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Refuse of Sensor's Energy Consumption in Wireless Sensor Networks Using Routing Protocols

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Abstract— **A collection of huge number of a smaller amount of cost, a smaller amount of power as well as multifunctional small intelligent sensors is called as a Wireless Sensor Network(WSN). In these Wireless Sensor Networks, sensor nodes are have an extremely limited power supply. The main aim of this power routing procedure is dangerous for these Wireless Sensor Networks, because the majority of the sensor's power is utilized at the time of sending the data from a sensor node to the sink or Base Station (BS). In this paper, we will introduce a new routing protocol called as MIN-RC, which is mainly based on LEACH-C protocol to stabilize the power utilization of a variety of sensor nodes to solve the excess power utilization problem. LEACH-C is a centralized clustering algorithm, which is based on LEACH[5].**

The LEACH protocol is mainly used for the purpose of HIERARCHICAL routing. To solve the difficulty of power utilization between various sensor nodes, MIN-RC uses an adaptive round control method to balance the power utilizations by allowing present position of the network, cluster dimension, and the location of cluster head. To estimate and contrast MIN-RC with LEACH-C, we will use ns-2 simulator. The simulation work completes when the number of nodes are active is less than or equal to the number of clusters.

Keywords-Wireless Sensor Networks (WSN) routing; LEACH-C; MIN_RC; power utilization.

I. INTRODUCTION

Modern researches in wireless communications contains the growth of low-priced, less-power as well as multifunctional a very little intelligent sensors These sensors have the ability to sense, process data and communicate with each other via a wireless connection.[1, 2]. A group of a huge number of these little sensors is also called as a Wireless Sensor Network(WSN). In these Wireless Sensor Networks (WSN), sensor nodes are deployed to sense various actions or ecological phenomena through sensing, processing and also by forward the data to a fascinated person or user.

The main aim of an energy-aware routing protocol is very critical for these type of Wireless Sensor Networks. Since, the majority of the sensor's power is utilized by the communication procedure at the time of transmitting or sending some data or information from a sensor node to the sink or Base Station(BS). A low power utilization routing protocol will prolong the Wireless Sensor Network life time [1, 2, 3]. In order to prolong the life time of WSN many routing protocols have been designed to minimize the energy consumed by routing operations [1].

Clustering based routing protocols:

Clustering is the procedure, in this the sensor nodes are ordered in a set about the Cluster Head by the task of an observance position and also inter cluster comparison occupied in the data processing. In hierarchical (cluster-based) routing protocols, these sensor nodes are categorized into a practical hierarchy method to structure a many-hops communication representation. The main objective to use this particular method is to decrease the power utilization which will be used to transmit the data to the sink or Base Station (BS), and it will be achieve through decreasing the different number of messages sent to the Base Station (BS) during data aggregation and also synthesis.

Merits of Clustering:

- It is useful to achieve Scalability.
- It provides Bandwidth reuse.
- It provides an improved resource sharing.
- It decrease communication transparency.

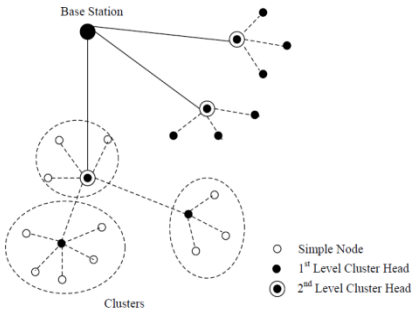

Fig: Hierarchy of Cluster model

Distribution of power utilization among these nodes can also extend the network life time and also increase the effectiveness of the Wireless Sensor Network. Manipulation of a cluster-based routing protocol need to thought of the cluster arrangement, cluster head selection, data aggregation, and also inter and intra- cluster communications [1, 2]. The routing protocol LEACH [4, 5] uses a scheme where the cluster head is randomly rotated to distribute energy consumption among sensor nodes and many researchers attempt to enhance this protocol.

PEGASIS [3, 6] forms a set of chains of closed neighbours with a leader for each chain, each neighbour sends data to its closest neighbour until all the data which is sent by the members is aggregated at the chain leader. At that time, the chain leader transmits or sends an aggregated information to the Base Station (BS) as a representative of the additional chain members. In TEEN [7] and APTEEN [8] threshold values are used to control data transmission. HEED [9] selects a set of nodes as cluster heads depending on the residual-energy of the node and on a secondary parameter intra-cluster communication cost for cluster head selection.

In this paper, we will explain the difficulty of overload power utilization in the cluster based Wireless Sensor Networks(WSN), and introduce MIN-RC, which is a routing protocol and it is based on the existing LEACH-C protocol that reduces the difference of power utilization caused through uneven clustering. The proposed MIN-RC routing protocol use a changeable round time instead of a permanent round time which is present as in existing LEACH-C protocol, and we will also take into account, the smallest amount of cluster dimension to manage the round time, and at all times it will reduce the round time with respect to the present position of the network.

II. ASSOCIATED WORK

The Low Energy Adaptive Clustering Hierarchy (LEACH) routing protocol is one of the majority of ordinary routing protocols which is used for hierarchical routing. This LEACH protocol is introduced to stabilize the power utilized in these Wireless Sensor Networks (WSN) by means of selecting various sensor nodes to perform as cluster heads. These sensor nodes gather the data from the remaining nodes, and then aggregate the gathered data, after that transfer this aggregated data straightly to the sink or Base Station (BS). The LEACH protocol functionality is shown in the following figure:

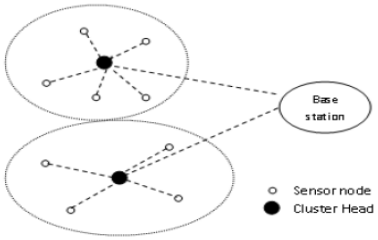

Fig: Functionality of LEACH protocol

This LEACH algorithm partition the Sensor's Network life time into different rounds, and each and every round is having two stages:

1. *Setup stage* (Cluster's arrangement)
2. *steady stage(*working stage)

$T_i(t) = k/(N-k*(r \bmod(N/k)))$ if $C_i(t)=1$

$T_i(t) = 0$ if $C_i(t)=0$ →(1)

In the 1st stage that is., in Setup stage, the clusters are arranged through the set of nodes by itself using the above equation (1),

where

N is the number of nodes,

k is the number of clusters,

r is the present or current round number,

and C_i is the function which is to be determined.

If the sensor node i is to be chosen as a cluster head in the current round (*r mod(N/k*)), where each and every node will choose an arbitrary number between 0 and 1, if this particular arbitrary number is larger than the threshold value T then the sensor node is to be preferred as a cluster head and transmit an announcement message which contains its Identification. Remaining nodes (non-cluster head) make a decision to connect a cluster based on the signal power of the acknowledged announcements, then these nodes transfer a Join-Request message to the chosen Cluster Head CH. After that, the Cluster Head CH collect the combination of messages from remaining nodes which will be determined to connect this particular cluster; then the Cluster Head CH generate a TDMA (Time division multiple Access) program and transmits this particular program to the all of the cluster members which are present in the cluster. Then this TDMA program is having a time period for each and every node to exchange information with a Cluster Head CH.

In the second stage, that is., in the steady stage, it will be divided into a various number of frames; in each and every frame the sensor node transmits its data to a Cluster Head CH by using its time period in the particular TDMA program. After this it will change its particular position to the sleep mode. When the Cluster Head CH node collect the data from its cluster members, then the Cluster Head CH combines the received data and transfers this combined data straightly to the sink or Base Station (BS). This procedure is continues upto the completion of the round, after the finishing of each and every round, sensor nodes goes through the setup stage another time to choose a latest set of cluster heads which will be used for the subsequent round.

Algorithm paradigms for WSN:

Applications of Sensors requires the communication of various sensor nodes to perform different actions or algorithms. In reality, three different types of algorithms are be implemented on Wireless Sensor Networks (WSN).

- Centralized algorithms
- Distributed algorithms
- Local based algorithms

Design constraints for routing in WSNs:

With respective to the decreased computing, battery assets of various sensors, the routing protocols in Wireless Sensor Networks are predictable to accomplish the following requirements[16]:

- Autonomy
- Energy efficiency
- Scalability
- Mobile adaptability

The purpose specific protocol meant for the Cluster Head choice, LEACH-Centralized occupy centralized clustering algorithm and it is an enhancement of the LEACH protocol. LEACH-C[5] is a centralized clustering algorithm which based on LEACH. In an existing LEACH-C routing protocol, the sink or Base Station (BS) choose a very few nodes to perform as cluster heads by taking the residual power and also the position of each and every node.

In the setup stage, in an existing LEACH-C protocol, all the nodes transmit or send their positions and also their present power altitude to the sink or Base Station (BS). After getting all of these nodes information, this sink or Base Station (BS) will select different nodes to perform as cluster heads for the subsequent round. The nodes which are having the highest energy than the average energy of all the sensor nodes are suitable to employed as cluster heads.

Then, this particular Base Station (BS) performs an annealing algorithm to form k clusters, where k is a predetermined optimal number of clusters[5], by means of the finish of this stage, the sink or Base Station (BS) transmits or sends the cluster data or information message which contains the cluster head Identifier id, for each and every sensor node. When the sensor node will collect the cluster's data or information message , then the sensor node compare its Identifier id with one of the Base Station's message.

If the cluster head Identifier id which is present in the information is matched with the message which is present in Base Station's message, then that particular node will considered as

cluster head. If not, it will decide its time period and it also entering into the sleep mode. The steady stage which is present in the existing LEACH-C protocol is also same as the LEACH protocol steady stage.

In [10] the round time T is determined by the energy level of the CH and non-CH members and percentage of the nodes alive in the round.

VR-LEACH (Variable Round-LEACH)[11], which is an improvement for the LEACH protocol changes the round time according to the residual energy of the cluster head at the beginning of the round, the energy cost in every frame and the constants λ. In this VR-LEACH protocol, a stable value for λ as well as the frame time μ are calculated for each and every round time, here these calculated values of λ, and μ are mentioned with an experimental results.

In[10, 11] no mention is made as to how the round time T could be distributed among clusters, because all clusters must finish the round at the same time and start the next setup phase to form new clusters for the next round.

III. PROBLEM STATEMENT

A.MODEL OF A WIRELESS SENSOR NETWORK

We will think about a Wireless Sensor Network (WSN) model, where the number of various sensor nodes N are arbitrarily organize in excess of the sensing area in a consistent way. These sensor nodes observe ecological phenomena and transmit their data or information to the sink or Base Station (BS). We are having several preface assumptions for the Wireless Sensor Network (WSN) model. These sensor nodes and the Base Station (BS) are motionless after the exploitation and this Base Station (BS) is to be placed far away from all these sensors, and all of these sensor nodes are consistent and they all are having the similar competencies where each sensor node has a distinctive identifier (*Id*). The protocols present in Wireless Sensor Network are shown in figure:

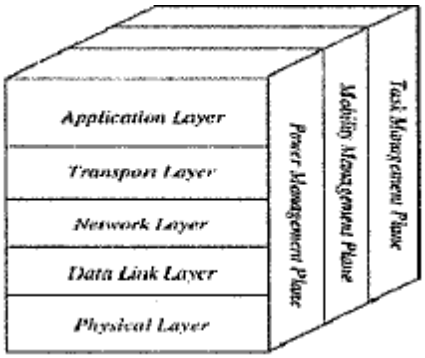

Fig: Various protocols in Wireless Sensor Network model

Each sensor node is prepared with position recognition nature for example in Global Positioning System (GPS), sensor nodes know how to manage their broadcast power to send straightly to the sink or Base Station (BS). All these nodes begins with the similar power altitude and the Base Station (BS) is having unrestricted power supply, sensor nodes are having the data at every time to transmit to the Base Station (BS). Great data combination, where this particular Cluster Head CH combines the grouped data messages expressed into a distinct message.

We will use a straightforward power representation as in LEACH protocol, with power dispersion 50nJ/bit for transmitter electronics $E_{Tx\text{-}elec}$ and receiver $E_{Rx\text{-}elec}$ electronic

$$ETx\text{-}elec = ERx\text{-}elec = Eelec \qquad (2)$$

Power utilization is 100pJ/bit/m^2 for a transmitter amplifier ($_{amp}$). To transmit the (*l*-bit) message in excess of a distance *d, then* the power utilized by the radio is

$$E_{Tx}(l, d) = E_{Tx\text{-}elec}(l) + E_{Tx\text{-}amp}(l)$$

$$= \begin{cases} lE_{elec} + l\varepsilon_{fs} d^2 & d < d_0 \\ lE_{elec} + l\varepsilon_{mp} d^4 & d > d_0 \end{cases} \qquad (3)$$

Where d_0 is the threshold distance.

In the standardized division of N sensor nodes into k different clusters, then the average cluster size is N/k, and the Base Station (BS) is far away from any of the cluster head (distance to BS $d_{toBS} > d_0$), and the d^4 power failure is used, for that reason the energy or power E_{CH} is utilized by the Cluster Head CH to finish a particular frame is

$$E_{CH} = lE_{elec}\left(\frac{N}{k} - 1\right) + lE_{DA}\frac{N}{k} + l\varepsilon_{mp}\, d_{toBS}^{4} \quad (4)$$

Where E_{DA} is the power or energy utilization for the data aggregation, and the power or energy utilized for each of the non cluster head is

$$E_{non-CH} = lE_{elec} + l\varepsilon_{fs}\, d_{toCH}^{2} \quad (5)$$

In an existing LEACH-C protocol, it uses a stable round time T, and the stable time period σ for each of the sensor node to exchange with its Cluster Head CH, therefore the average of the frame time F_{avg} is

$$F_{avg} = \left(\frac{N}{K} - 1\right) \cdot \sigma + \lambda \quad (6)$$

Where λ is the time used for an combining and also transmitting the data to the sink or Base Station (BS), therefore the average number of frames represented as NF in a particular round R for each of the cluster is

$$NF = T / F_{avg} \quad (7)$$

And the whole energy or power utilized by a Cluster Head CH to finish a round R is:

$$ER_{CH} = NF * E_{CH} \quad (8)$$

B. OVERLOAD POWER UTILIZATION PROBLEM

The existing LEACH-C routing protocol is not think about the number of sensor nodes in each and every cluster, or the space to the sink or Base Station (BS) while structuring the clusters, therefore the Cluster Head CH would be placed at any position in the sensing ground, and any of the cluster can be assembled with the help of various number of sensor nodes.

Fig.1 illustrates the minimum and maximum range of different clusters in excess of the network instance. It shows the various ranges of different cluster sizes at each and every round, consequently this particular difference should be throw back onto the power utilization for a Cluster Head CH of each of the cluster. In addition to this, it will also depends upon the remaining cluster members of cluster equations (3), (4). In this effort we are mainly having attention on in what way that the minimum range cluster influence the presentation or performance of the whole network.

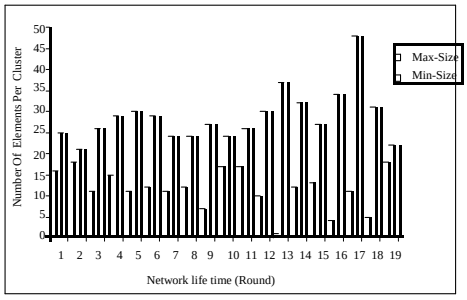

Figure 1. The minimum and maximum cluster ranges per round. A network of 100 nodes and 5 clusters, where the average cluster size is 20, shows how clusters sizes vary during the same round.

For any of the cluster C, the amount of frames through a particular round is conquered by means of the number of sensor nodes in that cluster C. Fig.2 represents the allocation of these nodes in a particular round R_t, where CHi, CHj are the two different cluster heads for the clusters Ci, Cj respectively.

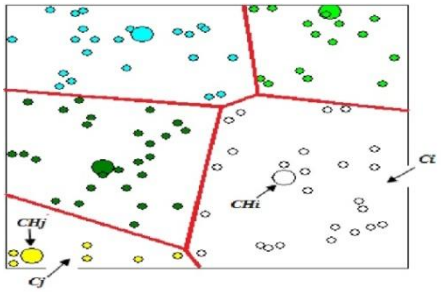

Figure 2. Cluster arrangement during round R_t, nodes belongs to the same cluster has the same color and large circles represents Cluster Head.

If the amount of nodes in the clusters C*i*, C*j* may vary, then this multiplicity of these clusters sizes directed to the variety of the utilized power by each and every Cluster Head CH. Then the Cluster *Cj* is having the smallest quantity of cluster members than the cluster *Ci*, then the Cluster Head *CHj* will transmit or send more number of frames to the sink or Base Station (BS) than the Cluster Head *CHi*, and for this reason that, this cluster *Head CHj* wants to modify its broadcast power using ($_{mp}d^4$) to transmit each and every message to the sink or Base Station (BS).

Therefore, the Cluster Head *CHj* will utilize extra power throughout the similar rounds than the Cluster Head *CHi*, except the isolation between clusters sizes is little and the Cluster Head *CHi* is placed beyond than the Cluster Head *CHj*. Therefore in energetic clustering, the clusters with extremely little sizes may be placed at any place within the sensing region, and it will unbalance the power utilization and also enlarge the variety in power utilization between various Cluster Heads, we will call this procedure as the overload power utilization.

Since, the size of a cluster Cj acquire lesser and the network have an unstable cluster position at the present round. So, we will plan our explanation to construct the network get well as soon as probable commencing this particular condition. Observably, reducing the round time may give to the network, a chance to rapidly get better from this unstabled clustering condition and also from an unstable power utilization. A very strong influence of this round time through the least amount of cluster size can decrease the round time toward make progress from an unstable clustering, the following section IV demonstrates in detail about our proposed protocol.

IV. THE PROPOSED PROTOCOL (MIN-RC)

In this paper, we introduce a new routing protocol called as MIN-RC which based on the existing LEACH-C protocol to stabilize the power utilization of various sensor nodes to resolve the overload power utilization problem. The proposed MIN-RC routing protocol utilize an inconsistent length round depends upon the least amount of cluster size.

Network life time of a proposed MIN-RC protocol is divided into various rounds, and this each round begins with the setup stage. In this setup stage, each and every node transmits or sends its identifier Id, position and also the present stage of residual power to the sink or Base Station (BS). Then that Base Station (BS) divides the network into k different clusters and prior to transmitting the cluster data to various sensor nodes, then the Base Station (BS) compute the time used for the subsequent round $T_{current}$.

To resolve the difficulty of overload power utilization, and reduce the multiplicity of the power utilization between different nodes, the proposed MIN-RC protocol used an adaptive round-control technique to stabilize the power utilizations.Where, the round time $T_{current}$ is described by the establishment of a round $R_{current}$ which is based on the least amount of cluster size and the best cluster size, instead of using a stable round time T which is used for each and every round in their network life.

For the cluster C_{min} which is having the smallest size (minimum number of nodes M_{min}), then the frame time F_{min} is defined as follows:

$$Fmin = Mmin * \sigma + \lambda \quad (9)$$

Then we will describe the present round time $T_{current}$ is as follows:

$$Tcurrent = NFavg.\ Fmin \quad (10)$$

Where,

NFavg is the average number of frames for a cluster with the size N/k.

Equation (10) ensure that the Cluster Head CH which is of the least sized cluster is not transmit or send frames more than the average number of frames NF_{avg} frames throughout the round, and it will decreases the overload power utilization of the Cluster Head of C_{min}, and also like C_{min} is having the least cluster size, accordingly no other Cluster Head CH of some other cluster can transmit or send frames are greater than the average number of frames NF_{avg}.

After describing the round time $T_{current}$ used for the present round, the sink or Base Station (BS) transmits or sends the cluster data or information, and also the customized $T_{current}$ to all of the sensor nodes within the network. Therefore, each of the node will decide its cluster and also its time

period in the particular TDMA program, and it will begins the steady state stage. The steady state stage of the proposed MIN-RC protocol is similar to the steady state stage which is present in the existing LEACH-C protocol.

V. SIMULATION WORK

To analyze and contrast the proposed MIN -RC protocol with the existing LEACH-C protocol, we will use an ns2 simulator [12] with ns-extension by Heinzelman [13].

TABLE: PARAMETERS TABLE

Parameter	Value
Sensing area	100 x 100
Network size	100 nodes
Location of BS	50,175
Data message	500 bytes
Packet header.	any packet type 25 bytes
Initial Energy	2J
E_{elec}	50 pJ/bit
$_{Fs}$	$10pJ/bit/m^2$
$_{Mp}$	$0.0013pJ/bit/m^4$
Number of cluster	k=5.

In our research, the network which is having 100 sensor nodes are arbitrarily arranged within the sensing region between (0, 0) and (100,100). We will assume that all of these sensor nodes are motionless, and any of the sensor node will transmit or send straightly to the sink or Base Station (BS). Table I. represents the system activities for our simulation work, which are related to those used in the LEACH [5] protocol. The simulation work completes while the number of sensor nodes are present in the network are smaller than or equivalent to the quantity or amount of clusters.

The simulation outcomes define and represent that the proposed MIN-RC protocol is more competent than the existing LEACH-C protocol and it can also convey extra information or data than the existing LEACH-C protocol.

Fig. 3 shows the various number of sensor nodes are active over simulation time. Nodes which are present in the existing LEACH-C protocol are having very great life time than the proposed MIN-RC protocol; but the nodes in our network model transmit or send some extra data than the existing LEACH-C protocol.

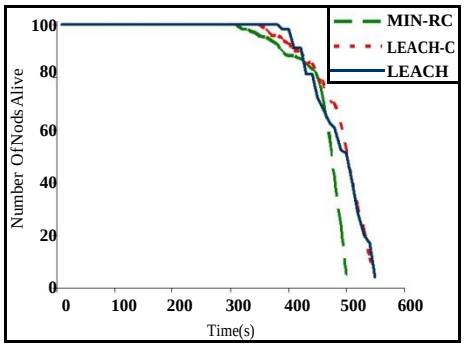

Figure 3. The number of nodes alive during the simulation time

Fig. 4 represents average of the utilized power to transmit or send the data signal beginning from any of the sensor node to the sink or Base Station (BS). The proposed protocol MIN-RC utilizes minimum power than the existing LEACH-C protocol, it is because of the proposed MIN-RC protocol can be able to very rapidly get better from the position of an unstabilized clustering. Therefore, it will avoid additional power utilization caused by means of an uneven clustering. It will indicating that the proposed MIN-RC protocol is very much better than the LEACH-C protocol in terms of power utilization.

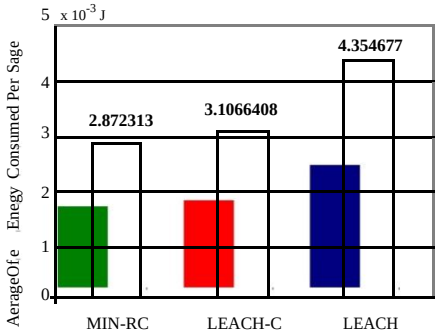

Figure4. The average of the energy consumed per data message received at the BS, shows that MIN-RC consumed less energy than LEACH-C

The proposed MIN-RC protocol controls the round time focus to the least cluster size. Therefore, the proposed MIN -RC protocol is having some extra rounds when compared to the existing LEACH-C protocol, and also some extra setup stage messages. However, we will see in Fig. 6, that the additional setup transparency is not having a serious cause on the entire network performance presentation as the MIN-RC protocol still having an enhanced power utilization.

VI. CONCLUSION

In this paper, we will illustrate the proposed MIN-RC protocol, which is an improvement of the existing LEACH-C protocol, and it is an adaptive round-control method to better utilization of the power utilized throughout the round time of a Wireless Sensor Network (WSN) communication protocol. Our proposed or planned technique allows the size (number of nodes) of the cluster in every round and also the best number of frames to describe the time-span of the present round, and our models also overcomes the overload problem of an existing LEACH-C protocol, which will improves the network effectiveness (the number of data messages received at the BS) by means of about 8%. However, when we establish the least amount of cluster size in our proposed system and it is having an additional set of connections transparency.

It is the piece of our effort to seek to describe the best possible value used for the round time, with respect to the present position of the network, taking into the concern, the cluster size as well as the position of the cluster head.

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