Development of Mobile Data Collection Scheme in Energy harvesting Wireless Sensor Networks

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***Abstract*: Recent Technologies have mainly focused on low-cost, low-power, multifunctional sensor nodes for wireless communication that is capable of supporting Diverse sensing applications such as environmental monitoring, intrusion detection, battlefield surveillance, and so on. In our paper we are employing MOBILE DATA COLLECTOR (Sencar) method; we incorporate the technique of energy-aware transmission range adjusting to tune the transmission range of each sensor node according to its residual battery energy. In case of residual battery, energy keeps reducing after performing several iterations on message relaying and environment sensing tasks, the transmission range will be set to a smaller value.. Note that the underlying message routing method may affect the performance of the entire operating scheme (the Mobile Collector relocating and the message routing) significantly as the parameters of the routing algorithm vary. Although the MOBILE DATA COLLECTOR method can be incorporated with any existing routing method here the concept of anchor based mobile nodes has been introduced which is a special node in sub regions from which the data is collected by the mobile collector. Here we have selected nine parameters for comparison such as End-to-End time delay, Number of Hops, Energy Consumption, Number of Alive and Dead nodes, Residual Energy, Lifetime Ratio and Routing Overhead, Throughput.**

***Keywords*: Wireless Sensor networks, Node Deployment algorithm, Randomized algorithm, Sencar algorithm**

I.INTRODUCTION

.Node is the building block for all Networks. Node mainly includes a Battery, Memory system and an Antenna (Sensor). Network is nothing but collection of several nodes. Networks are of two types: Non-Hierarchical and Hierarchical networks. In case of Non-Hierarchical networks, all nodes are located in a single area and have neighboring nodes. These neighboring nodes must be always within the transmission range. Transmission Range is defined as the distance until which a node can communicate with another node in the network and ceases if it crosses the range. Here the routing tables support global topology and the nodes communicate among themselves with their own algorithms. While in case of Hierarchical networks nodes are spread across multiple sub areas. Here we come across Normal Nodes and Cluster Nodes. Normal nodes are responsible for communication between different nodes in same area where as Cluster nodes are responsible for communication between nodes of different regions. Here the routing tables support local and global limited topology. Our paper is on Non-Hierarchical network. Here we go through different algorithms and compare the results.

II. LITERATURE SURVEY

In the paper [1] titled "Studying the feasibility of energy harvesting in a mobile sensor network," the authors mainly discuss regarding reliability of the wireless sensor networks. In our system, a small percentage of network nodes areautonomously mobile, allowing them to move in search of energy, recharge, and delivery energy to immobile, energy-depleted nodes. We call this approach energy harvesting. We characterize the problem of uneven energy consumption, suggest energy harvesting as a possible solution, and provide a simple analytical framework to evaluate energy consumption and our scheme.

In the paper [2] titled "Energy scavenging for mobile and wireless electronics " the authors describe that Energy harvesting has grown from long-established concepts into devices for powering ubiquitously deployed sensor networks and mobile electronics. Systems can scavenge power from human activity or derive limited energy from ambient heat, light, radio, or vibrations. Ongoing power management developments enable battery-powered electronics to live longer. Energy harvesting's true legacy dates to the water wheel and windmill, and credible approaches that scavenge energy from waste heat or vibration have been around for many decades. Nonetheless, the field has encountered renewed interest as low-power electronics, wireless standards, and miniaturization conspire to populate the world with sensor networks and mobile devices

In the paper [3] titled "Perpetual environmentally powered sensor network" the authors describe that Environmental energy is an attractive power source for low power wireless sensor networks. We present Prometheus, a system that intelligently manages energy transfer for perpetual operation without human intervention or servicing. Combining positive attributes of different energy storage elements and leveraging the intelligence of the microprocessor, we introduce an efficient multi-stage energy transfer system that reduces the common limitations of single energy storage systems to achieve near perpetual operation. We present our design choices, tradeoffs, circuit evaluations, performance analysis, and models.

In the paper [4] titled "Design considerations for solar energy harvesting wireless embedded systems" the authors describe that Sustainable operation of battery powered wireless embedded systems (such as sensor nodes) isa key challenge, and considerable research effort has been devoted to energy optimization of such systems. Environmental energy harvesting, in particular solar based, has emerged as a viable technique to supplement battery supplies. However, designing an efficient solar harvesting system to realize the potential benefits of energy harvesting requires an in-depth understanding of several factors.

III. METHODOLOGY

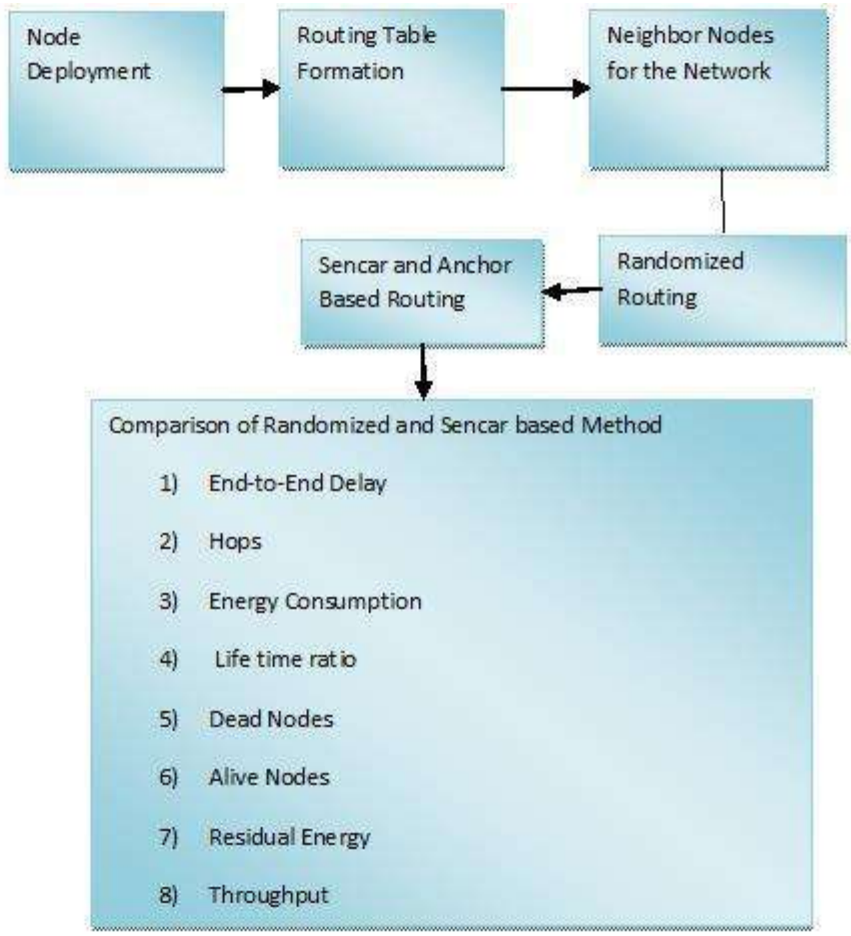

Fig.1 System Architecture

Fig.1 shows the System architecture of how exactly the project works.

Node Deployment

The Node Deployment is the algorithm which is used to place the Nodes in the different regions and each of the regions consist of at least 5 Nodes.

Routing Table Formation

This is the module which is used to form the routing tables for the various Nodes in the network.

Neighbor Nodes in the Network

This Module is used to determine the IN Nodes in the Network. These are the set of Nodes which are in the GPS Range of other Nodes in the network.

Randomized method

This is the path determination algorithm which is used to form the path from sender Node to destination Node securely and deterministic manner.

MOBILE DATA COLLECTOR

In this algorithm the entire area is divided into set of N sub areas in this case 8 sub areas and then an anchor node is selected which collects the data from other nodes or even performs the concept of uni-casting. The anchor node is selected based on the weight computation which depends upon the density of neighbors, data rates of the link

IV. TYPES OF ALGORITHMS

A. Node Deployment Algorithm

This algorithm is used to place the nodes in the network. It takes 5 inputs namely: Xmin, Xmax, Ymin,,Ymax, Nnodes and display the output as Node Deployment Matrix with NodeID, Xpos and Ypos. Fig.2 shows the flow chart of the algorithm. Its first takes the necessary inputs(Xmin, Xmax, Ymin, Ymax, Nnodes) and generates an unique node ID, X position of the node that lies between Xmax and Xmin, Y position of the node that lies between Ymax and Ymin. This triplet is stored as matrix and the same procedure is repeated.

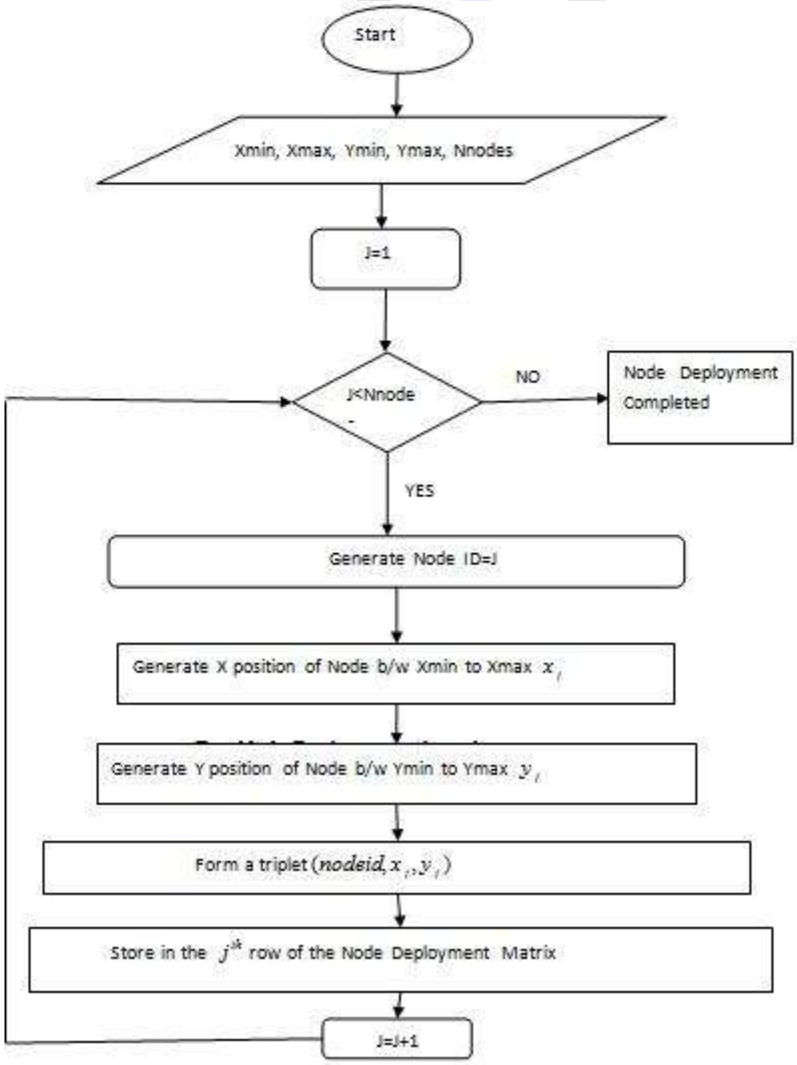

Fig.2 Node Deployment Algorithm

B. Randomized Algorithm

The Randomized communication Algorithm is used to find the route from the source Node to destination Node. Fig.3 shows the flow chart of randomized algorithm. Here the input has Source and Destination node. It now fetches the Routing table and finds the neighboring list of the selected source node. The set of Nodes are found which have the distance within the coverage area. If the set of neighbors has the destination Node then routing process is stopped otherwise goes on. The forward Node towards the destination is found by picking one of the Node randomly from the neighbors. The process is repeated until the destination Node is reached.

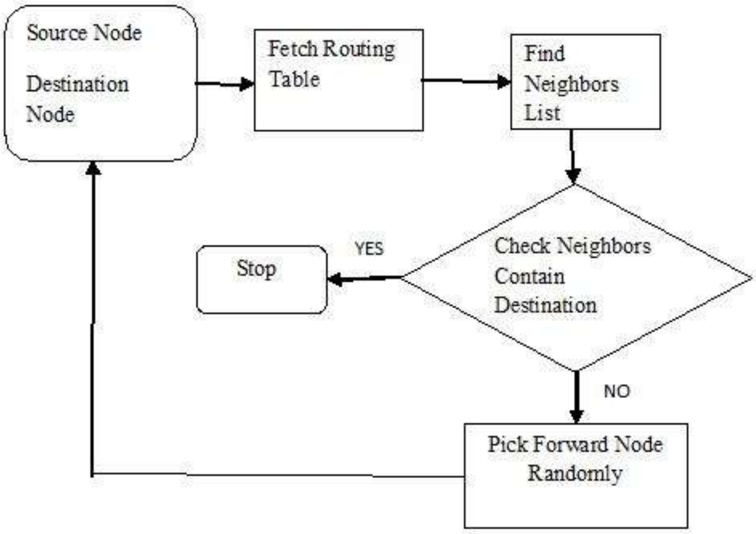

Fig.3 Randomized Algorithm

C. Sencar and Anchor based Algorithm

This Fig.4 shows the Sencar and Anchor based Routing flow chart which has taken Source Node, Sencar Node and Anchor List as inputs. It finds the count of Anchor List and Communicates between sencarnode to anchor node. The

same procedure is repeated for all the anchor nodes. Here the anchor nodes are selected with the help of Anchor selection Algorithm.

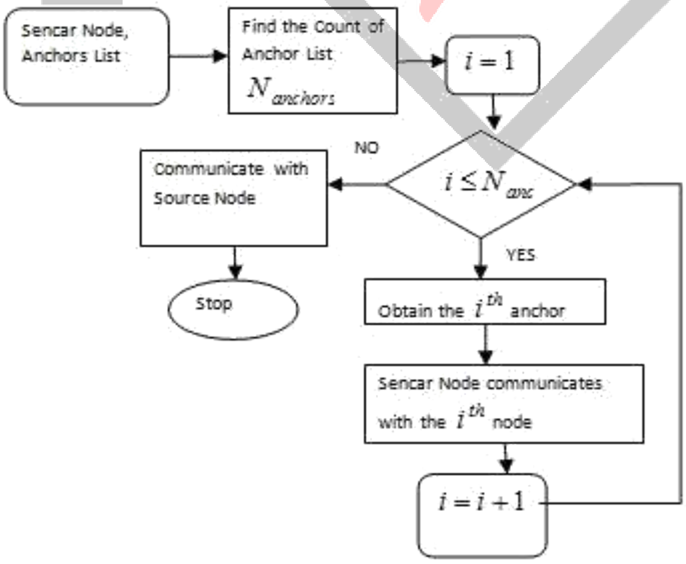

Fig.4 Sencar and Anchor based Algorithm

V. COMPARISION PARAMETERS

A. End to End Delay

End to End Delay is the time taken for the RREQ to go from the source node to destination node and then send back the RRPLY from destination node to source node.

$$E2E_{delay} = t_{stop} - t_{start}$$

Where,

t_{stop} = This is the Time at which reply is recieved

t_{start} = This is the Timeat which request is sent

B. Number of Hops

It is defined as number of intermediate links between source nodes to destination node.

C. Energy Consumption

The total energy consumption is given as follows

$$TE = \sum_{i=1}^{l} E_c(i)$$

Where,

l = Number of Links

$E_c(i)$ = Energy consumed across i^{th} link

D. Battery Updating Process

Whenever a node participates in routing then the battery energy gets updated using the following condition.

Updated energy = current energy – consumed energy

Updated energy must be always <= 0

E. Number of Alive Nodes

This is defined as the count of set of nodes whose battery level is greater than or equal to B/4 Where B is initial Battery Power.

F. Number of Dead Nodes

This is defined as the count of set of nodes whose battery level is less than B/4 Where B is initial Battery Power.

G. Routing Overhead

The routing overhead is defined as

$$\text{Routing Overhead} = \frac{\text{Number of control packets}}{\text{Number of Data packets}}$$

H. Residual Energy

It is defined as the remaining energy of the network. The Residual Energy of the network is given by

$$RE = \sum_{i=1}^{N_{nodes}} RE_i$$

where

N_{nodes} = total number of nodes, RE_i = Residual Energy for i^{th} node

I. Throughput

$$\text{Throughput} = \frac{\text{Number of data packets}}{\text{unit time}}$$

VI. SIMULATION RESULTS:

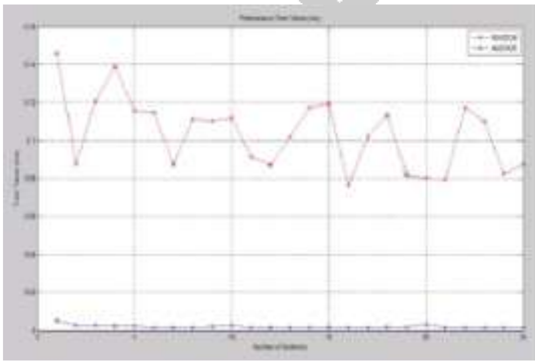

Fig.5 Comparison for End-to-End Delay

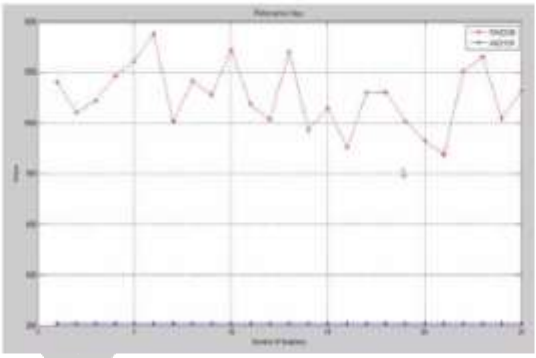

Fig.6 Comparison for number of Hops

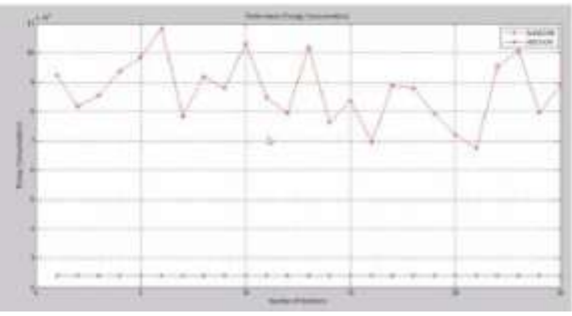

Fig.7 Comparison for Energy Consumption

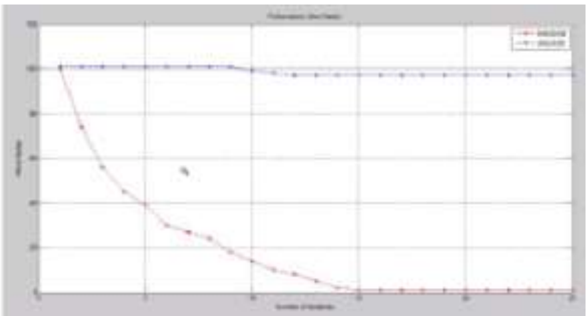

Fig.8 Comparison for Number of Alive nodes

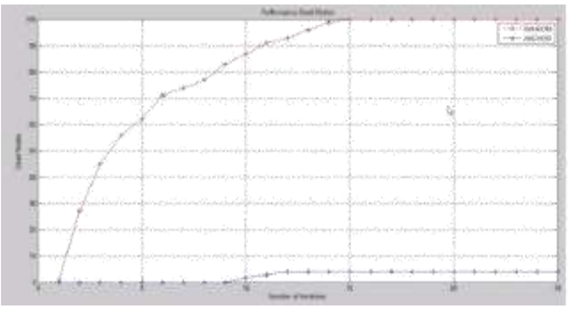

Fig.9 Comparison for Number of Dead nodes

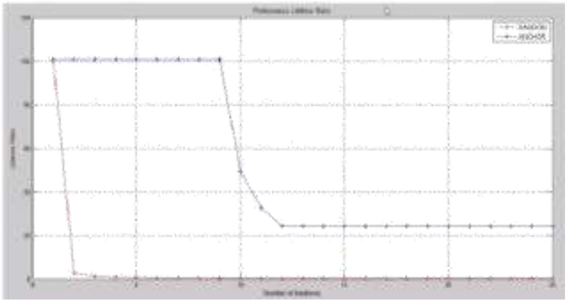

Fig.10 Comparison on Lifetime Ratio

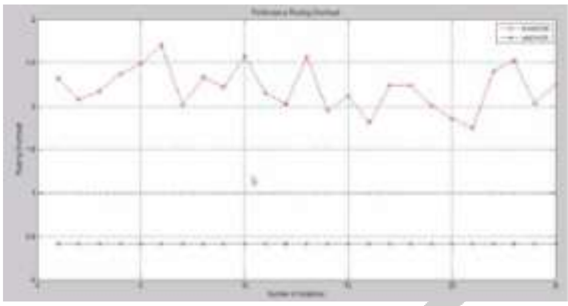

Fig.10 Comparison for Routing Overhead

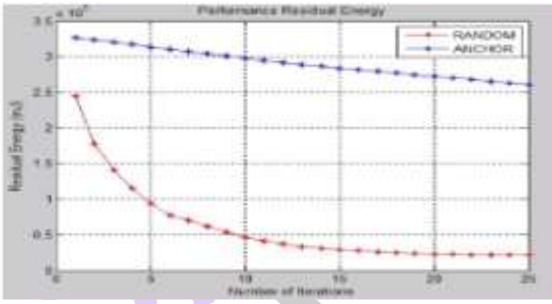

Fig.11 Comparison for Residual Energy

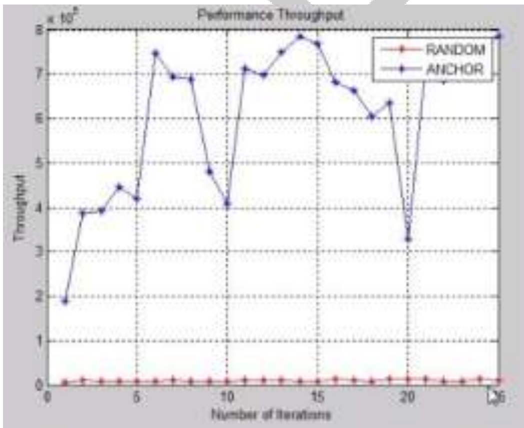

Fig.12 Comparison for Throughput

From the above comparisons it is proved that Sencar and Anchor based Algorithm is the best compared to Randomized Algorithm.

VII.CONCLUSION

In this project the 3 algorithms namely Node Deployment Algorithm, Randomized Routing Algorithm and Sencar and Anchor based routing algorithms have been described. Node Deployment Algorithm is used to find the position to locate the nodes. Randomized Routing algorithm is used to find neighbors and then pick who reply time is lowest like this process is repeated until the destination is reached. Like this process is repeated with each node acting like the receiver. Sencar and Anchor based routing algorithm performs the data collection by using a weight factor computation for selection of anchor nodes and then the data is collected by using combination of anchor nodes and mobile sink. Finally comparison is performed between randomized routing and Sencar based routing algorithm and proved that proposed method is the best with respect to the following parameters namely End to End Delay, Number of Hops. Energy Consumed, Number of Alive Node, Number of Dead Nodes, Residual Energy. Lifetime Ratio and Routing Overhead, Throughput.

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