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FRAMEWORK OF MOBILE DATA GATHERING AND ENERGY RECHARING OF WIRELESS SENSOR NETWORKS

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***Abstract*- A sensor node is nowadays employed in varied application areas where human intervention is limited. The uninterrupted functioning of the network is subjected to the battery lifetime of each node. Recharging of the sensor nodes can be carried out effectively by the mobile sensor node called the SenCar. Continuous and steady network operation can be provided to wireless sensor network by energy replenishment techniques. Both energy replenishment and data gathering can be achieved by utilizing the mobility of the sensor. A multifunctional mobile entity called sencar is employed in the sensing field, which serves not only as mobile data collector but also as an energy transporter. It sequentially visits the selected sensor node in the sensing field called anchor points to gather the data, in the meanwhile it refills the sensor batteries. The anchor point gathers all data from the neighboring sensors, whose sensed data are processed and only the necessary information is sent to the anchor points. The SenCar must have a battery with high capacity so that it does not die after recharging a node. The well planned path planning technique improves the network utility. The effectiveness of this approach is validating in Omnet++ simulator and provides the results. This shows that the solution can achieve continuous network operation.**

***Keywords*- Energy harvesting, Energy replenishment, Mobile data collector, SenCar**

I.INTRODUCTION

A wireless sensor network is a network of coordinated sensors nodes working together in a sensing environment. The node are randomly distributed over the specific area Each sensor node comprises one or more microcontrollers, flash memories for data storage, processing units or processing chips, Radio frequency transceivers, and a power source, which is usually a battery driven power source.

The sensor nodes are mainly employed for sensing various parameters of the surrounding environment and the physical conditions such as pressure temperature, power consumption, humidity etc., from the sensing environment. Its is used in wide range of application such as industrial process monitoring, perimeter security and surveillance, civil structural monitoring, Health monitoring, Habitat and ecosystem monitoring, Automated Building climate control. Also this wireless sensor network have many challenges energy efficiency, Robustness Responsiveness and self configuration and adaptation ,Scalability ,Systematic Design .This challenges must be tackled at multiple levels through different protocols and mechanism.

Routing of wireless sensor network can be made robust and efficient by incorporating different types of local states information such as link quality, link distance, residual energy and position information. In communicating the sensor nodes the networks employ bidirectional communication scenario so that the sensor nodes in the sensing environment gather the data and transfer it to the sink and the sink sends the control information to the nodes and also report the data to the end users. A sensor node is always deployed inside or placed very close to the environment from where the required data to be collected. The position of the sensor nodes can be fixed or static based on the area where it is employed. All the sensor nodes co-operate and coordinate each other to accomplish a certain task and route the necessary message to the sink.

The aim is to efficiently transmit data to the base station so that the lifetime of the network will be maximized.

The major limiting factor for the sensor lifetime is energy supply. Each node will be designed to manage it supply of energy to local node to maximize total network lifetime. Consumption of the power can be reduced through decreasing the transmission power or through the decreasing duty cycle. Both of the methods alternatives involve sacrificing the other system metrics. The soul energy to the wireless sensor network is the battery source used in the nodes. Sensor nodes are prone to failures due to insufficient battery power. If the sensor nodes are not recharged within a certain amount of time the node cannot continue its assigned operation. The challenging task is on how to recharge the sensor nodes efficiently.

The sensor nodes possess different recharging rate and this consideration is very well essential for the efficient data gathering and recharging. For the energy a source available from the environment is subjected to varied limitations a sensor node cannot rely on a single source of energy.

The objective is to maximize the energy efficiency of the sensor node without failure due to the energy constrains. The major constraint of sensor nodes is low battery energy, which restrict the lifetime and the quality of the network for the above mentioned reason, the protocols in the sensor networks should consume the resources of the nodes efficiently in to achieve a longer network lifetime. Also the selection of the anchor points is vital to make sure that no sensor node is dried out of battery. While selecting the anchor point, the nodes at the multi- hop distance are clustered together and they transfer the processed data from the sensing environment to the candidate node selected as the anchor point. When the SenCar is at the static sink it process the battery update status received from each of the anchor points to select the next set of the anchor points. So this processing time is also taken into account because during this time period the battery status of the sensor node has degraded because of the sensing.

The goal of the path planning of the sencar may well planned so as to avoid the obstacles in the path way. many obstacles an avoidance algorithm is propose so as to avoid collision with obstacles .It was usually based on the map. It is often implemented as a more or less independent task. However efficient obstacles avoidance should be optimal with respect to the overall goal, the actual speed of the mobile collector, the actual and future risk of collision.

This paper is organized as follows: Section II discus about the Related works, Section III describes the system model and in Section IV conclusion of the project is given.

II.RELATED WORK

Battery life of a sensor node depends on the time it spends in the sensing process, the time duration in which it goes to a sleep modes , the time it takes to process the data, time spend for transferring the data. The energy consumption during sensing, sleeping, processing, and transferring are essential in computing the battery status of a sensor node. Even this is non-uniform for different nodes.

In [1] a scheme of joint wireless energy replenishment and mobile data gathering (WerMDG) considers the time varying nature of energy recharging of the nodes and also considers the energy consumptions while sensing transmitting and receiving data. The advantages in employing the wireless energy recharging in the wireless sensor network energy provisioning does not depend on the environmental factors and there is no connection between the SenCar and the sensor node, which is being charged. Also, the process of recharging does not interfere with the sensing, transmission and data gathering functions

M.Ma [2], authors proposed a moving path planning algorithm for the mobile sensor called sencar. They also employed a data gathering mechanism. Sencar starts the tour from the sink, travels along the entire network. Collects the data from the entire sensor while travelling around the network .when it reaches the starting the starting point it uploads the collected data from the sensors. In this scheme the sensor have to travel to the whole network which means it have to meet each and every individual sensor in the network. This proposed scheme could extend the lifetime of network considerably compared to the network which has only a static observer. However the sensors are limited in its energy capacity. Meeting every sensor in the whole network could results in the power constraint of the sencar. Due to this data collection fairness may get affected.

Z.Zheng [3], author proposed centralized and two distributed algorithm for the data gathering strategies. This proposed scheme involves the advantage of data gathering performance without the sensor node failure .they uses the Renewable energy sources such as wind and solar power which provides the continuous operation of the network without disturbance. Route and data collection planning in the algorithm in this proposed work jointly maintain the network lifetime .Even though the Renewable energy sources which could change dynamically because of the climatic change in the environment condition. Such sources won't be available everytime.While it is required to charge the sensor batteries.

The sensor nodes itself transfer the data to the static sink after processing it as in [2] and [3]. The relay based routing is used for the data gathering from the sensor nodes employed but this created congestion near the static sink and there are loss of data packets thus make the sensing useless.

The mobility of the sensor is used in the data gathering mechanism [4].they called the mobile sensor as the M-collector. This M-collector could be the mobile robot or the vehicle equipped with the powerful transceiver and battery. Multiple M-collectors are used in the sensing field .Similar to the working of the sencar this M-collector also roams around the entire field and collects the generated data from the sensor. After collecting the data from the sensor in the field it transfer it to static sink .Single hop data gathering techniques is used to collect the data .It mainly focus on the problem of the length of each data gathering tour, using the multiple M-collectors in the sensing field tour length may get reduced. So many number of the possible sub tours will be in the field. This scheme could improve the lifetime of the network. However congestion may occur in the static sink.

The mobile collectors were used in place of static nodes for collecting information from the static nodes as described in [4]. But this creates routing problems in visiting the sensor node. As more mobile nodes were employed, there needs a scheduling providing the recharging process a first position followed by the data collection.

M.Zhao[6] authors ,proposed the anchor based data gathering scheme .Mobile collector are employed in the sensing field .Mobile collector will roam around the field .but instead of reaching each and every sensors. Mobile collectors only go to the anchor of the sensors. It stays near the anchor point for the period of the journey time called sojourn time. The nearby sensors of the anchors transfers the collected data to the anchor .which may be in the multihop fashion. This mobile collector may have the fixed or varying journey time at each anchor point. Constraints in data gathering performance are decomposed into many sub problems and it was solved distribute.

Experiments are carried out to wirelessly recharge the sensor nodes using magnetic coupling technique, which yielded 40% efficiency while transferring 60 W power output within a range of two meters. Intel has also verified recharging the same amount of power between the coils withan efficiency of 75%. The advancements in the wireless recharging using radio frequencies also save the lifetime of the sensor networks [9].

Also in [10]a joint design of energy replenishment and mobile data gathering (JMERDG) to characterize the data gathering performance for flow-level network utility maximization model.This model only includes energy consumed for data transmission. On the other hand, there is a need to consider the energy consumed while sensing and collecting data. It utilizes mobile collector's collects data and recharges the nodes by assuming constant recharging rate.

But in practice, the recharging rate for each node is time-varying rather than a constant rate. This creates a challenge in obtaining the optimal rate for each node.

This scheme does not tell about the recharging of the SenCar. Also the SenCar visits the static sink node, which is usually a monitoring centre for recharging and to deliver the collected data.

Kuei-Ping Shih [11], proposed a algorithm which is known as RGP, Route Guiding Protocol that could permit Location based routing Protocol which avoids the obstacles. This act as the guide for the packets transmission .It records the forbidden region for the sensor which is surrounded by the obstacles .Packet are guided to overcome those Obstacles and move through the shortest path from the respective node to the sink node. This scheme gives the low overhead and minimizes the average route length and could improve energy consumption.

III.SYSTEM DESIGN

In the Proposed work, each sensor node has limited battery lifetime. The energy is depleted while the sensor node is employed for continuous monitoring in the sensing environment. Otherwise the sensor node may go to the sleep mode and wakes up whenever there is a trigger of incoming of the required data. This is an energy conservation scheme and other energy conservation protocols are also needed.

Here there are receiver circuits, transmitting circuit and communication circuit and the circuits with minimal external components are as follows:

Receiver circuit: Amplification, frequency conversion, filtering, A/D converter, automatic gain control, and restoration to the correct data are included in the receiver circuit.

Transmitting circuit: Transmitter is carried out in such a way that, every bit data is spread by the Spread Spectrum Sequence. It is send to the Digital to Analog convertor, and then to the low-pass filter.

Communication circuit: The interface is used to send and receive data and also to read and write.

While considering the difficulty in transmission when large data is to be sent, there should be a buffer to store data in order to prevent system failure and to cache them, large data storage is required.

A. *SenCar*

A Wireless Sensor Network is considered to be employed in a sensing field, where human entry is limited. The sensor nodes are continuously sensing any one of the environmental or physical parameters from the sensing environment. In this field a mobile node called a SenCar, which is multifunctional and could be a Robot or a vehicle is deployed. It consists of a transceiver which is capable of gathering data from the sensor node.

The SenCar is also planted with resonant coils for recharging the sensor node it visits and also a high capacity battery.

The module SenCar send the information gathered from the anchor point to the static sink, as soon as while it leaves a sensor node.So the journey of the SenCar to the Static sink is avoided. The SenCar works both as a mobile collector and wireless recharger. While the SenCar roams over the sensing area, it recharges itself using the vibration generated energy as described in [13]. The power output generated from these sources is integrated into the single battery source. Once the SenCar recharges the sensor node for a predefined time, it collects the data and updates it with the data from other nodes. All nodes transfer update information about the battery status to the SenCar. But this process is not considered here and it is a future work.

B. *Anchor Point*

The SenCar first determines a set of Anchor points. Each anchor point consists of a set of neighboring nodes in one-hop distance and is in the coverage area of the anchor point. The anchor points collect data from these neighboring nodes. The data from the nodes are the data that was sensed from the field and are processed to provide the anchor point with the most required and only the important data. Also the status of the battery of these nodes is send to the anchor point wirelessly. The selected anchor points are visited in the first journey. When the SenCar completes this journey, it updates the data collected from the anchor points and the other sensor nodes and chooses the next anchor points to visit in the next journey. The neighboring nodes of the anchor points visited in the previous journey are involved in some work, so they are prone to be the next anchor points.

Let N be the set of all nodes employed in the sensing environment and B_i be the battery capacity of the sensor node$i$. N_a Represents the one-hop neighbouring set of nodes in the coverage area of the anchor point a. The SenCar first chooses a set of anchor points out of the available sensor nodes and starts its journey from the static sink. The SenCar nodes in a constant speed and visits every anchor point for a prefixed time-periodτ_a and then it moves to the next anchor point. At the anchor point, the SenCar recharges the static node through magnetic coupling mechanism and the battery is recharged into a high level but it is always lesser than the total battery capacity. Then it collects the data collected at the anchor point including the data from the neighboring node, which comprises the processed data and the status of the battery. The data collected at the sensor node is always processed in the processing unit and only the essential data is transmitted. This reduces the amount of data to be transmitted. Once all of the selected anchor points are visited, the SenCar updates the battery capacity status for all nodes and determines the next set of anchor points. So the latency will be reduced than in [1].

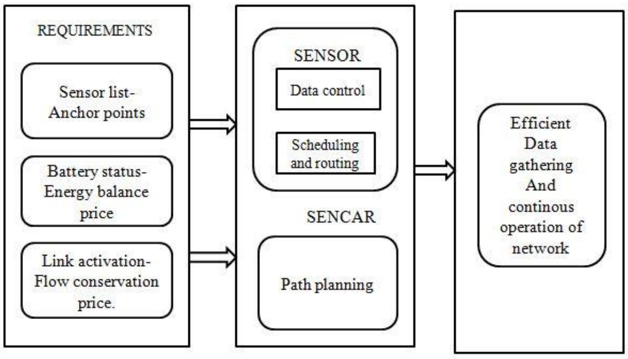

Fig1.1 Architecture of the system

C.Anchor point selection

Receives sensor list, battery status, and tour bound as input. Sort sensor list in ascending order according to battery status.Calcute the shortest tour length by TSP Nearest Neighbour algorithm for anchor points in A Travelling sales man problem nearest neighbor algorithm TSP-NN (A) denotes its tour length. Tour length equals the bound of the journey (l_{tsp}) target sensor (A) is found

$$x(A) = y(l_{tsp});\text{break} \qquad (1)$$

Or else upper half or lower half of the list is chosen to search for target sensor.

$$x(A) = y(l_{tsp}) + 1;\text{ if Tourbound is greater} \qquad (2)$$

$$x(A) = y(l_{tsp}) - 1;\text{ if Tourbound is lesser} \qquad (3)$$

D.Scheduling and routing

Data control could be carried out in the transport layer. Scheduling and routing takes place at the network layer. Sequential greedy algorithm is used for solving scheduling problem.Intially the flow amount of the link (i,j) be 0 for all the sensors corresponds to anchor point A. By Initializing the battery capacity and minimum remaing energy of sensor i .The information about the sensor and the weighted link could be collect from neighbor node.Calcute the maximum weighted link W_{ij}. Finding the preferred outgoing neighbor and destined anchor point by scheduling algorithm and Pass the information to the neighbour nodes and allocate a flow amount for the link (i,j) at A_i.If a link is selected once it should get removed and hence remove the selected link of the sensor (i*,j*) for A_i and find links for other nodes of the anchor point A.

$$W_{ij} = \beta(\mu_{ij}^{tx}) - \gamma(\mu_{ij}^{rx}) - \varepsilon_{ij}^{a} \qquad (4)$$

Weighted maximum link can be obtained by considering the flow conservation of the sensor(i,j) at anchor point a, $(\beta(\mu_{ij}^{tx}))$, energy balance price of the sensor(i,j) at anchor point a ,($\gamma(\mu_{ij}^{rx})$) .Remaining energy of the sensor(i,j) at anchor point a. (ε_{ij}^{a}) .

Adhoc on demand distance vector routing protocol uses the sequence number to the ensure the freshness of the route. It builds routes using the route request and route reply query cycle. It builds route between nodes only desired by the source nodes. Maintain it as long as they need by the source each node has the routing table. Overhead is low in comparisons with the table driven and to reestablish a new route when a route breakdowns.

A well-planned moving path of SenCar may minimize the save a lot of energy, and prolong the network life. Sencar need not be going to travel only in the straight path. The travelling path may consist of turning points. We use divide and conquer method to find the turning points to reduce the maximum traffic load at any sensor.

E. *Energy recharging*

The SenCar works both as the energy transporter and data collector. For energy recharging of the sencar magnetic coupling is used .This technique can offer the wireless sensor network a infinite lifetime. High efficiency can be obtaining for over several meters and can be used in omnidirection and not dependent to weather condition. Taking this concept of electrical recharging it is done in the simulation and the results are shown.

IV.CONCLUSION

The wireless sensor networks finds application in various fields like in military, agriculture, ocean, mines, industries, etc., the lifetime of the sensor battery is depleted by the functions like sensing, processing, transmitting and reception of data and control signals. The SenCar deployed in this system do not visit static node for recharging and transferring of data.

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