An Optimized Energy Efficient Routing Protocol Wireless Sensor Networks Based on Threshold-LEACH Algorithm

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Abstract- *This paper focuses on the application of Wireless Sensor Networks (WSNs) in fields wherein human intervention is infeasible. One of the key challenges in Wireless Networks is the enhancement of Network lifetime that enhances the efficiency and applications of the WSNs. Wireless Sensor Network (WSN) consisting of an hundred or thousand number of nodes which are deployed manually or randomly in the target region, and is useful for environment monitoring & tracking purposes. These nodes sense the environment's information, change into an acceptable form of signal, thereafter send it to the respective destination. Energy saving is the prime aim in WSN, which depends upon the clustering and packet routing. From previous literature, it has been found that dynamic Cluster Head (CH) selection process is necessary in WSN. In Low Energy Adaptive Clustering Hierarchical (LEACH), the CH selection was random, and didn't include energy aware parameters. In this proposed paper a modified LEACH with parameter threshold has been presented with yields higher network lifetime compared to existing approaches.*

Keywords- Wireless Sensor Network (WSN), Network Lifetime, Dead Nodes, Low Energy Adaptive Clustering Hierarchical (LEACH), parameter threshold.

I. INTRODUCTION

Wireless Sensor Network is collection of numbers of sensor nodes. Sensor nodes gather the sensory information and communicating with other nodes in networks [1]. Sensor node contain the microcontroller, transceiver, external memory and sensors [2]-[3]. Key Challenges in wireless sensor network is saving energy and extend the network life time [4]. To increase the capability of networks, clustering techniques is used [5]. In Clustering techniques, all node are divided into serval cluster and one of the sensor node is elected as Cluster Head (CH) and rest are cluster member (CM) [6]. Only Cluster Head (CH) can collect the data from the other node and send to base station [7]. For the data transference in wireless sensor network and selection of Cluster Head many clustering based routing protocols are used [8].

Wireless Sensor Networks are formed by tiny sensing devices for wireless communication, actuation, control and monitoring [9]. Given the potential benefits offered by these networks like simple deployment, low cost, lack of cabling and mobility they providing numerous applications among which some are categorized as [10]-[11]:

Disaster Relief Operations: The WSN framework structural planning for flood forecasting comprises of sensors (which sense and gather the information applicable for counts), a few nodes alluded to as computational nods and a manned focal checking office (which checks the results with the accessible online data, executes an incorporated rendition of the forecast calculation as an excess system, issues cautions and starts departure strategies) [12]. Diverse sorts of sensors are obliged to sense water release from dam, precipitation, stickiness, temperature, and so on. The information gathered by these sensors are utilized within the flood prediction calculation. The computational nodes have compelling CPUs needed to execute the appropriated expectation model. The computational nodes should impart the forecast results to the observing node. They additionally have correspondence between themselves for discovering breaking down of nodes [13].

Intelligent Buildings/Bridges: To reduce the energy use of buildings, WSNs could be deployed to measure temperature, humidity and air flow, which then could be used to adapt the temperature within the building automatically. Also sensors could be used to monitor the mechanical stress level of buildings, such as bridges, to find out the likelihood of a collapse.

Biodiversity Mapping: WSNs can be used, for example, to monitor the erosion processes on the ground of the ocean. Closely related is biodiversity mapping in which a number of plants or animals in a certain region are monitored [14].

Building Architecture: In larger facilities with multiple buildings sensors could be used to track vehicles in that area or to detect intruders. Another application could be the deployment of sensors in a chemical plant to detect leaking chemicals.

Precision Agriculture: Remote Sensing directs the farmer’s efforts towards crop needs of water, nutrients and other attention. The information provided enables the farmer to act significantly to the problems with minimal investment by knowledge of land, need and quantity. Development of wider array of such devices greatly benefits the agriculture sector. Sensor networks integrate spatiotemporal patterns and trends in climate, pressure, motion, hydrology, soil moisture and reports best management options to agriculture manager.

Military Applications: To sense the movement of army, WSNs are mined over a wide area and is further subjected to sense biological or chemical explosives. The military rely on this technique for strategy formation and defence mechanisms [15]. The objective of a typical ground surveillance system is to alert the military command to targets of interest, such as moving vehicles and personnel in hostile regions. Such missions typically require a higher component possibility regarding human being in addition to need a high penetration of stealthiness. Hence, the ability to deploy unmanned surveillance missions, by employing wireless sensor networks, is associated with great realistic importance for the military. Effective recognition, arrangement, and following oblige an observation framework to get the current position of a vehicle and its signature with worthy accuracy and trust. At the point when the data is received, it must be accounted for to a remote base station inside a satisfactory inactivity [16].

Medicine and Health care: Sensors can be placed at certain items, such as parcels, to allow a simple tracking of objects during transportation or within a warehouse.

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II. SYSTEM DESIGN

The proposed system is based on minimizing transmissions and transmitting data only when the changes in the data are non-trivial or significant [18]. We have considered some assumptions that are follow as:

1. Once the deployment of sensor nodes is finished, then all of them considered in static nature.
2. All sensor nodes contain same equal energy. 3. All the cluster members uses single hop communication, and send its information directly to the respective CH [19]. Data aggregation has been performed by every CH

A. Radio Model

The radio model presented in this approach can be mathematically modelled as:

If a k-bit data packet is transmitted to a distance 'd', then the energy consumption is given by:

$$E_{TX}(k,d) = k\left(E_{elected} + \epsilon_{fs}\, d^2\right), d < d_0 \quad (1)$$

And

$$E_{TX}(k,d) = k\left(E_{elected} + \epsilon_{fs}\, d^4\right), d > d_0 \quad (2)$$

Here,

$d_0 = \frac{\epsilon_{fs}}{\epsilon_{mp}}$, break point distance

$E_{elected}$ is the energy dissipation for 1-bit transmission or reception.

k denotes the packet size

ϵ_{fs} denotes energy dissipation for free space.

ϵ_{mp} denotes energy dissipation for a multi path propagation scenario.

LEACH is the one of the most effected clustering algorithms of WSN. LEACH reduces the energy consumption of network by employing clustering scheme, where every cluster having one CH [20]. Once the deployment of sensor nodes are completed, thereafter clustering process begins. Here, firstly all the CHs of the network are selected, where CH selection was based on probability-dependent threshold, as given in Eqn. 3, thereafter remaining nodes of the network select the nearest CH based upon the received signal strength of the CHs [21]. All the CHs used as a router that directly communicated to the BS. LEACH perform clustering in a distributed manner. Mathematically:

$$T(n) = \frac{p'}{1-p' * (r' mod (\frac{1}{p'}))}\ if, n \neq G \qquad (3)$$

Here,

p' is defined as the desire percentage of sensor nodes, which are able to act as CH from all nodes of the sensing region,
G contain those nodes which have not have selected as CH in 1/p' previous rounds
and r' is the current round number.

B. Proposed Threshold Based Leach Model

The proposed model is based on the stability of the parameter threshold so as to minimize the total number of transmissions. Moreover, the modified version of the LEACH also uses the ratio of the residual energy to the initial energy of the nodes given by:

$$T(n) = \frac{p'}{1-p' * (r' \bmod (\frac{1}{p'}))} \frac{E_{res}}{E_i} \; if, n \neq G \qquad (4)$$

Here,

$\frac{E_{res}}{E_i}$ denotes the ratio of the residual energy to the initial energy of the nodes.

To implement this kind of an adaptive routing mechanism, a thresholding concept is used. The following key points can be noted:

a) Transmission is reduced by assigning a hard threshold and a soft threshold.
b) Assigning a delay time.
c) Transmission is started only after the hard threshold is exceeded
d) Retransmission is done in only 2 cases
   1) Soft threshold is exceeded
      or
   2) Delay time is exceeded

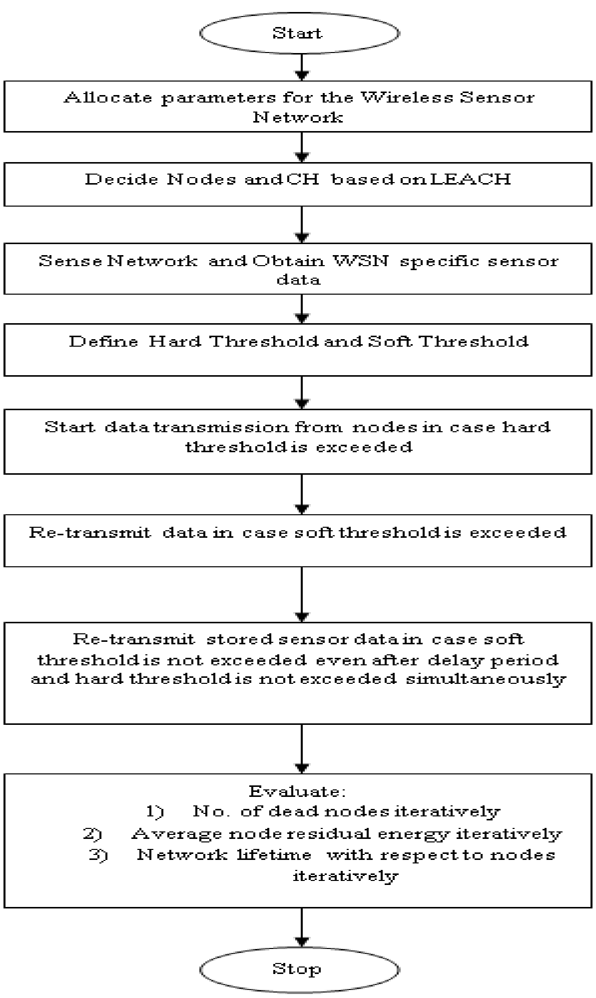

Fig.1 Flowchart of Proposed System

III. RESULTS

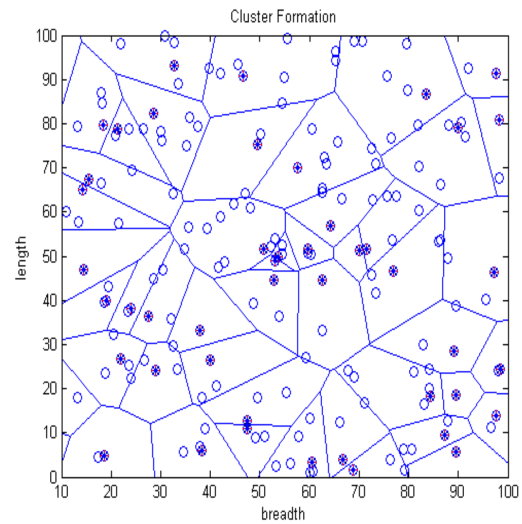

Fig.2 Initial Clustering

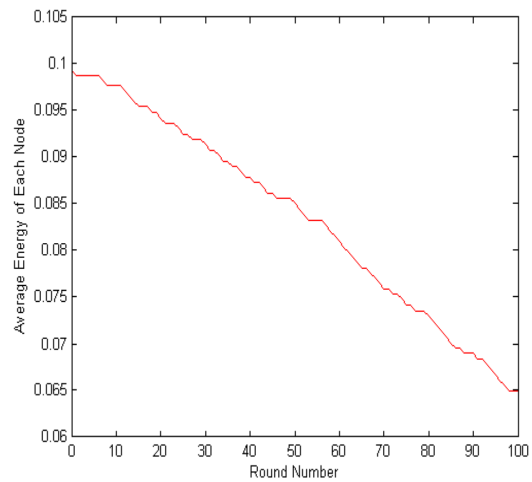

Fig.3 Average Energy of Nodes

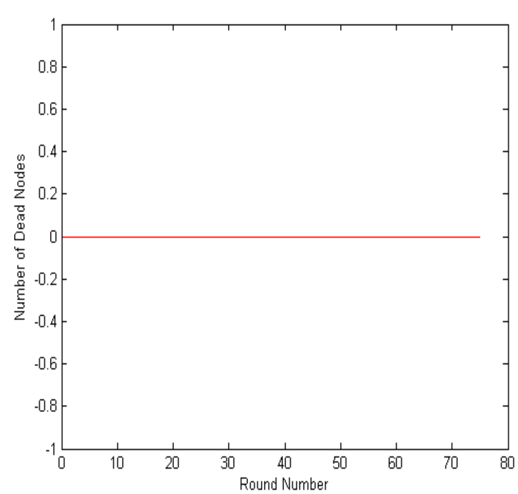

Fig.4 Analysis of Dead Nodes

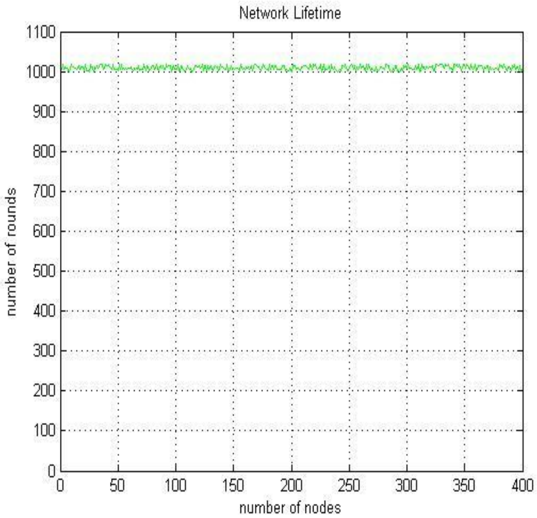

Fig.5 Network Lifetime Analysis

Description of Results Obtained:

Figure.2 depicts the initial clustering of the nodes of the sensors based on the residual energy and the limiting distance. It should be noted that the clustering is dynamic and changes with each iteration of information transfer to the control station.

Figure.3 depicts the average energy of the nodes as the data transfer from the sensors of the wireless network starts and the iterations increase. It can be clearly seen that the average energy of the nodes dip as the number of iterations increase.

Figure.4 shows the number of dead nodes as the number of iterations increase up to 75, where it can be seen that the number of dead nodes is nil.

Figure.5 depicts the network lifetime as a function of number of rounds and number of nodes. It can be seen that the proposed system attains around 1000 iterations or rounds as the number of nodes increase up to 400.

IV. CONCLUSION

It can be concluded from the results obtained that the proposed system reduces the number of transmission based on the soft threshold (step size) and hard threshold approach. The parameters evaluated are number of dead nodes iteratively, average energy per node iteratively and network lifetime as a function of nodes iteratively. It can be seen that the proposed technique attains high value of network lifetime.

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