An Energy-Efficient, Delay-Aware, Lifetime-Balancing and Data Collection Protocol for Heterogeneous Wireless Sensor Networks

Merina Devi Hemam, N.V. Uma Reddy

Abstract: The technique that is used in this paper is to make it more simpler for wireless sensor networks problem .To make the energy more efficient a protocol is used that is called EDAL. It is rebuilt from the existing system called OVR which uses NP-hard algorithm. To make more prominent a centralized heuristic is design to make the computational overhead more smaller and to detect the dead nodes. As it has some limitation distributed heuristic is design which is the best for large scale networks.

Keywords: Power consumption, delay, energy efficient, heuristic algorithm, wireless sensor networks.

I. INTRODUCTION

Advances in wireless communication made it possible to develop wireless sensor networks(WSN) consisting of small devices, which collect information by cooperating with each other. These small sensing devices are called nodes and consist of CPU(for data processing), memory(for data storage), battery(for energy) and transceiver(for receiving and sending signals or data from one node to another). The size of each sensor node varies with applications .For example, in some military or surveillance applications it might be microscopically small .Its cost depends on its parameters like memory size, processing speed and battery[1]. Today, wireless sensor networks are widely used in the commercial and industrial areas such as for e.g. environmental monitoring, habitat monitoring, healthcare, process monitoring and surveillance. For example, in a military area, we can use wireless sensor networks to monitor an activity. If an event is triggered, these sensor nodes sense it and send the information to the base station (called sink) by communicating with other nodes. The use of wireless sensor networks is increasing day by day and at the same time it faces the problem of energy constraints in terms of limited battery lifetime. As each node depends on energy for its activities, this has become a major issue in wireless sensor networks. The failure of one node can interrupt the entire system or application. Every sensing node can be in active(for receiving and transmission activities), idle and sleep modes. Inactive mode nodes consume energy when receiving or transmitting data. In idle mode, the nodes consume almost the same amount of energy as inactive mode, while in sleep mode, the nodes shut down the radio to save the energy. The following steps can be taken to save energy caused by communication in wireless sensor networks[2].

To schedule the state of the nodes (i.e. transmitting, receiving, idle or sleep).

- Changing the transmission range between the sensing nodes.
- Using efficient routing and data collecting methods.
- Avoiding the handling of unwanted data as in the case of overhearing.

Many sensing applications share in common that their source nodes deliver packets to sink nodes via multiple hops, leading to the problem on how to find routes that enable all packets to be delivered in required time frames, while simultaneously taking into account factors such as energy efficiency and load balancing [3]. The key motivation for this work stems from the insight that recent research efforts on open vehicle routing (OVR) problems are usually based on similar assumptions and constraints compared to sensor network [4]. Specifically, in OVR research on goods transportation, the objective is to spread the goods to customer's infinite time with the minimal amount of transportation cost. One may wonder, naturally, if we treat packet delays as delivery time of goods, and energy cost as delivery cost of goods, it may be possible to exploit research results in one domain to stimulate the other. In WSNs the only source of life for the nodes is the battery .Communicating with other nodes or sensing activities consumes a lot of energy in processing the data and transmitting the collected data to the sink. In many cases (e.g. surveillance applications),it is undesirable to replace the batteries that are depleted or drained of energy[5] . Many researchers are therefore trying of in power-aware protocols for wireless sensor networks in order to overcome such energy efficiency problems as stated above. All the protocols that are designed and implemented in WSNs should provide some real-time support as they are applied in areas where data is sensed, processed and transmitted based on an event that leads to an immediate action. A protocol is said to have real-time support if and only if it is fast and reliable in its reactions to the changes prevailing in the network. It should provide redundant data to the base station or sink using the data that is collected among all the sensing nodes in the network. The delay in transmission of data to the sink from the sensing nodes should be short, which leads to a fast response.

II. SYSTEM ANALYSIS

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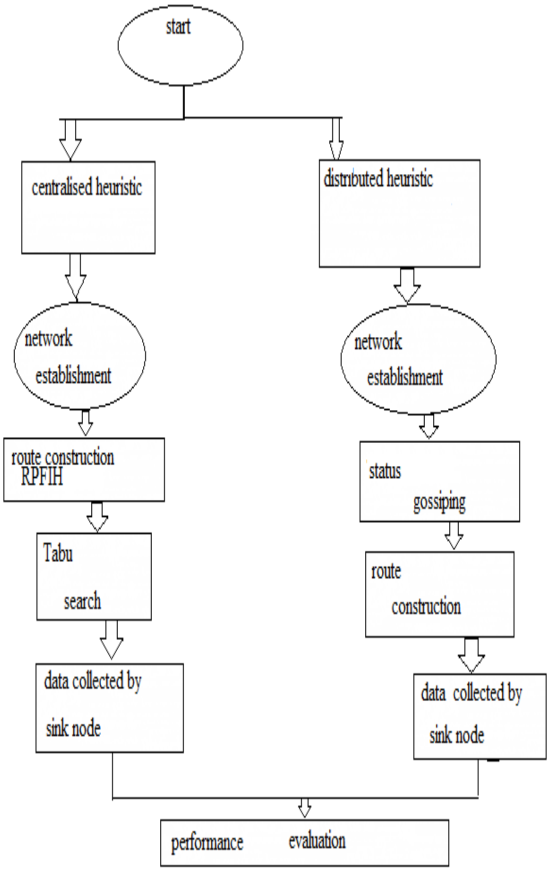

Fig. 1: System model

A. Problem Model

The purpose of this project is to find protocols that are energy efficient and support real-time traffic for environments like habitat monitoring or area surveillance.

Wireless sensor nodes which uses battery are for detecting and collecting information from those areas where there is very little hope form annual handling to recharge or change batteries. These sensing nodes collect all the possible information from the source and forward them on to the network towards the sink for further process. To make the functioning more prominent and with a better lifetime for a sensing node within the network, energy consumption is considered as it is a major concern.

These node try to detect and collects information if any object that is moving or any event that's triggered. The network that is carrying this information use an ordinary protocol stack which does carries out the general process of transmission without any concerns for energy efficiency factor. The given down below are the assumptions for the surveillance applications in wireless sensor networks which are used as a frame of reference in the study.

Wireless sensor networks has many sensing nodes that are distributed in a wide area. They can sense an event occurring in the environment and these sensing nodes are distributed or placed according to the requirements of the application.

Energy must be saved, so that the batteries do not get drained quickly as there are no easily replaceable in applications such as surveillance.

Quality of service make sure that the effective communication within the given or bounded delay time. Protocols must be check for the stability of the network; redundant data should be transmitted over the network in any type of traffic distribution. It also needs to maintain certain resource limiting factors, such as bandwidth, memory buffer size and processing capabilities. The transmission plays a major role in WSNs. Nodes can be taken as single-hop or multi-hop depending upon the type of network structure chosen for communication or transmitting data to other nodes within the network. The sensor nodes can be dynamic or stable depending on the application. In surveillance applications, sensor nodes are placed in unwanted areas so it can be self-organizing and self-creating.

The performance of wireless sensor networks is based on the following factors.

Scalability**:** Scalability is a major role in wireless sensor networks. A network area which is never static, changes depending upon the user requirements. The nodes in the network area must be scalable in order so that it adjusts themselves to the changes in the network topology depending upon the user.

Energy Awareness**:** Every node uses some energy for activities like sensing, processing, storage and transmission. A node in the network should know how much energy will be utilized to perform a new task that is submitted, the amount of energy that is dissipated can vary from high, moderate to low depending upon the type of functionality or activity it has to perform.

Node Processing Time: means the time taken by the node in the network for performing all the operation starting from the sensing activity to processing the data or storing data within the buffers and transmitting or receiving it over the network.

Transmission Scheme: Sensor nodes which collect the data transmit it to the sink or the base station either using the flat or in multi hop routing schemes.

Network Power Usage: The sensor nodes in the network uses a limited amount of network power which helps them to perform certain activities like sensing or processing or even forming groups within the network area. The amount of energy or power that is utilized by the sensor nodes or a group of sensors within the network is known as network power usage.

B. Complexity analysis

The need to select a known NP-hard problem and show that, in polynomial steps, it can reduced the problem. The particular NP-hard problem that is selected is the open vehicle routing problem with time deadlines (OVRP-TD) , which is a variant of vehicle routing problem with time windows (VRPTW) . This problem aims to find the least-cost routes from one point to a set of scattered points and has been proven as NP-hard.

C. Centralized Heuristics

Heuristic solutions to reduce its computational overhead. A centralized meta-heuristic that employs tabu search to find approximate solutions. The nodes have been selected as sources at the beginning of each data collection period. The heuristic algorithm has two phases: route construction, which finds an initial feasible route solution, and route optimization, which

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improves the initial results using the tabu-search optimization technique. Heuristic algorithm based on the revised push forward insertion (RPFIH) method is presented. The original push forward insertion algorithm is proposed and modify it to fit the needs of wireless sensor network. At the beginning of RPFIH, for each node, the minimum-cost path to the sink is found.

D. Distributed Heuristics

The centralized heuristics that has developed in EDAL requires information to be collected from each node to a centralized one. But in distributed sensor networks, step will typically incur additional overhead. Therefore, it is usually desirable to distribute the algorithm computation into individual nodes. A distributed heuristics algorithm for EDAL, where at the beginning of each period, each source node independently chooses the most energy-efficient route to forward packets. It consists of two phases: status gossiping and route construction. In the gossiping phase, each source node sends forward spreading its current status, including its remaining energy level, toward its neighbour source nodes within hops .In the status data of nearby nodes is collected by each source node with the received backward. During the gossip phase, the ants are forwarded with a modified geographic forwarding routing protocol, which chooses the node with the maximum remaining energy while making geographical progress toward the destination as the next hop.

III. PERFORMANCE ANALYSIS

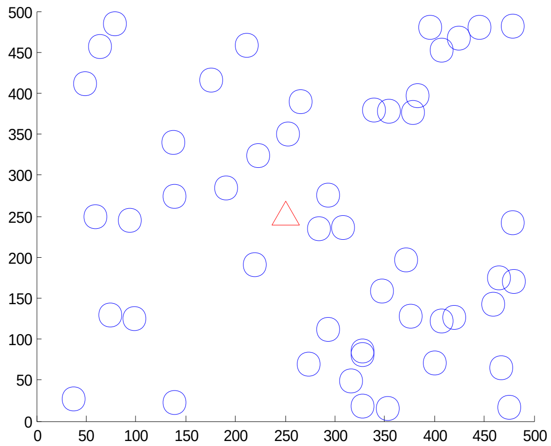

Fig. 2: Node Architecture

In the architecture of node considering a reference node of 50 which can be change   as it is heterogeneous with a length 500 and width of 500 and 250 each for transmitter and receiver. As the reference is 50 so out of 50 one will source and the remaining will be the sink. The communication can happen between the transmitter and receiver node   but it can also happen between the transmitter and transmitter and receiver with receiver. The coordinate is found out between the node so that shortest distance is located where the packets or data will be transferred.

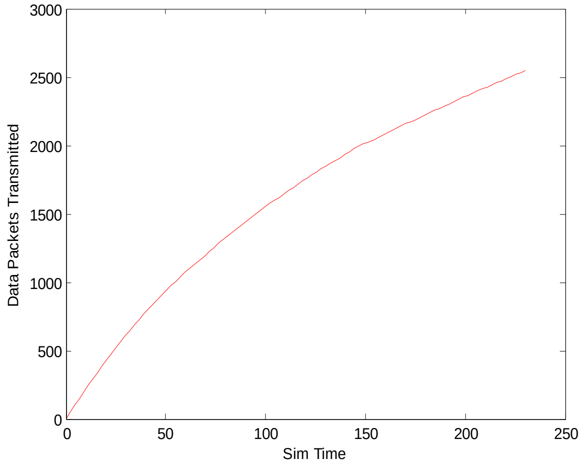

Fig. 3: Packet Transmitted

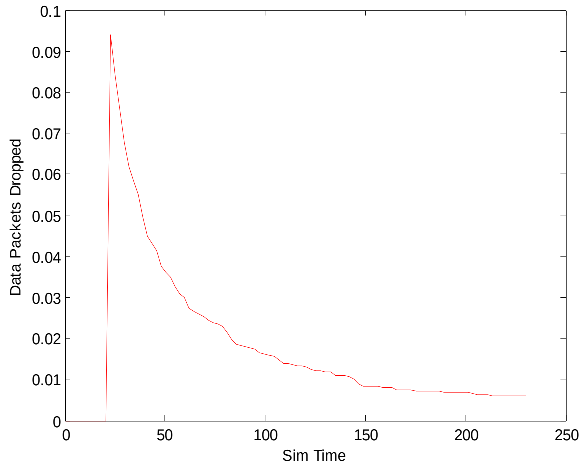

Fig. 4: Packet Dropped

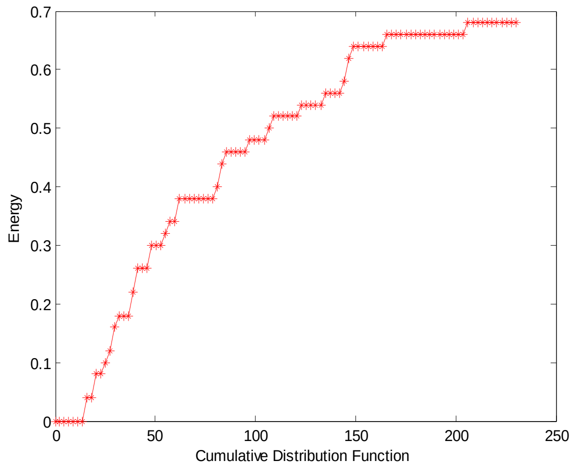

Fig. 5: Energy graph

In figure 5 when the packet is transmitted with time the throughput is more as long as the node are not dead. When one of the node is found dead   the will be link between the node the packet transfer will be dropped but the energy won't be wasted because more energy will be given to the dead node when the iteration is done . The iteration will carry on until the whole sink node receives the packet. Thus energy will be efficient .So as long as the

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packet is being transmitted the energy will increase that will increase the lifetime of a node. The energy is compare with cumulative distributive function.

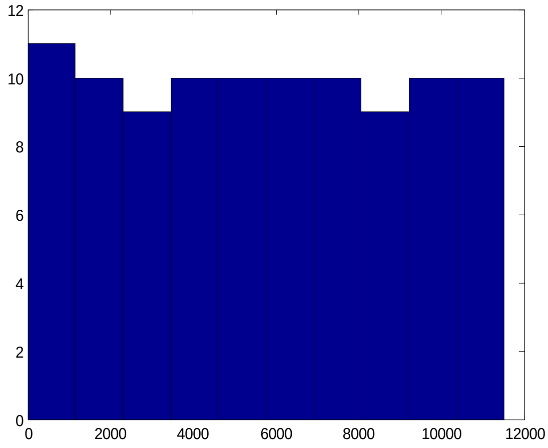

Fig. 6: Network lifetime

The comparison of network lifetime with the compress rate .As more the compress rate less the lifetime of a node.

IV. ADAVANTAGES

• Network lifetime: This metric is computed as the ratio of network lifetime of different algorithms to the network lifetime of MST, which is taken as the standard unit.

• Average selected node number: It is collected as the number of nodes used to form routes under different delay bounds.

• Average energy consumption: It is measured as the average energy consumption of the whole network in each period.

• Node remaining energy: This metric is generated as the percentage of remaining energy from the full battery on each nod e.

• Packet delays: It is the time consumed for transmitting the packet from the source to the destination.

V. SCOPE FOR FUTURE WORK

This project was limited to the design of energy efficient but some additional work can be done by doing the particular path selection in the node. And the other additional work is avoiding the congestion which will reduce the traffic while sending the packets so that it won't be delay.

VI. CONCLUSION

EDAL, an Energy-efficient Delay- Aware Lifetime-balancing protocol for data collection in wireless sensor networks is the advanced version of open vehicle routing problems with time deadlines (OVRP-TD). EDAL is used to generate routes that connect all source nodes with shortest path node and minimal total path cost, under the constraints of packet delay requirements and load balancing needs. The problem formulated by EDAL is NP-hard. Therefore, a centralized heuristic to reduce its computational Complexity and distributed heuristic is also developed to further decrease computation overhead for large-scale network operations. Based on both simulation it is observe that compared to baseline protocols, EDAL achieves a significant increase on network lifetime without violating the packet delay constraints. Finally, it is demonstrate that by integrating compressive sensing with EDAL, additional lifetime gains can be achieved.

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