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Wireless Recharging Structure in WSN using Named Data Networking

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Abstract

To address the power constraint problem in wireless sensor network the recharging batteries of sensor nodes in sensor network through wireless energy transmission is a great

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alternative. To increase the lifetime of the sensor network through wireless charging various schemes has been proposed. In this paper we proposed an NDN based wireless recharging framework for sensor nodes, in which the sensor nodes are recharged when its level of the battery reduces below the threshold value. To travel to the nodes the minimum weighted sum algorithm has been used in which with minimum travelling cost the mobile sinks reaches the nodes. The priority schedule has been introduced to recharge to the emergency sensor nodes. The simulation results demonstrate that the proposed framework elongates the network lifetime compared to the existing recharging framework.

Keywords-Wireless sensor network, sencars, wireless recharging, minimum weighted sum algorithm**,** named data networking.

I- INTRODUCTION

In Wireless sensor network, the nodes are powered with batteries. The limited power of battery has constraints a big challenge, especially where the network is used for long term monitoring of an events. In last decade there have been a flourish of research efforts to increase the sensor network lifetime.Although various energy harvesting methods have been proposed for extraction of energy from wind noise vibration solar these approach has limitations [2]. Because extraction of energy is depends on the resource availability. Moreover the size of harvesting devices is more when compared with the sensor node where these devices consume more power than the nodes in the network.

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Wireless energy transmission technique has opened a new dimension to power wireless sensor networks. The key idea of wireless charging technology is to dispatch a sencar to move around the network and charge energy to the node that has lower battery level. As the applications of wireless energy transfer are several. For example, wireless energy transfer has already been functional to replenish battery energy in medical sensors and implantable device in healthcare industry.

The recharging of which nodes and in which order will impacts critically the efficiency and the lifetime of the network. A few works have studied the recharging of sensor nodes problem. The gathering of the energy level of nodes information is an challenging issue and these information delivering to sencar is an another important issue. when the energy status information of nodes is delivered in delay to the sencar, then the node whose energy level is low has been died.The time to recharge for a few hundred nodes will take several days. During this period the energy level of sensor node will change significantly because of some unpredictable external events and activities and thus the battery has been drained. This leads to the energy depletion of nodes and leading to disruption in sensor network functions.

The Named Data Networking techniques has been used to gather and inform the energy status information to sencars. The single sencar will supports to the smaller network sizes. In this paper multiple sencars has been used to support for the larger network sizes. The multiple sencars provides scalability and robustness. The sencar has more energy supplies than the single sensor node and thus it is capable of recharging the sensor nodes.Until the sensor nodes report their energy level after some period of time a scalable and efficient energy information aggregation protocol has been used which gathers battery status level continuously from sensor node. Based on the latest energy information received the sencars recharges to the nodes.

The wireless charging technology has several advantages , based on these advantages little work has been proposed. In this work, the network design is framed as (1) Multiple sencars,(2) network of sensor nodes equipped with wireless power receivers, and (3) head nodes and proxy node for deciding the charging sequences to be executed by the sencars. The NDN based energy aggregation and gathering protocol has been used which satisfy both normal and emergency nodes needs multiple sencars for recharging.

We have conducted wide simulations to discover the performance of the proposed system in large scale networks. Simulation results shows that the proposed system can entirely make use of the wireless charging technology effectively to increase the lifetime of the wireless sensor network.The rest of paper is organised as follows. Section 2 shows the related work. Section 3 presents the proposed system. Section 4 report the simulation results on large scale networks respectively. Finally section 5 concludes the paper.

II- RELATED WORK

In research field there have been more effort in wireless energy transmission. The breakthrough technology by kurs has experimentally showed the efficient non radiative energy transmission in practical. They showed by using the two magnetic resonant objects of same frequency of resonant to exchange energy efficiently. They showed the power can be transfer efficiently with irrespective of the environment and even without line of sight.In paper[3], the deployment of the sensor nodes are done in industrial wireless sensing platform and commercial off the shelf RFID readers. An greedy algorithm has been designed to find the recharge sequence to increase the nodes lifetime in sensor network by wireless charging[4].

An experimental tests has been performed by using the powercast devices. In paper [5], J-RoC joint routing has been introduced where it requires continuous information exchanges between sensor nodes in the field and the mobile charger. As in this scheme an single mobile charger has been used to charge the sensor nodes.The decisive works[6],[7] of resonant inductive coupling based wireless energy transmission are capable of transferring large amount of energy in little time with high capably .In the paper [8],for travel and to recharge the sensor node various schemes has been used and the nodes batteries are recharged partially.

In [2],the author has been constructed the shortest Hamilton cycle algorithm which provides the nominal travelling path to reach the sensor nodes by mobile vehicle. In paper [9], the author has made the mobile chargers to recharge sensor nodes and also to recharge another charger, thus large network can be covered and mobile chargers return back to same point.

A.Coordination of mobile vehicles

In wireless sensor network, for collecting data from the nodes multiple mobile vehicles are allowed to traverse in the network and thus data are collected. In paper [10], the mobile vehicles are moving in random way over the nodes and collecting the data. In the paper [11], multiple controlled mobile vehicles are adopted for data collection in the objective of balancing the load. In [12], a set of heuristics are proposed to schedule the data collection of multiple mobile vehicles to meet sensors dynamic buffer overflow time constraints. Depending on the node buffer size the nodes are visited by mobile vehicles.In paper [13],the author has proposed a approach to minimize the total travelling cost of multiple mobile vehicles is studied. In the collection of data more than one vehicle may visit the same sensor node in very short period. While using multiple sencars to recharge, when the same sensor node incur high cost and this situation should be avoided totally.

III- PROPOSED SYSTEM

The sensor nodes are placed randomly in the field and the network is divided into hierarchical layers. The energy information is gathered in aggregated forms from each layer head nodes. Thus for large area network the recharge can be performed and thus scalability is increased. The nodes in each layer is done to formed the area. Based on the geographical coordinates of sensing field the area is divided. Each area is further divided into small subareas and thus the levels in the network increases. This division process is continued until in bottom level layer there is no further division of subareas. Thus when the sencar goes to recharges to such areas the nodes energy level do not change more and thus they not interrupt to recharge.

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In Name Data Networking for each sub layers the names has been assigned. Thus by unique name the sub area is identified in hierarchical. Each and every node has ID including the name of its bottom level sub area and an identifier. The head node in each division of sub areas is selected based on the node that has the highest residual energy and more no of neighbors. When the head node energy is low, an another node is selected based on highest residual energy and neighbors .Then it acts as new head node.

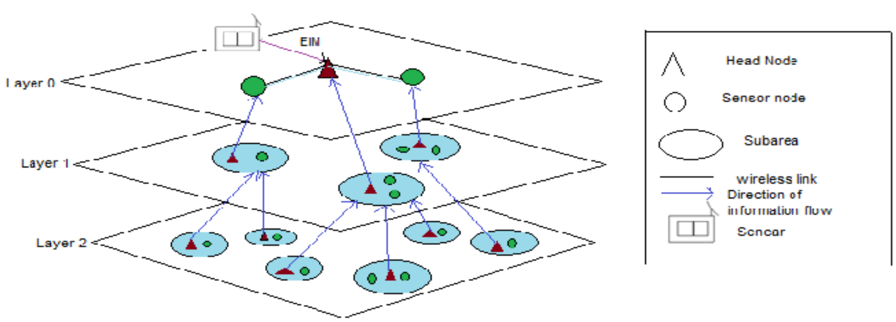

Fig.1. Nodes Energy information meeting

When the sencar request for energy information of nodes, the head node sends the query to other normal nodes. These head nodes information is sent to the top level head node through the mechanism of named data networking which constantly update the routing states in intermediate nodes to follow the movement of sencars. The top head node and then sends the aggregated information to the sencar.To reduce overhead of energy information transmission the head node is allowed to pre select the sensor nodes to be recharged. The head node selects the area where the nodes can be recharged with higher amount of energy.

The emergency occurs when the node energy level goes below the emergency threshold value. These node identity is send to the proxy node which is in top level of hierarchy. These proxy node maintains the queue of emergency nodes information. The node that is not head nodes are the normal sensor nodes. These emergency nodes has the highest priority than the other nodes and thus the sencar first recharges the emergency node.The sencars communicate among themselves as they are equipped with powerful antennas. To know there location in the field they use global positioning system. To avoid duplicate selection of same node to be recharged by more than one sencar ,the sencar is allowed to receive the information which is nearest to the nodes to be recharge. Thus travelling cost is also reduced. The sencar will gets the energy information only after it recharges the nodes.

Minimum Weighted Sum Heuristic Algorithm

The minimum weighted sum algorithm considers both the residual energy for lifetime of nodes and the traveling time to reach the nodes. This algorithm schedules recharge assignment among sencars. During when the node j has lower residual energy and higher traveling distance than the node i, the node j will dead when the sencar goes to recharge the node i which has small traveling distance, without considering the residual energy of nodes. At this time without considering the distance the node j is recharged first. The weighted sum w_{ij} of traveling from node i to next node j and the residual energy of node j lifetime is,

$$W_{Ij} = \alpha\, t_{ij} + (1-\alpha)\, L_j$$

W_{ij} is used to decide which node j to recharge next. A sensor node with smaller weighted value has higher priority to be visited and recharged first.

Input: weight parameter α £ [0,1] in step size 1/[A-1],sencar position at node k, travelling time from node i , j, $t_{i,j}$,residual lifetime L_i, $V_{I,j}$ £ M, node list Ω_i at service station, I £ M
Output: weighted parameter α and schedule sequence Q
Initialize minDist = ∞
For α=0.......1
While M≠0
Compute weight $w_{k,i} \leftarrow \alpha\, t_{k,i} + (1-\alpha) L_i$
Communicate service station IF $\Omega_I = 1$, set $w_{k,I} = \infty$
END IF
Find $j \leftarrow \arg\min w_{k,i}$
$Qt \leftarrow Q_t + j$, $M \leftarrow M - j$
Update $\forall_I$ £ M, $L_i \leftarrow L_i - t_{k,i} - t_i$
If $Li \leq 0$
Declare infeasible and break (inform service station)
End If
Move to position j, $k \leftarrow j$, recharge and update L_i
End While
If feasible
Compute total cost dist(Q_t)
If dist(Q_t) < minDist
MinDist ← dist (Q_t), Q ← Q_t
End if
End if
End for

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IV-SIMULATION

To evaluate the performance of Named Data Networking based framework in large networks the simulation have been conducted in simulator. In simulation 115 nodes are placed randomly in the 150m x 100 m field.

Table.1.Simulation Parameters

Parameters	Value
Field length	150 X 100,
Number of nodes	100
Number of sencars	4
Transmission range	15m
Energy consumption	37.5mJ
Sencar speed	1m/s
Threshold value	15%
Battery capacity of sencar	2000 E c (KJ)
Battery capacity of a sensor node	10 E s (KJ)

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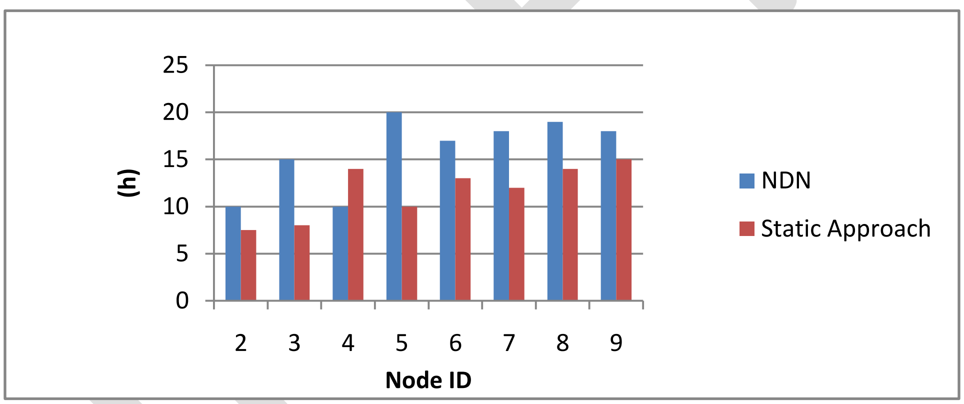
Sensor's tx power consumption	0.05(J/Packet)
Sensor's rx power consumption	0.06(J/Packet)
Number of levels	3

Fig.2. Lifetime of Individual sensor Node



The NDN based networking has improves the lifetime of the sensor nodes of 80% .This is skilled by charging to the nodes that has lower energy level. Based on the data packets transferred by nodes they consumes the energy.

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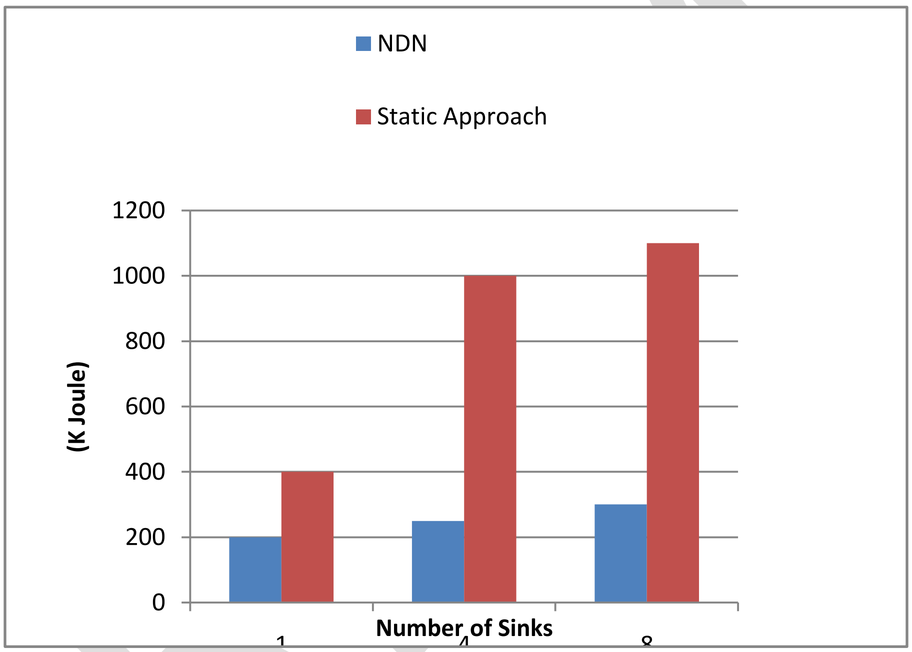

Fig.3. Energy Consumed by Sencar movement

The sencar charging capacity is enclosed, increasing the nodes to be recharge would decrease the amount of energy to charge to sensor nodes. In NDN based networking by using the minimum weighted sum algorithm the sencar can reach the node in small distance and thus the sencar energy level consumption is reduced and thus the sencar can charge for more number of nodes to be recharged.

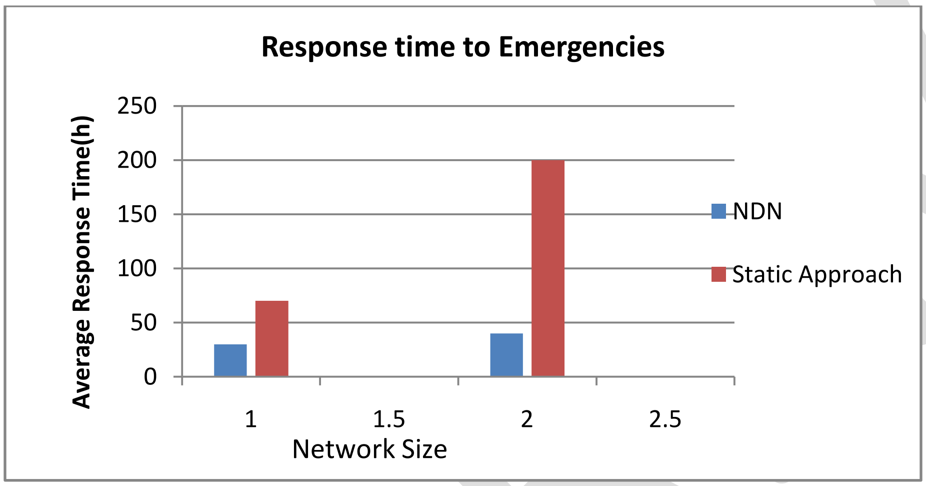

Fig.4.Average Response time to emergency sensor nodes in network

The named data networking based framework takes around 10 hours to response to the emergency nodes than compared with static approach which takes minimum 60hours because in static approach the priority has not been given to emergency nodes and the normal nodes. Thus this approach resolves non-practical situations earlier than static approach.

V- CONCLUSION:

In this paper the NDN based wireless recharging framework has been proposed to enlarge the sensor network lifetime. We present the design of named data networking based wireless recharge framework and evaluate its efficiency. This framework satisfy the needs of both normal and emergency sensor nodes and thus all the nodes in the network are recharged before their energy is entirely exhausted. The simulations shows that the network lifetime has been prolonged drastically.

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