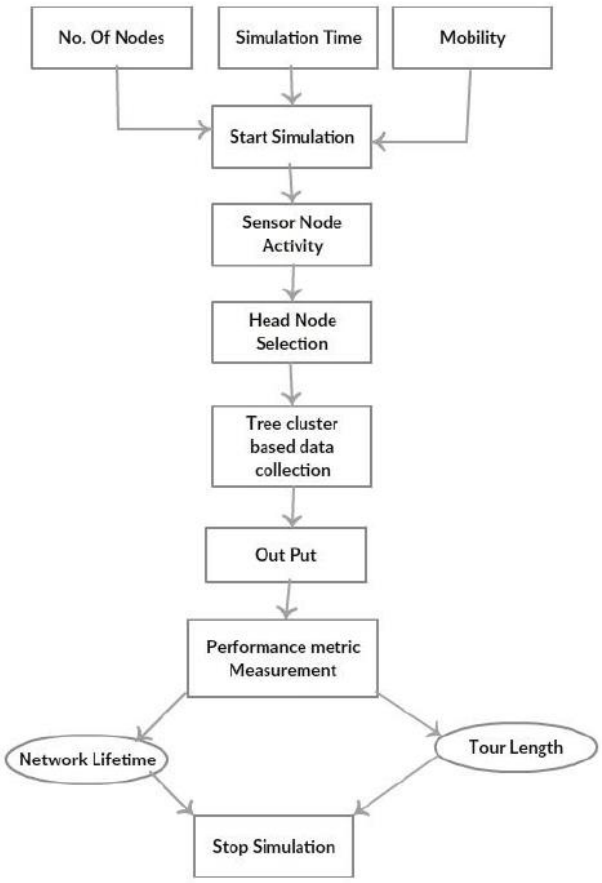

Fig. 2. Architecture Diagram.

Above diagram shows the flow of our proposed system. System take no of nodes, simulation, mobility as a input and then start simulation process.

IV. MATHEMATICAL MODULE

The equations used to calculate transmission and reception costs for a k-bit message and a distance d are as below:

Transmitting:

$$E\ tx\ (k, d) = E\ tx - elec\ (k) + E\ tx - amp\ (k, d) \quad \text{.....(1)}$$

$$E\ tx\ (k, d) = E\ elec * k + \epsilon amp * k * d\ 2 \quad \text{.....(2)}$$

Receiving:

$$Erx(k) = Erx - elec(k) \quad \text{..... .....(3)}$$

$$Erx(k) = Eelec * k \quad \text{.....(4)}$$

Algorithm
Initialize {
1. Base station: Accept the number of clusters N1;
2. Divied the whole network into N1 clusters;
3. Choose cluster head from each cluster;
4. Notify the node which is cluster head.}
Repeat :{
1. Node Ni: if (Accept the notify message NM from the base station)
2. Then work in cluster head ;
3. If (Accept the broadcast message BM from cluster head node)
4. Then work in sensing mode.
For cluster head p:{
1. Receive data born cluster member q;
2. Calculate the weight value Wp and Wq;
3. If (Wp > Wq), Wp Work in cluster head;
4. Else p work in sensing mode;
5. Notify q to be cluster head ;}

IV. SIMULATION RESULTS AND ANALYSIS

In this we discuss the performance of our system with existing systems. We measure performance with respect to network life time and Average Tour Length

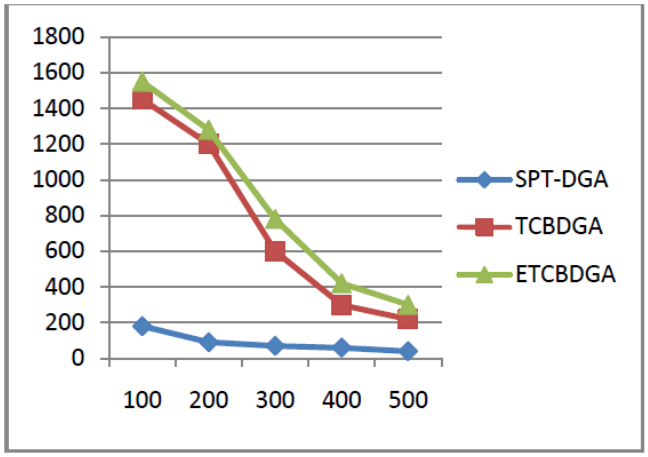

Fig. 3. Comparison of network lifetime.

In above graph x axis shows number of sensor and y axis shows network life time. Network life time is nothing but the number of the data collection round until the first sensor node of the network dies as a result of depleting its energy resources

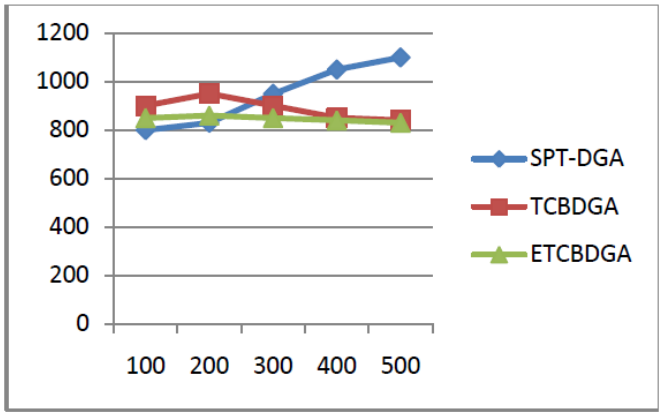

Fig.4. Comparison average tour length.

In above graph x axis shows number of sensor and y axis shows average tour length. When N is small, the SPT-DGA

performs a little better than TCBDGA, but when N becomes larger, the average tour length of our TCBDGA decreases. That's because that we consider the node density when selecting parent node of each node, so that the selected number of RPs is less than that of SPT-DGA. This significantly influences the tour length when the number of nodes becomes larger. Also, we can see our ETCBDGA always has the shortest tour length compared with the other two algorithms, but we do not regard it as the best one for the reason that it does not consider the load balancing of the whole network.

V. CONCLUSION

In this paper, propose a Tree Cluster based data gathering technique (TCBDGT) which balances the energy consumption in order to reduce heavy burden around them. The network lifetime of TCBDGT is increase as compared to other existing data gathering techniques. Our system can expressively balance the load of the whole network, reduce the energy consumption, alleviate the hotspot problem and increase the network lifetime and maintain average tour length.

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