Double Stage chain routing Protocal in WSN

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***Abstract*: Wireless sensor networking is most popular fields in today's world. In this paper, we have discussed the different energy optimization protocols of WSN. We have forwarded a new protocol "Double Stage Chain Routing Protocol" from WSN. Our main focus is on extending the residual energy and network's life time at least more than LEACH, CCM and TSCP. The result of our protocol is represented with the help of graph with comparison with TSCP and it is found that DSCRP gives better network lifetime than LEACH. The proposed algorithm is acceptable in the network lifetime of DSCRP as well as in network life time.**

***Keywords*: WSN, SCRP, LEACH, PEGASIS, DSCRP**

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I. Introduction

Wireless sensor network consist of different sensors. These sensors are temperature sensor, humidity sensor, pressure sensor etc. Temperature sensor is used to sense the temperature of the environment and humidity sensor is used to sense the humidity of the environment. The sensors communicate to each other through the wireless medium in a distributed environment. But energy source is the main challenging task of the of the sensor node. A sensor node consumes energy for media listening, data transmission and data receiving. An inefficient routing protocol always decreases the network lifetime of the wireless sensor network. So it is important to design an efficient protocol for WSN. The sensors which are small, lightweight and portable are specially designed for` collecting a group of information at diverse location. For example the weather sensors have the ability to sense the factors like temperature, humidity, atmospheric pressure, and wind speed, direction etc. The soil sensors can sense the soil parameters such as temperature, moisture, conductivity, salinity, soil PH values etc. Similarly a plant sensor can sense temperature, moisture, carbon di-oxide, hydrogen, photosynthesis etc. The major issues relating to WSNs are the energy efficiency. The sensors usually depend on batteries for power. While the data travels over the network, every node consumes some amount of energy in gathering data, fusing the gathered information with the own information, and forward the fused information to the next immediate node in WSN. Thus, the network lifetime of WSN depends on the energy consumption of the sensor nodes in the transmission. Various algorithms have been designed in this respect, whose aim is to provide more and more efficiently with respect to energy that increases the lifetime of a network. The protocols proposed for WSNs are classified into various classes.

In this paper, review of different protocols are presented and proposed a new routing protocol for WSN. We also give the overview of the protocol proposed by us which is "Double Stage Chain Routing Protocol" [6]. Our main focus is on extending residual energy and the network's life time at least more than LEACH, CCM and TSCP. The result of our work is a new protocol, namely Double Stage Chain Routing Protocol (DSCRP) in WSN, which we could term as advancement of TSCP [9].

II. Related Work

A. Low Energy Adaptive Cluster Hierarchy (LEACH)

It is a hierarchical WSN routing protocol which is self organized and self adaptive. In order to save energy, clusters are formed and cluster head is selected where the data of all the other nodes are aggregated. The cluster head transmitted the aggregated data to the sink. The cluster heads are changed randomly in the network to balance the residual energy [1, 6, 10].

B. Power Energy Gathering in Sensor Information System (PEGASIS)

PEGASIS is a powerful routing protocol in WSN which is based on chain routing protocal. Each node in the sensor sends the information to its immediate neighbor sensor node and also receives the information from the neighbor node. The chain head of the node is selected randomly and it's sends the information to the base station [2,4].

C. Chain Cluster Based Mixed Routing Protocol (CCM)

Chain Cluster Based Mixed Routing Protocol is more powerful than PEGASIS and LEACH. It combines all the basic properties of PEGASIS and CCM. It means that it a chain based cluster routing protocol where low energy consumption, and short transmission delay is maintained [5].

D. Two Stage Chain Routing Protocol (4)

In this protocol, the nodes are taken in a grid form and consider each row as a chain. This protocol is divided in two steps. In first step, all the chain nodes send their data to their nearest neighbors and finally to the chain head. In second step, the chain heads forms a vertical chain and select a main head randomly. All the nodes in the vertical chain send their data to the chain head and send the aggregated data to the BS. In first step, the chain head is selected in a sequential manner and all the head nodes are in the same column. The sensor node used greedy algorithm to send the information to the chain head [3, 4].

E. Single stage chain routing protocol (SCRP)

In this protocol the network is divided into different numbers of chains with a fixed number of nodes. At first, a chain head is selected from one end of the chain and then chain heads are selected sequentially within the chain in different rounds. Data is transmitted from one node to neighboring node and gets fused. When the fused data reaches the chain head, it is sent to base station [7].

III. METHODOLOGY

In DSCRP, data fusion is performed at each step. Each row of nodes form a chain where the nodes transmit data to the nearest neighboring node only when the absolute difference between the data sensed by the node in the current round and the previous round exceeds the threshold value. The data of the two nodes then gets fused and is transmitted again to the next nearest neighboring node. This process continues until the data reaches the chain head which is chosen using the chain head selection method of CCM. The nodes in a chain become chain head in turns.

The chain heads of all the chains collectively form a cluster. The data is transmitted from one node to another until it reaches the cluster head. The cluster head in the cluster of chain heads is the one with the maximum residual energy and minimum distance from the base station. Once all the data reaches the cluster head, it is sent to the base station. The algorithm is given below.

A. Algorithm for DSCRP (horizontal chains)

The algorithm is explained below for horizontal chains:

Let the S(a,b) chose as assigned chain head for m^{th} round
// for horizontal chains
STEP 1: S(a,b) will generate two parameter and send them to S(a,1) and S(a,b)
STEP 2: Let the index for the nodes with the token be K=1 and L=n
STEP 3: The node takes the input from the sensors and stores it in variable cur
STEP 4*: // horizontal chains*
If (K<b)
{
If (abs(cur1-prev1)>th)

//cur1 = data sensed by the node in this round
//prev 1= data sensed by the node during previous transmission
//th = pre-determined threshold value which is used

To determine if there is sufficient change in sensed data
{
Fuse data received from S (a, K-1) where K>1;

S (a,K) will transmit the fused data along with its parameter to the neighbor nodes S(a,K+1);

K=K+1;
}
Else
{
It will send the token and data excluding its own data to its neighboring nodes S (i, K+1)
K=K+1;
}
}
If(L>b)
{
If (abs (cur2-prev2)>th)

To determine if there is sufficient change in sensed data
{
Fuse data received from S (i, L+1) where L<n;
S (i,L) will transmit the fused data along with its parameter to its neighbor nodes S(a,L-1);

L=L-1;

}
Else
{
It will send the token and data excluding its own data to its neighbor nodes S(a,L-1)
L=L-1;
}
}
STEP 6: repeat step 5 until both K and L is equal to j

B. Algorithm for DSCRP (Vertical chains)

//for vertical chain
STEP 1: A cluster head S(v,j) is selected among the chain heads for the jth round
STEP 2: S (v,j) will generate two tokens and send them to S(1,j) and S(n1,j)
STEP 3: let the index for the nodes with the token for S be K=1 and L=n1;
STEP 4: if(K<v)
{
Fuse data received from S(K-1,j) where K>1
S(K,j) will transmit the fused data along with its parameter to its neighbor node S(K+1,j)
K=K+1;
}

if(L>v)
{
Fuse data received from S(L+1,j) where L<n
S(L,j) will transmit the fused data along with its token to its neighboring node S(L-1,j)
L=L-1;
}
STEP 5: repeat step 4 until both K and L is equal to v
STEP 6: The cluster head sends the collected data to the Base Station

C. Working Principle and Model of DSCRP

Our protocol works in two stages. In the first stage a horizontal chain is formed and a chain head is selected sequentially. All the chain heads send token to both the ends of the chain and all the other nodes when receive the token sends their sensed data only if their values crosses a threshold value, which is given manually as per conditions. In this manner the data from the nodes are fused and reach the chain head. The chain head then forms a cluster and a cluster head is selected based on minimum distance from the base station (BS) and remaining residual energy. The cluster head then fused all the data and sends to the base station (BS).

A square area is taken for the model of our routing protocol. Details of the network model are specified below

TABLE I. SYSTEM DETAILS AND PARAMETERS IN DSCRP

Area of the model	**10 × 10 square units**
Number of sensors deployed	100
Distance between each sensor node and its adjacent neighbours	1 unit
Packet length (k)	200 bit
Number of rounds	600 rounds
Threshold value	given manually as per conditions

Specification of a single sensor node**:**

1. All the sensor nodes are capable of transferring data to the base station.

2. Data is transferred from each sensor node to the closest neighbor in the first stage till the data reaches the chain head.

3. All the sensor nodes are identical having the same energy (= 0.5 J).

IV. RESULTS AND DISCUSSION

The network model is implemented using ns2. It is strong tool to analysis the network model [8,9,11]. The network model constitutes a 10 K 10 matrix i.e, there are a total of 100 sensor nodes in the model. Each node is placed at a unit distance from one another. A chain is formed in each row of the matrix. Thus, we have 10 chains altogether where 10 sensor nodes are present in each chain. Chain head selection starts from one end of the chain and proceeds from one sensor node to the next sensor node. Two tokens are generated from the chain head which propagates the two ends of the chain. These tokens help to attain mutual exclusion during the transmission of data. If a sensor node at one of the ends of a chain is the current chain head then the token received by the chain head is not accepted. The sensor nodes which hold the token is allowed to transmit data to the nearest neighbor within the chain only if the difference between the currently sensed value and previously sensed value exceeds the threshold value. The nearest neighbor fuses the data received to its own data and the process of propagation of data and token continues till all the data reaches the chain head.

The 10 chains heads from all the chains in the network model forms a cluster. The chain head with the maximum residual energy and minimum distance from base station is selected as the cluster head. The data propagates from one sensor node to the nearest neighboring sensor node and gets fused. This process continues until all the fused data is received by the cluster head. Finally, all the fused data received by the cluster head is sent to the base station.

For calculating the transmitting energy of a packet the equation is:

Et(k,d)=Ec*k+Ea*k*d2 (i)

For calculating the receiving energy of a packet the equation is:

Er(k)=Ec*k (ii)

Where;
Et=energy consumed during the transmission
K=size of the data packet
D=distance between the node and the closest neighbor
Ec=energy needed to run the transmitter or the receiver
Ea=Energy consumed to run the amplifier
Er=Energy consumed during the receiving
The values assumed are as follows:
Ec=50 nJ/bit
Ea=100pJ/bit/m2
K=200bits

The value for distance between two nodes is 1 unit, while the distance between the chain head and the base station is given bL:

d=sqrt((KLoc-K)2+(LLoc-L)2) (iii)

Where:
KLoc= K coordinate of transmitting node
LLoc= L coordinate of transmitting node
K= K coordinate of base node
L= L coordinate of base node

Taking the same number of rounds, residual energy was found to be 3.6378 J (approx 7% of the total energy) in LEACH. Thus, consumption of energy is far less in DSCRP compared to LEACH making it significantly more energy efficient.

The figure below shows the Network Architecture of the proposed system.

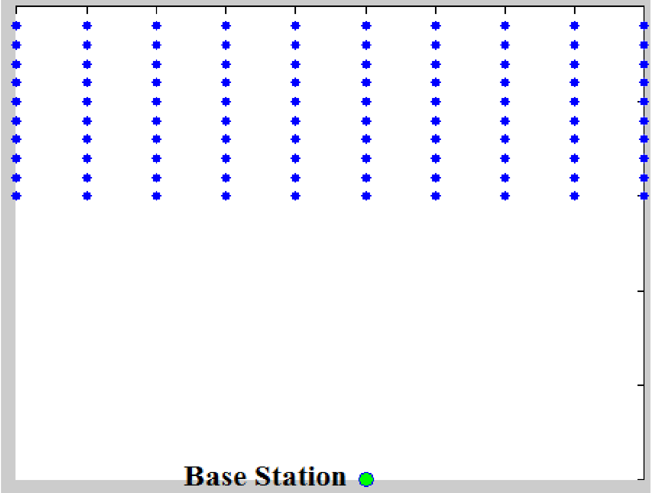

Fig. 1. Network architecture of DSCRP

TABLE II. ROUND AND DEAD NODE IN DSCR

Round	Dead Node
After 100 rounds	0
After 200 rounds	0
After 400 rounds	0
After 600 rounds	0
Total number of nodes died	0
Node death started at round	NIL

The details of network from the start round in DSCRP are given in Fig. 2.

	round	chain_head	residual_energy	cluster_head	residual_energy(cluster_head)
1	1	1	0.5000	1	0.5000
2	1	11	0.5000	1	0.5000
3	1	21	0.5000	1	0.5000
4	1	31	0.5000	1	0.5000
5	1	41	0.5000	1	0.5000
6	1	51	0.5000	1	0.5000
7	1	61	0.5000	1	0.5000
8	1	71	0.5000	1	0.5000
9	1	81	0.5000	1	0.5000
10	1	91	0.5000	1	0.5000
11	2	2	0.5000	1	0.5000
12	2	12	0.5000	1	0.5000
13	2	22	0.5000	1	0.5000
14	2	32	0.5000	1	0.5000
15	2	42	0.5000	1	0.5000
16	2	52	0.5000	1	0.5000
17	2	62	0.5000	1	0.5000
18	2	72	0.5000	1	0.5000
19	2	82	0.5000	1	0.5000
20	2	92	0.5000	1	0.5000
21	3	3	0.5000	1	0.5000
22	3	13	0.5000	1	0.5000
23	3	23	0.5000	1	0.5000
24	3	33	0.5000	1	0.5000
25	3	43	0.5000	1	0.5000
26	3	53	0.5000	1	0.5000
27	3	63	0.5000	1	0.5000
28	3	73	0.5000	1	0.5000
29	3	83	0.5000	1	0.5000
30	3	93	0.5000	1	0.5000
31	4	4	0.5000	1	0.5000
32	4	14	0.5000	1	0.5000
33	4	24	0.5000	1	0.5000
34	4	34	0.5000	1	0.5000

Fig. 2. Network deatils of DSCRP (First 34 rounds)

The details of network in the middle of rounds in DSCRP are given in Fig. 3.

	round	chain_head	residual_energy	cluster_head	residual_energy(cluster_head)
3347	335	65	0.4808	10	0.4820
3348	335	75	0.4815	10	0.4820
3349	335	85	0.4814	10	0.4820
3350	335	95	0.4820	10	0.4820
3351	336	6	0.4796	2	0.4807
3352	336	16	0.4807	2	0.4807
3353	336	26	0.4805	2	0.4807
3354	336	36	0.4800	2	0.4807
3355	336	46	0.4806	2	0.4807
3356	336	56	0.4799	2	0.4807
3357	336	66	0.4793	2	0.4807
3358	336	76	0.4805	2	0.4807
3359	336	86	0.4794	2	0.4807
3360	336	96	0.4796	2	0.4807
3361	337	7	0.4790	5	0.4801
3362	337	17	0.4795	5	0.4801
3363	337	27	0.4799	5	0.4801
3364	337	37	0.4800	5	0.4801
3365	337	47	0.4801	5	0.4801
3366	337	57	0.4790	5	0.4801
3367	337	67	0.4791	5	0.4801
3368	337	77	0.4799	5	0.4801
3369	337	87	0.4799	5	0.4801
3370	337	97	0.4795	5	0.4801
3371	338	8	0.4786	6	0.4799
3372	338	18	0.4788	6	0.4799
3373	338	28	0.4790	6	0.4799
3374	338	38	0.4789	6	0.4799
3375	338	48	0.4788	6	0.4799
3376	338	58	0.4799	6	0.4799
3377	338	68	0.4785	6	0.4799
3378	338	78	0.4797	6	0.4799
3379	338	88	0.4788	6	0.4799
3380	338	98	0.4798	6	0.4799

Fig. 3. Network deatils of DSCRP (Middle rounds)

The details of network at the last rounds DSCRP is given in Fig. 4.

	round	chain_head	residual_energy	cluster_head	residual_energy(cluster_head)
5967	597	67	0.4631	10	0.4639
5968	597	77	0.4635	10	0.4639
5969	597	87	0.4625	10	0.4639
5970	597	97	0.4639	10	0.4639
5971	598	8	0.4617	9	0.4634
5972	598	18	0.4617	9	0.4634
5973	598	28	0.4622	9	0.4634
5974	598	38	0.4627	9	0.4634
5975	598	48	0.4628	9	0.4634
5976	598	58	0.4626	9	0.4634
5977	598	68	0.4628	9	0.4634
5978	598	78	0.4627	9	0.4634
5979	598	88	0.4634	9	0.4634
5980	598	98	0.4623	9	0.4634
5981	599	9	0.4605	5	0.4626
5982	599	19	0.4615	5	0.4626
5983	599	29	0.4620	5	0.4626
5984	599	39	0.4612	5	0.4626
5985	599	49	0.4626	5	0.4626
5986	599	59	0.4625	5	0.4626
5987	599	69	0.4623	5	0.4626
5988	599	79	0.4613	5	0.4626
5989	599	89	0.4616	5	0.4626
5990	599	99	0.4616	5	0.4626
5991	600	10	0.4621	3	0.4632
5992	600	20	0.4624	3	0.4632
5993	600	30	0.4632	3	0.4632
5994	600	40	0.4618	3	0.4632
5995	600	50	0.4620	3	0.4632
5996	600	60	0.4627	3	0.4632
5997	600	70	0.4624	3	0.4632
5998	600	80	0.4630	3	0.4632
5999	600	90	0.4629	3	0.4632
6000	600	100	0.4624	3	0.4632

Fig. 4. Network deatils of DSCRP (Last rounds)

The Fig. 5 shows the number of dead nodes and number of rounds.

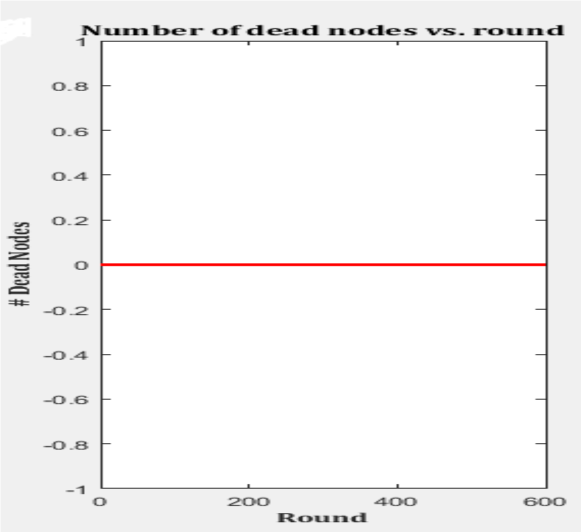

Fig. 5. Number of dead nodes and rounds

The Fig. 6 shows the sum of energy of nodes and number of rounds.

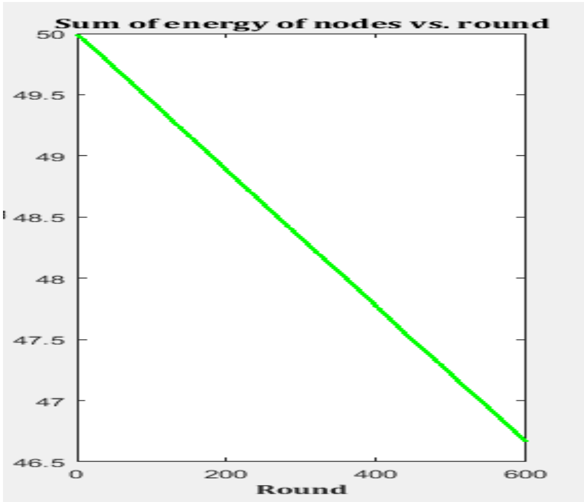

Fig. 6. EnergL of nodes with rounds.

V. CONCLUSION

We compared DSCRP with LEACH and TSCP for 600 rounds. After comparison we found that the total energy of the network in DSCRP has reduced to 46.75 J from the originally 50 J. The total energy of the LEACH network has reduced to 3.6378 J from the originally 50 J. After 600 rounds the total network energy for TSCP was 45 J and that in SCRP is 44.6J. It is clear from these data that DSCRP saves more energy in comparison to LEACH, TSCP and SCRP. From it is also observed that the nodes in DSCRP give better network lifetime than LEACH. Thus, the algorithm is successful in increasing the network lifetime.

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