A Delay-Aware And Energy-Efficient Routing Protocol For Wireless Sensor Networks

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Abstract: The Wireless Sensor Networks (WSNs) have emerged as a new category of networking systems with limited computing, communication, and storage resources. In many sensing applications 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. The technique that is used in this paper is to make it simpler for wireless sensor networks problem .To make the energy more efficient a protocol is used that is called EDAL. To solve this problem one data collection protocol is developed called EDAL, which stands for Energy-efficient Delay-aware Lifetime-balancing data collection. Methods used are centralized heuristic and ant colony gossiping to find best energy efficient path. CAS (Cooperation-Aware Scheme) is used to reduce the traffic in the network. To make more prominent a centralized heuristic is design to make the computational overhead smaller and to detect the dead nodes. As it has some limitation distributed heuristic is design which is the best for large scale networks.

Index Terms **– Energy efficiency, Ant colony gossiping, Centralized heuristic, Cooperation-Aware Scheme, Power consumption, delay, energy efficient, heuristic algorithm, wireless sensor networks.**

I. INTRODUCTION

Wireless Sensor Network (WSN) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location. A WSN consists of few hundreds to thousands of sensor nodes. The sensor node equipment includes a radio transceiver along with an antenna, a microcontroller, an interfacing electronic circuit, and an energy source, usually a battery. The size of the sensor nodes can also range from the size of a shoe box to as small as the size of a grain of dust.

The main constraint of sensor nodes is their very low finite battery energy, which limits the lifetime and the quality of the network. For that reason, the protocols running on sensor networks must consume the resources of the nodes efficiently in order to achieve a longer network lifetime.

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

This paper develops EDAL, an Energy-efficient Delay-Aware Lifetime-balancing data collection protocol. Specifically, EDAL is formulated by treating energy cost in transmitting packets in WSNs in a similar way as delivery cost of goods in OVR and by treating packet latencies similar to delivery deadlines. So introduce both centralized heuristic based on tabu search and a distributed heuristic based on ant colony gossiping, to obtain approximate solutions. Our algorithm designs also take into account load balancing of individual nodes to maximize the system lifetime.

II. RELATED WORK

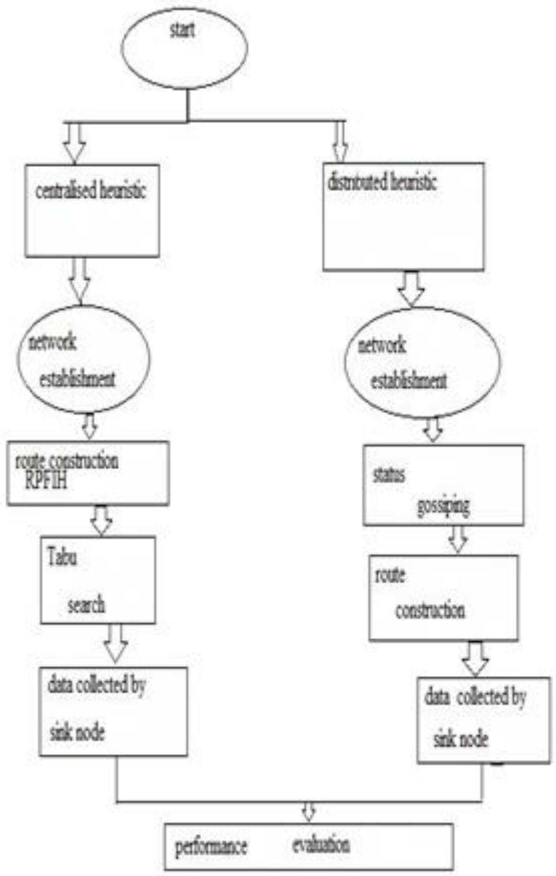

Fig. 1: System model

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 have 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 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 neighbor 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.

IV. EXISTING SYSTEM

The vehicle routing problem (VRP) is a well-known NP-hard problem in operational research. VRP finds routes between a depot and customers with given demands so that the transportation cost is minimized with the involvement of the minimal number of vehicles, while satisfying capacity constraints. With additional constraints, VRP can be further extended to solve different problems, where one of the most important is the vehicle routing problem with time windows (VRPTW). This problem occurs frequently in the distribution of goods and services, where an unlimited number of identical vehicles with predefined capacity serve a set of customers with demands of different time intervals (time windows). VRPTW tries to minimize the total transportation cost through the minimum number of vehicles, without violating any timing constraints.

Once routes have been found using EDAL, further refine the data collection efficiency through an emerging technique called Compressive Sensing. CS is a technique through which data are compressed during their transmission to a given destination by exploiting the fact that most sensors may not always have valid data to report when they sample the environment , especially for nodes deployed in stable environments with rare and infrequent events to be detected.

A new data aggregation technique derived from CS to minimize the total energy consumption through joint routing and compressed aggregation Compressive sensing and particle swarm optimization algorithms to build up da ta aggregation trees and decrease communication rate. These two methods are different from EDAL in th at they require all nodes to contribute sensing data during the data collection phase.

V.PROPOSED SYSTEM

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 networks. Specifically, in OVR research on goods transportation, the objective is to spread the goods to customers in finite time with the mini mal amount of transportation cost.

One may wonder, naturally, if treating 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.

Motivated by this observation ED AL, an Energy-efficient Delay-Aware Lifetime-balancing Protocol is developed. Specifically, EDAL is formulated by treating energy cost in transmitting packets in WSNs in a similar way as delivery cost of goods in OVR and by treating packet latencies similar to delivery deadlines.

To reduce its computational overhead, introduce both a centralized metaheuristic based on tab search and a distributed heuristic based o n ant colony gossiping, to obtain approximate solutions. This also takes into account load balancing of individual nodes to maximize the system lifetime.

On the other hand, the proposed CAS is a cooperative strong node mechanism in which a threshold is preset in order to determine whether the node traffic is over or not. The privilege of corresponding sensor nodes is upgraded when the load exceeds the threshold. Therefore, the sensor node can command its child nodes to change the transmission path for distributing the traffic effectively. Moreover, once the traffic is over the overall network flow threshold, it is necessary to add the other new sensor nodes into the network for relieving the traffic.

VI. PERFORMANCE ANALYSIS

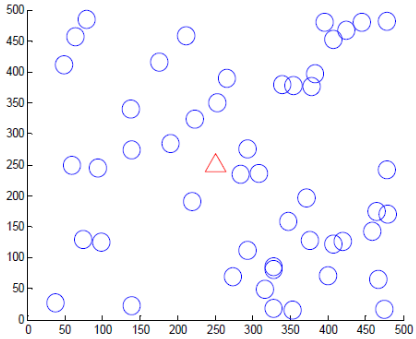

Fig. 2: Node Architecture

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.

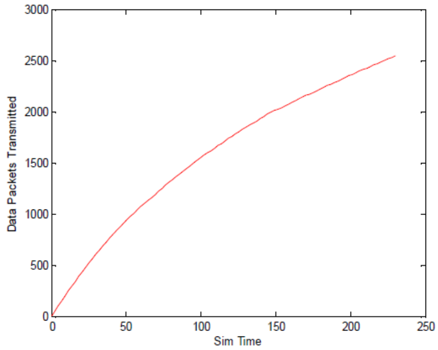

Fig. 3: Packet Transmitted

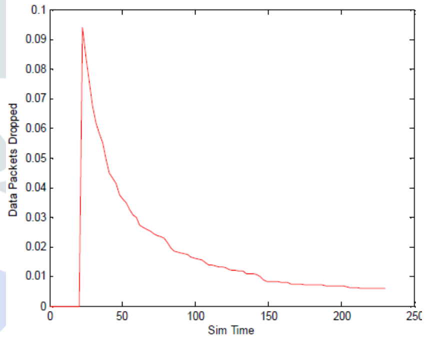

Fig. 4: Packet Dropped

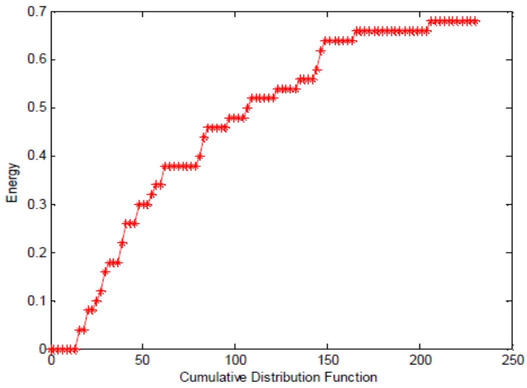

Fig. 5: Energy graph

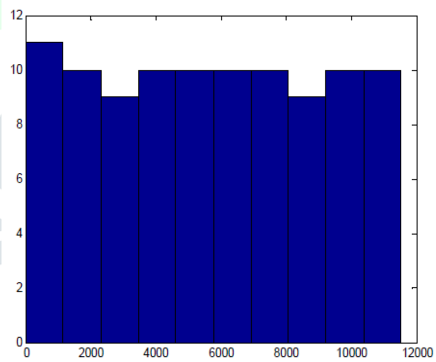

Fig. 6: Network lifetime

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 packet is being transmitted the energy will increase that will increase the lifetime of a node. The energy is compare with cumulative distributive function The comparison of network lifetime with the compress rate .As more the compress rate less the lifetime of a node.

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 a s 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

VII. 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.

VIII. 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. 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. Based on both simulations it is observed 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. An Energy efficient Delay Aware Lifetime balancing EDAL protocol was proposed in wireless sensor networks which are promoted by flourishing techniques developed for open vehicle routing problems with time deadlines. The proposed system EDAL solves the problem of high energy consumption in sensor networks by balancing the loads in nodes. The centralized heuristic algorithm generates routes that connect all nodes with minimal total path cost, under the constraints of packet delay requirements. Ant colony optimization is used to find the best path to transfer the data. The lifetime of the deployed sensor network is also balanced by assigning weights to links. Here high energy nodes are chosen to balance the load which in turn increases the lifetime of wireless sensor network. Thus traffic in the network also reduced by finding alternate route when congestion occurs which in turn reduces delay

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