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Adaptive Energy Optimized Minimum Hop Routing In Sensor Network

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Abstract: A sensor network is one of the most adaptive research area that requires the optimization in term of energy effectiveness, load balancing etc. The sensor network is defined under the particular localization architecture and having the challenges in terms of load minimization, energy loss reduction, security etc. One of such common and most adaptive research problem is routing. In this paper, optimization is provided to the one of the effective routing algorithm called minimum-hop routing. As the communication is performed, each participating node in the network losses some amount of energy. The minimum hop routing, generates an energy effective path to perform the communication. But this effective path increases the load on the selective hops of defined routing approach. Because of which, the hops of this routing path dies earlier to other nodes. The technique proposed in this paper is the improvement to minimum hop routing by identifying the optimal compromising nodes to the minimum-hop routing path nodes.

Keywords: Wireless Sensor Network (WSN), Minimum Hop Routing (MHR), adaptive zones, energy consumption.

I. INTRODUCTION

A wireless sensor network is composed by hundreds or thousands of small compact devices, called sensor nodes, equipped with sensors (e.g. acoustic, seismic or image), that are densely deployed in a large geographical area. These sensors measure ambient conditions in the environment surrounding them and then transform these data into electric signals which can be processed to reveal some characteristics about phenomena located in the area around these sensors. Therefore, can get the information about the area which is far away. Specifically, for a wireless sensor network where each node is provisioned with an initial energy, if all nodes are required to live up to a certain lifetime criterion, what is the maximum amount of bit volume that can be generated by the entire network? At first glance, it appears desirable to maximize the sum of rates from all the nodes in the network, subject to the condition that each node can meet the network lifetime requirement. Mathematically, this problem can be formulated as a linear programming (LP) problem within which the objective function is defined as the sum of rates over all the nodes in the network and the constraints are: 1) flow balance is preserved at each node, and 2) the energy constraint at each node is met for the given network lifetime requirement. However, the solution to this problem shows that although the network capacity (i.e., the sum of bit rates over all nodes) is maximized, there exists a severe bias in rate allocation among the nodes. In particular, those nodes that consume the least amount of power on their data path toward the base station are allocated with much more bit rates than other nodes in the network. Consequently, the data collection behavior for the entire network only favors certain nodes that have this property, while other nodes will be unfavourably penalized with much smaller bit rates.

Wireless Sensor Network Components:-
The concept of wireless sensor networks Components is based on a simple equation
Sensing + CPU + Radio = Thousands of potential applications

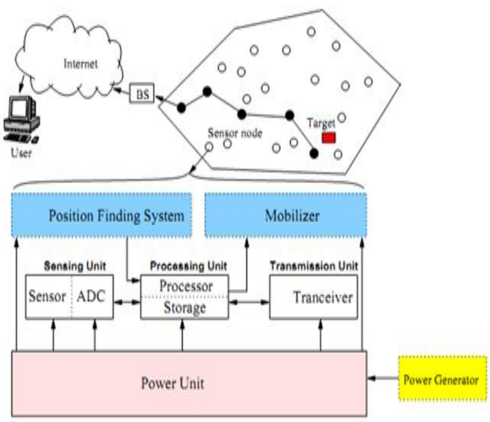

Fig1. Components of WSN

Conceptually, a sensor node consists of a power unit, sensing unit, processing unit and radio unit that is able to both transmit and receive data. Sometimes the sensor node also has a mobility unit as well as a localization unit e.g. a global positioning system (GPS).

Sensing Unit:- The sensing unit consists of two subunits, one or a group of sensors and an analog-to-digital converter (ADC).
• A/D converter- It is used for converting the analog signal into digital signal. It takes an analog signal from sensor and converts it into digital signal and relay to microcontroller for further processing.
• Sensors-WSN consists of large number of sensor nodes where each node contains more than one sensor at the same time depending upon the application. There are different types of sensors like acoustic sensor, resonant temperature sensor, magnetic field sensor etc. Basically sensor is device that sense physical phenomenon such as pressure, motion, speed etc and transform it into analog signal and the same signal are processed by analog to digital converter. Now-a-days sensors are used in machines, medicine, cars, manufacturing etc. Sensor may be directional or omni-directional and may be active or passive. An active sensor is sensor that senses the phenomenon with active manipulation. Example of active sensor is radar. A passive sensor is sensor which senses the environment without active manipulation. Examples of passive are thermometer, light, hygrometer, microphones etc.

II. RELATED WORK

Most of the early works [3]–[7] assume that the joint distribution of sensors' observations is known and that the real-valued messages can be sent from the sensors to the fusion center without distortion, which are unrealistic for practical sensor networks because of the high communication and high energy cost. Subject to the resource (bandwidth and energy) limitation nature of wireless sensor networks, several bandwidth-constrained distributed estimation algorithms [8]–[20] have been investigated recently. The work of [8]–[10] addressed various design and implementation issues to digitize the transmitted signal into one or several binary bits using the joint distribution of sensors' data. In [11] and [12], a class of maximum likelihood estimators (MLE) was proposed to attain a variance that is close to the clairvoyant estimator when the observations are quantized to one bit. The work of [13] and [14] addressed the maximum likelihood estimation over noisy channel for bandwidth-constrained sensor networks with or without knowing the sensing and channel noise parameters at the fusion center. Without the knowledge of noise distribution, the work of [15] and [16] proposedto use a training sequence to aid the design of local dataquantization strategies, and the work of [17] and [18] proposedseveral universal (pdf-unaware) decentralized estimation systems based on best linear unbiased estimation (BLUE) rule for distributed parameter estimation in the presence of unknown, additive sensor noise. While most of the aforementioned work on bandwidth-constrained distributed estimation are posed for a given number of sensors (one observation per sensor) [8]–[18], the work of [19] proposed quasi-optimal distributed parameter estimation algorithms to minimize the estimation mean square error (MSE) with a total rate constraint. Bandwidth-constrained distributed estimation in encrypted wireless sensor networks is also addressed in [20]. To explicitly address the energy constraint in wireless sensor networks, the minimal-energy distributed estimation problem has also been recently considered in [21]–[26]. In [21] and [22], the total sensor transmission energy is minimized by selecting the optimal quantization levels while meeting the target estimation MSE requirements. On the contrary, the work of [23], [24] is to minimize the estimation MSE under the given energy constraints. The work of [25], [26] addressed the energy-constrained distributed estimation problem (under the BLUE fusion rule) by exploiting long-term noise variance statistics.

III. MINIMUM HOP ROUTING IN WSN

Minimum Hop Count Algorithm (MHC) is built on the basis of minimum numbers of hops [6], using the communication means of multi-hop routing in the spread process. First, sink node is flooding the query broadcast and sending information to other sensor nodes. Each sensor node returns the confirmation when it has received the information of the sink node. During the process of flooding [8], through the confirmation of the number of hops and then it creates the hop count field in route selection. The nodes do not need to maintain the network topology, under the certain probability of sending the sensor node, just make sure that make the maximum distance transmission of the data at each step.
Drawbacks of minimum hop routing in WSN:

- In the minimum hop routing protocol [14], sometimes they may cause a lot of redundant information in the network and do not consider the energy consumption of the network. The choice of receiving node is only considering how close to the sink node and do not consider the energy factor of the receiving node.
- The energy consumption and data collisions and in different circumstance, the distribution of nodes, numbers, scale and density are not the same.
- In the Flooding method, each node must know the energy situation of other nodes' hops, so there may cause the possibility of the duplicate transmission and result in loss of node energy.

So in order to solve the problem, this paper has put forward an improved algorithm described in following section.

IV. ADAPTIVE ENERGY OPTIMIZED MINIMUM HOP ROUTING IN SENSOR NETWORK

In this section, optimization is provided to the one of the effective routing algorithm called minimum-hop routing. As the communication is performed, each participating node in the network losses some amount of energy. The minimum hop routing, generates an energy effective path to perform the communication. But this effective path increases the load on the selective hops of defined routing approach. Because of which, the hops of this routing path dies earlier to other nodes. The proposed algorithm is the improvement to minimum hop routing by identifying the optimal compromising nodes to the minimum-hop routing path nodes. Each node of this minimum hop path will generate an effective an adaptive zone and behave as the controller to that zone. This controller will identify the effective compromising nodes by performing the sensing range and energy analysis. Zone controller will also define a ratio for each compromising node for acting as the substitute to the zone controller. Now as the communication will be performed, with each transmission the adaptive zone equalized minimum hop route will be identified. The presented work will perform the equalize consumption of energy over a route so that the energy balanced routing will be performed. The presented work is performed in matlab environment. The work is analyzing the network under energy and network life parameters.

Proposed Algorithm:

```
/*Nodes is the List of N sensor Nodes defined randomly over the network*/
{
For i=1 to N
[Specify Energy Parameter and Failure Probability for All Nodes]
{
Nodes(i).Energy=Random;
Nodes(i).FailureProbability=Random
}
Generate Distance Matrix over Nodes called DistMat
For i=1 to N
[Identify Failure Nodes over Network]
{
For j=1 to N
[ Analyze All Neighbor Nodes]
        {
If (DistMat(Nodes(i),Nodes(j))>SensingRange)
{
Set FailList(i)=1
Set FailList(j)=1
}If (Energy(Node(i)<EThreshhold)
{
Set FailList(i)=1
}
If(Energy(Node(j))<EThreshold)
{
Set FailList(i)=1
}}                                    Cont….
If(FailureProbability(Node(i),Node(j))>Threshold)
{
FailList(Node(i))=1;
FailList(Node(j))=1
}}}
Specify Src Node and Dst Node for Communication Divide the Georaphical area between Src and Dst in Zones under Sensing Range Specification where
ZoneRadius=SensingRange
NoofZones=Distance(Src,Dst)/ZoneRadius
For i=1 to NoofZones
[Generate Zone Based Path Between Source and Destination]{
Find Node List for Zone(i) called ZNodeList
For j=1 to Length(ZNodeList)
{
If (Not In FailList(ZNodeList(i))
{
Set Path(i)=ZNodeList(j)
Break;
}}
Return Path
}
```

Fig2. Proposed algorithm

The presented approach is based on the minimum hop switch path based approach in which the complete routing path will be divided in smaller zones. This zone is created by the nodes of minimum hop routing path under the energy and sensing range parameters. The path formation is shown here under

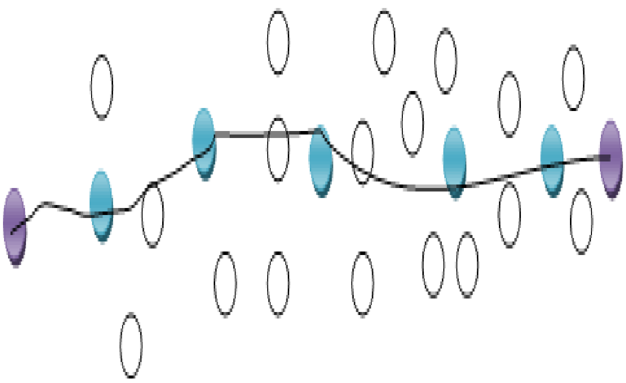

Fig 3. Path formation

Here the blue nodes are representing the nodes that are participating in standard minimum hop path. In this approach these nodes work as the zone controller and generate the compromising nodes based on the sensing range and energy analysis. It returns more than one adaptive path without increasing the number of nodes in minimum hop path. The compromising path based zones are shown here under

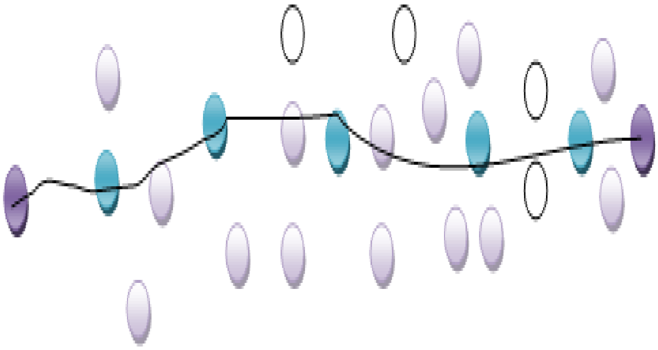

Fig 4. Compromising path based zones

Here pink nodes are showing the comprosing nodes in each zone. The zone controller will also define a ratio analysis to generate the zone adaptive minimum hop path so that the reliable communication will be drawn over the network. Theapproach reduces the energy consumption and improves the network life.

V. EXPERIMENTAL RESULTS

The experiment is using the MATLAB for simulation.The proposed approach is the dynamic adaptive approach that will generate the effective minimum hop routing between current source and sink nodes. Also energy and range specification based approach is suggested in this approach. Figure 4 shows round based energy consumption analysis which represents that our approach is performing the equalize consumption of energy over a route so that the energy balanced routing can be performed. Similarly fig 5 shows round based distance analysis and fig 6 shows round based hop count analysis.

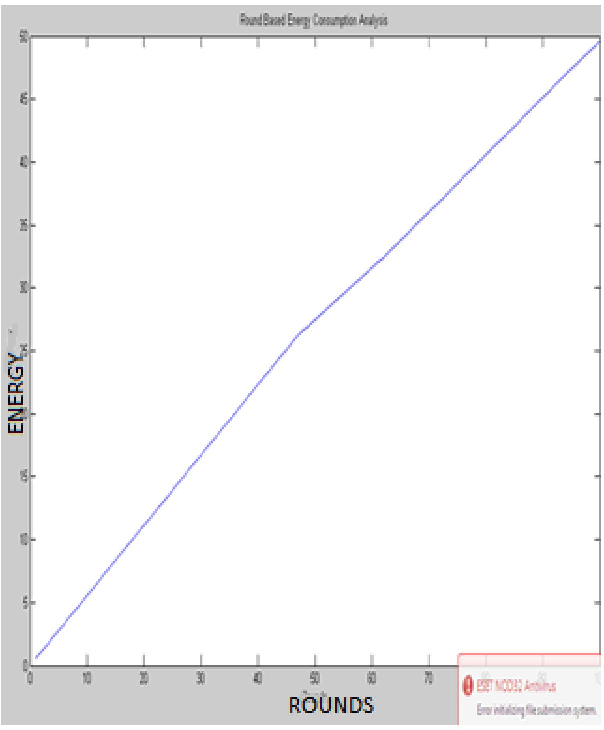

Fig5. Round based energy consumption analysis

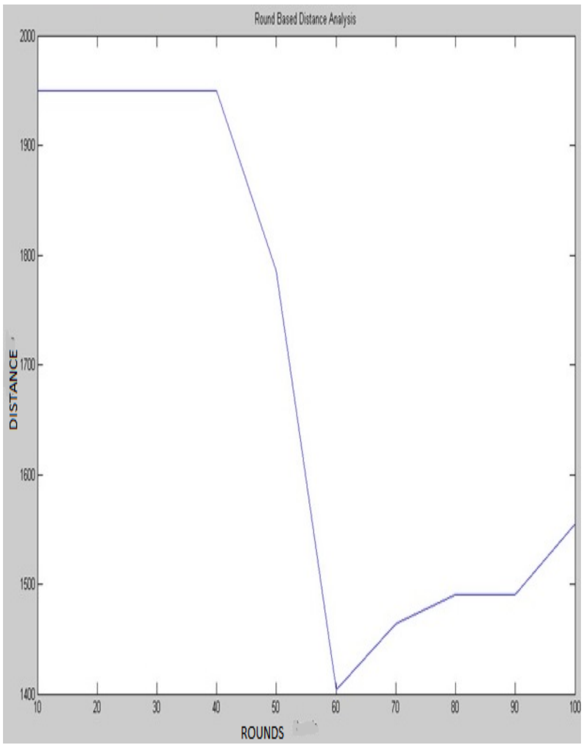

Fig.6 Round based distance analysis

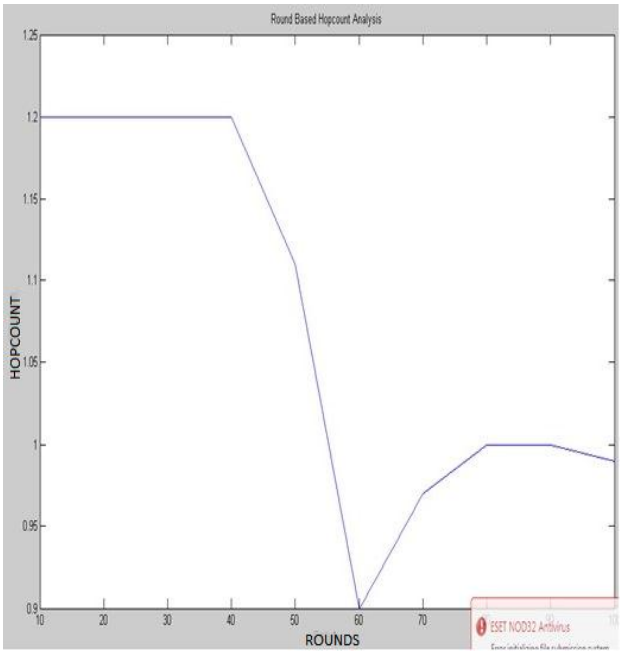

Fig7. Round based Hopcount analysis

VI. CONCLUSION

A sensor network is one of the most adaptive research area that requires the optimization in term of energy effectiveness, load balancing etc.Consequently, there have been active research efforts on performance limits of wireless sensor networks. These performance limits include, among others, network capacity and network lifetime.in this research paper we have suggested an "Adaptive Energy Optimized Minimum Hop Routing in Sensor Network" approach that generates the energy adaptive multi-hop route between source and destination. The proposed scheme also improves the network life. The selective compromising node generates the dynamic minimum hop so that optimized route can be obtained.The main objective of this approach was to identify the minimum hop path nodes based on sensing range and energy specification.

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