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Enhanced Cuckoo Search Based Intercluster Data Aggregation for WSNs

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Abstract: ***The sensor nodes have restricted battery power and it is not easy to replace nodes scattered over large geographical areas energy has become scarcest resource of WSNs. So, a large no. of protocols has been proposed to conserve energy but still much enhancement can be done. So as to triumph over the limitations of the previous work a new improved technique is proposed in this paper. The proposed technique has the ability to overcome the limitations of the tree based routing protocol by using the reactivity and cuckoo search optimization based optimized path selection. In order to evaluate the effectiveness of the proposed protocol MATLAB has been used. Simulation results have shown that the proposed technique performs better than GSTEB in terms of network lifetime and residual energy.***

Keywords: GSTEB, energy-efficiency, WSNs, cuckoo search.

1. INTRODUCTION

Wireless sensor network (WSN) [1] stands for a collection of spatially dispersed sensor nodes used for observing and recording various kinds of environmental information and transmitting the collected data to a central location known as base station (BS). WSNs monitor various environmental parameters like temperature, sound, pollution levels, humidity and pressure, etc. A WSN could be made up of hundreds to thousands of sensor nodes. Size and cost of a single sensor node could vary significantly according to the functions performed by the node. Size and cost limitations of nodes give rise to energy, memory and computational speed constraints. WSNs may be deployed in large numbers in various environments, including remote and hostile regions, where replacement of sensor nodes or their battery is not a feasible option. So nodes in the network have restricted energy and it determines the lifetime of WSNs. For this reason energy efficient protocols should be developed to increase network lifetime. The area of WSN is flourishing and every day new ideas are emerging. Many energy efficient protocols have been developed to increase network lifetime some examples are LEACH [2], DDEEC [3], PEACH [4], and GSTEB [5] etc but still there is room for improvement so to overcome the drawbacks of previous protocols a new improved protocol has been proposed in this paper.

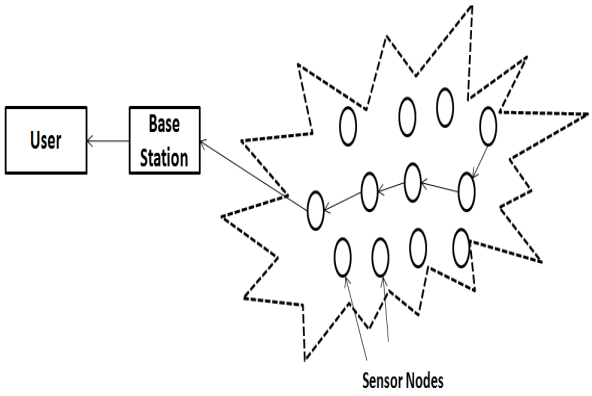

Figure 1 Wireless Sensor Network

2. GSTEB

General Self-Organized Tree-Based Energy-Balance routing protocol (GSTEB) is a dynamic tree based protocol in which BS selects a root node during every round and then BS transmits root node's ID and coordinates to every node. Every node chooses its parent by taking into consideration just itself and its neighbors' information. Subsequently, the network works out the path either by appointing BS as incharge and transmitting the path information from BS to nodes or by having the identical tree arrangement being built by individual nodes independently. This makes GSTEB a dynamic protocol. Goal of GSTEB is to increase network lifetime of different WSN applications. GSTEB improves load balancing thus increasing network lifetime. GSTEB performs better as compared to other protocols such as LEACH, PEGASIS, TREEPSI and TBC. Since GSTEB is a self-organized protocol, it only utilizes very low amount of energy in each round to alter the topography for balancing the energy utilization.

3 CUCKOO SEARCH OPTIMIZATION

Cuckoo search (CS) optimization [6] algorithm was developed by watching the obligate brood parasitism of a kind of cuckoo birds which reproduce by giving their eggs

in the host birds' nest. Some host birds can create difficulty for such reproductive methods of cuckoo birds by identifying alien eggs existing in its nest and destroying those eggs or leaving its nest and make a new nest somewhere else. Cuckoo search is based on this phenomenon, and is helpful for various optimization problems.

Cuckoo search (CS) uses the following representations:

1. Every egg in a nest denotes a solution.
2. A cuckoo egg denotes a new solution.
3. Motive of cuckoo search optimization is to replace a not-so-good solution in the nests with a new bette solution.

Pseudo-code for cuckoo search optimization

Function: $f(y),\ \ y=(y_1,y_2,y_3,....,y_n)$;

Consider a population of n host nest at the beginning;

WHILE (t < max gen)

Select a cuckoo arbitrarily (assume, i) and change its solution by levy flights;

Compute its fitness function F_i

[For maximization]; $F_i \alpha f(y_i)$

Select a nest from the available nests n (assume j) at random;

IF $(F_i > F_j)$ substitute j by the new better solution;

ENDIF

A portion (p_a) of the worse nests is dumped and new ones constructed;

Nests with best solutions are kept;

Grade the solutions/nests and discover the existing best;

Current best solutions proceeds to the next generation;

END WHILE

4 LITERATURE SURVEY

Wendi Rabiner Heinzelman et. al. [2000] [2] have studied communication protocols capable of having considerable effect on the overall energy dissipation of WSNs. From the study it is found out that the existing protocols based on direct transmission, multihop routing, and static clustering possibly will not be suitable for sensor networks so authors have proposed LEACH (Low-Energy Adaptive Clustering Hierarchy) which is a clustering-based protocol that makes use of the randomized rotation of local cluster heads to uniformly dispense the load between the nodes of the WSN. LEACH utilizes local coordination to facilitate scalability and robustness for dynamic networks, and includes data fusion in protocol so as to minimize the quantity of information being sent to sink. Adel Gaafar A.Elrahim et al [2010] [7] have proposed an energy efficient data forwarding protocol named as Energy Aware Geographic Routing Protocol (EAGRP) for WSNs which increases network lifetime. In EAGRP, nodes are aware of their location as well as energy. Availability of this information at nodes helps to maximize lifetime of the sensor nodes; resulting in increased network lifetime and consequently getting better packet delivery ratio and energy efficiency. This protocol is an efficient routing method for multi-hop WSNs. Simulation results demonstrate that proposed protocol performs better in terms of network lifetime and packet transmission. Brahim elbhiri et al. [2007] [3] have proposed a clustering technique named as Developed Distributed Energy-Efficient Clustering (DDEEC) scheme for heterogeneousWSNs. DDEEC is founded on DEEC protocol in which cluster heads (CH) are selected based upon the initial and residual energy of nodes. This scheme is based on efficient and dynamic altering of the CH election probability. Simulation results demonstrate that proposed protocol improves network lifetime as compared to the Stable Election Protocol SEP & DEEC. M. Aslam et al [2012] [8] have proposed a Centralized Energy Efficient Clustering (CEEC) routing protocol. They have designed the CEEC for three level heterogeneous WSN. CEEC can be applied to the WSNs with multi-level heterogeneity. In CEEC, entire network area is separated into three equivalent sections such that nodes with equal energy are located in same section. CEEC has improved throughput and network lifetime. A.A. khan et. al. [2012] [9] have proposed Heterogeneity-aware Hierarchal Stable Election Protocol (HSEP) with two protocol. In clustering protocols farther the CS is from BS more is the amount of energy consumed during transmission. Proposed protocol is designed to lower the amount of energy consumed during transmission from CH TO BS. Simulation proves that the proposed protocol increases network lifetime and stability period as compared to other protocols. Sangho yi et. al. [2007] [4] have introduced PEACH protocol, which is a power-efficient and adaptive clustering hierarchy protocol for WSNs. PEACH uses the overhearing characteristics of wireless communication and makes clusters that do not have additional overhead and supports adaptive multi-level clustering. PEACH can be used for both location-unaware and location-aware wireless sensor networks. The simulation results show that PEACH considerably improves energy utilization and increases network lifetime**.** Jing yang et. al. [2010] [10] have proposed a protocol for monitoring burst events in a type of reactive wireless sensor networks (WSNs). Proposed protocol is named as multipath routing protocol (MRP) based on dynamic clustering and ant colony optimization (ACO). First of all CH is selected based on a number of parameters, for instance residual energy. Then an improved ACO algorithm is used to look for multiple paths connecting CH to base station. At last the CH dynamically selects a path for data transmission with a

probability that depends upon various path metrics, such as energy utilization. Simulation results prove that MRP can improve network lifetime and load balance amongst nodes thus minimizing average energy utilization**.** Mao ye et al [2005] [11] have proposed a novel energy efficient clustering scheme (EECS) for single-hop wireless sensor networks, more appropriate for the periodical data gathering purposes. This method chooses CH having higher level of remaining energy in an independent style during local radio communication devoid of any iteration even than accomplishing better cluster head distribution; moreover it proposes a novel distance-based method for load balancing in CHs. Simulation demonstrates that EECS improves the network lifetime as compared to protocols such as LEACH and HEED. Chengfa li et al [2005] [12] have considered the hot spots trouble in multihop wireless sensor networks. To deal with the problem, an Energy Efficient Unequal Clustering (EEUC) method for periodical data gathering in wireless sensor networks is introduced. This method divides sensor nodes into irregular sized clusters such that size of the cluster increases with its distance from the sink node. Hence CHs nearer to the BS can save some energy meant for the inter-cluster data forwarding. Authors have also proposed an energy-aware multihop routing protocol designed for the inter-cluster communication. Simulation results prove that the proposed protocol balances the energy expenditure well between nodes and accomplishes better network lifetime. Anish arora et al. [2004] [13] have proposed a fast local clustering service (FLOC) which forms non overlapping and almost same sized clusters. Clusters are formed in a way that nodes inside unit distance of a CH becomes a part of its cluster, and any node m units away from the CH must not become a part of its cluster. FLOC takes advantage of the double-band character of wireless radio-model and completes clustering in constant time in any network size. Chieh- yih wan et. al [2002] [14] have introduced PSFQ (Pump Slowly, Fetch Quickly), a consistent transport protocol that suits a new category of consistent data applications being developed in WSNs. At present WSNs have a tendency to be application specific and are usually hard-wired to carry out a particular job competently and economically; but now there is a requirement to be skilled to re-task or reprogram collection of sensors in wireless sensor networks on the fly (e.g., during disaster recovery). Because of the application-specific character of WSNs, formation of a single massive transport system that can be optimized for every application is very tough. PSFQ follows a different route and supports a straightforward, robust and scalable transport which can be optimized according to the requirements of a number of reliable data applications. Simulation results demonstrate that PSFQ can perform better than existing techniques (e.g., an idealized SRM scheme) and is very responsive to the different error conditions faced in wireless sensor networks. Yan yu et al [2001] [15] inspired from the fact that sensor network queries are frequently geographical; an energy efficient routing protocol is proposed. Proposed algorithm transmits a query to the suitable geographical area, with no flooding. The proposed Geographic and Energy Aware Routing (GEAR) algorithm utilizes energy conscious neighbor selection to direct a packet towards the target area and Recursive Geographic Forwarding or Restricted Flooding method to distribute the packet within the destination area.

5 PROPOSED PROTOCOL

Pseudo code for proposed protocol is as follows

1. Initialize network;
2. Deploy n sensor nodes randomly in predefined sensor field;
3. Evaluate levels by using GSTEB;
4. WHILE $(CV > HT)$ do;
5. Apply cuckoo search optimization on clusters to find the bests route from nodes to sink;
6. Evaluate and update energy consumption;
7. IF all nodes = dead
8. Show network lifetime;
9. ELSE
10. RETURN to step 3
11. ENDIF
12. ENDWHILE

6 RESULTS AND DISCUSSIONS

In order to evaluate the effectiveness of the proposed protocol MATLAB has been used to compare the proposed protocol with GSTEB. We generate a randomly distributed network of 100 nodes in square area 100m*100m. Then, comparison is drawn between GSTEB and proposed protocol based on four parameters named as first node dead time, half node dead time, last node dead time and residual energy.

FIRST NODE DEAD: - Table 1 shows the first node dead evaluation of the GSTEB and the proposed protocol. In the table, it is clearly shown that the proposed protocol performs better as compared to the GSTEB.

TABLE 1: First node dead evaluation

ENERGY	GSTEB	PROPOSED PROTOCOL
0.01	15	51
0.02	28	103
0.03	42	171
0.04	56	202
0.05	70	276
0.06	84	313
0.07	97	342
0.08	110	450
0.09	130	470
0.1	138	508

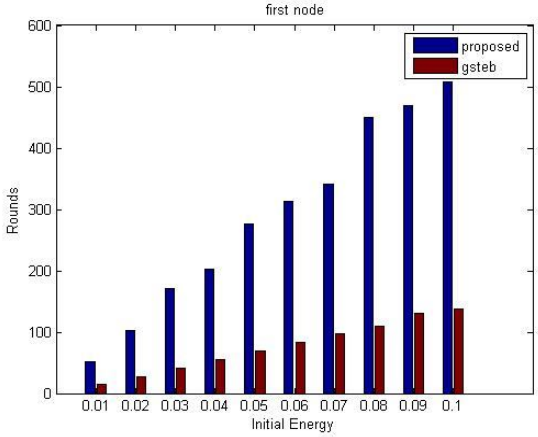

Figure 2: First node dead analysis

Fig 11 is depicting the comparison of proposed protocol with GSTEB in case of first node dead when the initial energy of nodes is changed. X-axis is representing initial energy of nodes. Y-axis is representing the number of rounds. It is clear from the graph that proposed protocol outperforms GSTEB protocol.

HALF NODE DEAD: - Table 2 shows the half node dead evaluation of the GSTEB and the proposed protocol. In the table, it is clearly shown that the proposed protocol performs better as compared to the GSTEB.

TABLE 2: Half node dead evaluation

ENERGY	GSTEB	PROPOSED PROTOCOL
0.01	34	76
0.02	62	133
0.03	91	219
0.04	121	287
0.05	156	361
0.06	186	435
0.07	213	497
0.08	245	611
0.09	268	611
0.1	288	722

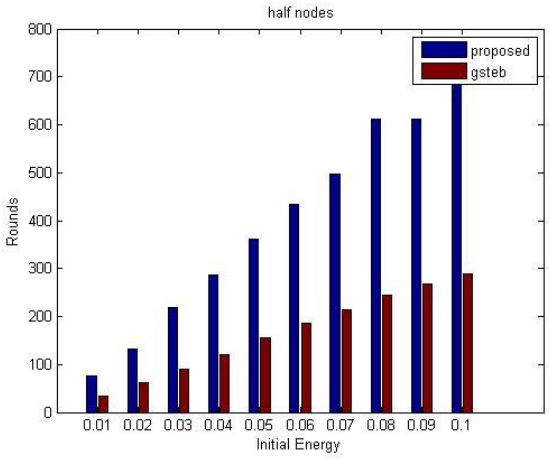

Figure 3: Half node dead analysis

Fig 11 is depicting the comparison of proposed protocol with GSTEB in case of half node dead when the initial energy of nodes is changed. X-axis is representing initial energy of nodes. Y-axis is representing the number of rounds. It is clear from the graph that proposed protocol outperforms GSTEB protocol.

LAST NODE DEAD: - Table 3 shows the last node dead evaluation of the GSTEB and the proposed protocol. In the table, it is clearly shown that the proposed protocol performs better as compared to the GSTEB.

TABLE 3: Last node dead evaluation

ENERGY	GSTEB	PROPOSED PROTOCOL
0.01	36	82
0.02	69	138
0.03	99	225
0.04	131	299
0.05	167	370
0.06	199	449
0.07	233	520
0.08	263	633
0.09	288	638
0.1	329	742

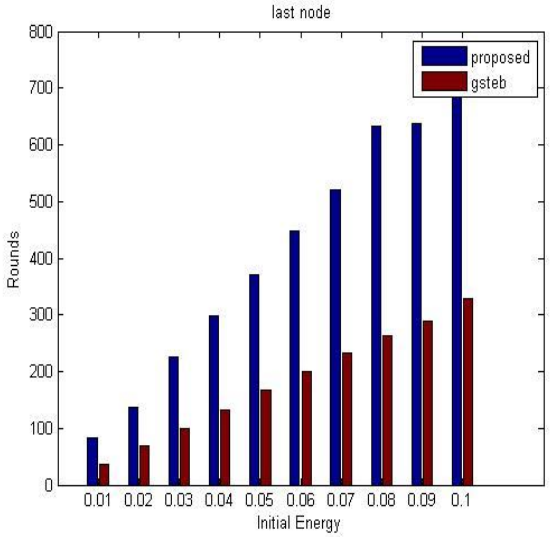

Figure 4: Last node dead analysis

Fig 11 is depicting the comparison of proposed protocol with GSTEB in case of last node dead when the initial energy of nodes is changed. X-axis is representing initial energy of nodes. Y-axis is representing the number of rounds. It is clear from the graph that proposed protocol outperforms GSTEB protocol.

RESIDUAL ENERGY: - Table 4 shows the residual energy evaluation of the GSTEB and the proposed protocol. In the table, it is clearly shown that the proposed protocol performs better as compared to the GSTEB.

TABLE 4: Residual energy evaluation

ENERGY	GSTEB	PROPOSED PROTOCOL
0.01	0.00025	0.00046
0.02	0.00096	0.00157
0.03	0.00217	0.00400
0.04	0.00374	0.00717
0.05	0.00603	0.01102
0.06	0.00869	0.01573
0.07	0.01176	0.02102
0.08	0.01550	0.02968
0.09	0.01948	0.03350
0.1	0.2311	0.04359

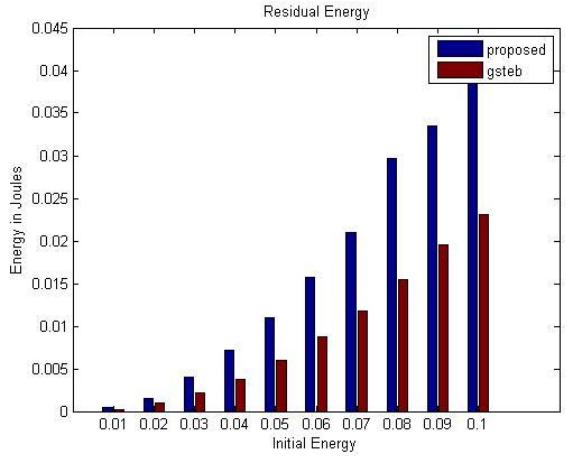

Figure 5: Residual Energy analysis

Fig 11 is depicting the comparison of proposed protocol with GSTEB in case of residual energy when the initial energy of nodes is changed. X-axis is representing initial energy of nodes. Y-axis is representing the energy in joules. It is clear from the graph that proposed protocol outperforms GSTEB protocol.

5 CONCLUSION

In this paper, a reactivity and cuckoo search based routing protocol for wireless sensor networks has been proposed. Moreover the effectiveness of the proposed protocol has been evaluated using MATLAB. Also the comparison of the proposed technique has been done with the GSTEB protocol based on four parameters named as first node dead time, half node dead time, last node dead time and residual energy. Simulation results have proved that cuckoo search based technique is better than GSTEB protocol.

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