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EEHCR: Energy Efficient Hierarchical Cluster Routing in Wireless Sensor Networks

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Energy management is one of the critical parameters in Wireless Sensor Networks. In this paper we attempt for a solution to balance the energy usage for maximizing the network lifetime, increase the packet delivery ratio and throughput. Our proposed algorithm is based on Energy Density of the clusters in Wireless Sensor Networks. The cluster head is selected using two step method and on-demand routing approach to calculate the balanced energy shortest path from source to sink. This unique approach maintains the balanced energy utilization among all nodes by selecting the different cluster heads dynamically. Our simulation results show the improvements in delay, energy utilization, network lifetime and throughput than earlier works.

keywords: Balanced Energy Shortest Path, Cluster, Network Lifetime, Wireless Sensor Network (WSN).

1. INTRODUCTION

Wireless Sensor Networks(WSNs) are used in numerous applications like Traffic management, Battle field surveillance, Environmental monitoring, Health care systems, Underwater applications and *etc.*, [1][2][3].

Energy utilization is one of the significant parameter for battery powered wireless sensor networks. It is essential to reduce energy consumption in all the sensor nodes to increase the network lifetime [4]. In WSNs, the nodes surrounding the sink have tendency to drain their energy soon compared to the nodes away from the sink and such irregular energy drain will decrease the network lifetime [5]. Unbalanced energy utilization can cause network partition even though many of the nodes may have maximum residual energy which are away from the sink [6]. Thus, it is necessary that every node should consume energy evenly in order to increase the lifetime of the network.

Energy efficiency and balanced energy utilization are two different aspects. Shortest path routing uses energy efficiently but may not result in balanced energy utilization. Topology, Applications and Routing protocols are main causes for unbalanced energy utilization. However, eventually a number of solutions are proposed by many of the routing protocols such as : Optimal Deployment of sensor nodes relative to applications [7][8], Organization of dynamic Topology of nodes based on transmission power requirements [9][10], the deployment of Mobile sinks or Relay nodes [11][12] and efficient data aggregation techniques to manage uniform en-

Lifetime increases by 18% over the other two protocols (Table 4).

The throughput of the network in EEHCR is shown in Figures 5 and 6. Uniform energy utilization coupled with high packet delivery ratio and low packet drop in EEHCR has resulted in higher throughput than TSCHS and EBRP. There is an increase in throughput of 38% in our protocol and the throughput profile is shown in Table 5.

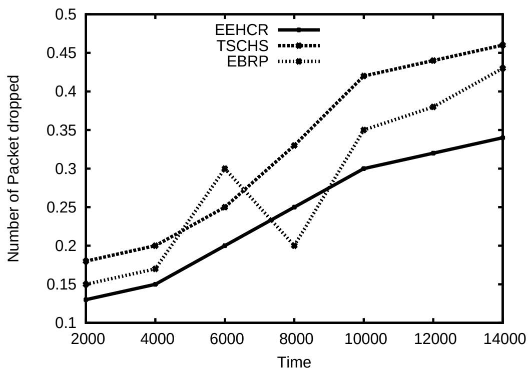

Figure 5. The Number of Packets Dropped in the Three Algorithms EEHCR, TSCHS and EBRP.

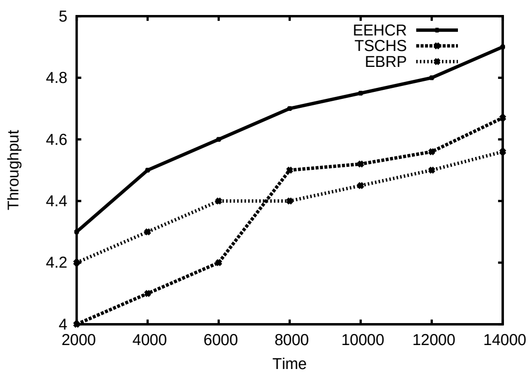

Figure 6. Comparison of Network Throughput in the Three Algorithms EEHCR, TSCHS and EBRP.

7. CONCLUSIONS

Balanced Energy utilization is one of the important parameters in increasing the lifetime of the WSNs. Cluster head selection and on-demand routing are two critical issues. The proposed algorithm EEHCR shows that the cluster head selection based on the energy density and the residual energy is more efficient and effective than other parameters. We have followed a unique energy density calculation, based on the parameters such as average residual energy of neighbor nodes and itself, distance from local cluster head and coverage area of each node. Such a method of cluster head selection supports balanced energy utilization and increase in throughout of the network. The shortest path calculation is based on On-Demand approach which considers depth parameter from source to sink. The cumulative efficiency of the Two steps cluster head selection coupled with shortest path On-Demand routing has increased the network lifetime. It is clearly observed that our algorithm performs better than ealier algorithms with respect to uniform utilization of energy, lifetime and throughput. This work can be extended to mobile sinks to reduce latency and further increase the lifetime of the network.

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Table 4
Network Lifetime

Simulaton	*Network Lifetime*			*Packet Delivery Ratio*		
Time(mSecs)	*EEHCR*	*TSCHS*	*EBRP*	*EEHCR*	*TSCHS*	*EBRP*
2000	0.98	0.98	0.98	0.82	0.73	0.78
4000	0.98	0.98	0.98	0.83	0.75	0.80
6000	0.98	0.98	0.98	0.86	0.78	0.81
8000	0.97	0.94	0.96	0.88	0.80	0.84
10000	0.93	0.86	0.88	0.92	0.84	0.86
12000	0.88	0.82	0.79	0.94	0.86	0.88
14000	0.82	0.75	0.72	1	0.88	0.9

Table 5
Network Throughput

Simulaton	*Packet Drop*			*Network Throughput*		
Time(mSecs)	*EEHCR*	*TSCHS*	*EBRP*	*EEHCR*	*TSCHS*	*EBRP*
0.78	0.13	0.18	0.15	4.3	4.0	4.2
0.80	0.15	0.20	0.17	4.5	4.1	4.3
0.81	0.2	0.25	0.3	4.6	4.2	4.4
0.84	0.25	0.33	0.2	4.7	4.5	4.4
0.86	0.3	0.42	0.35	4.75	4.52	4.45
0.88	0.32	0.44	0.38	4.8	4.56	4.5
0.9	0.34	0.46	0.43	4.9	4.67	4.56

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