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Energy Conservation Hierarchical Cluster Based Routing Protocols For Heterogeneous Wireless Sensor Networks

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Abstract
The WSN is composed of a collection of sensor nodes, which are small energy constrained devices. In wireless sensor networks, the energy of nodes is limited. So designing efficient routing for reducing energy consumption is the important factor. This paper mainly focused on the routing problem in Wireless Sensor Networks and proposed three routing strategies named as CCB (Cluster and Chain Based), TRCB (Transmission Ranges and Chain Based), and GRAB (Gradient Based) routing. In this paper we performed these three routing schemes inside LEACH protocol. In CCB routing approach nodes send the information to the base station by using the concept of both LEACH and PEGASIS routing schemes. In TRCB routing approach nodes send the information to the base station by using its own transmission ranges and distance metrics. In GRAB routing approach nodes send the information to the base station based on cost field and credit. The simulation results shows that GRAB routing performed better inside LEACH protocol compared to CCB and TRCB routing approaches.

1. Introduction
In Wireless sensor network applications only require the successful delivery of messages between a source and a destination. However, some applications are there, that need even more assurance. Those are the real-time requirements of the message delivery, and in parallel, the maximization of network lifetime. Some of the objectives to perform routing [1]

(i) Non-real time delivery
The assurance of message delivery is indispensable for all routing protocols. It means that the protocol should always find the route between the communicating nodes, if it really exists. This correctness properly can be proven in a formal way, while the average-case performance can be evaluated by measuring the message delivery ratio.

(ii) Real-time delivery
Some applications require that a message must be delivered within a specified time, otherwise the message becomes useless or its information content is decreasing after the time bound. Therefore, the main objective of these protocols is to completely control the network delay. The average-case performance of these protocols can be evaluated by measuring the message delivery ratio with time constraints.

(iii) Network lifetime
This protocol objective is crucial for those networks, where the application must run on sensor nodes as long as possible. The protocols aiming this concern and try to balance the energy consumption equally among nodes considering their residual energy levels. However, the metric used to determine the network lifetime is also application dependent. Most protocols assume that every node is equally important and they use the time until the first node dies as a metric or the average energy consumption of the nodes as another metric. If nodes are not equally important, then the time until the last or high-priority nodes die can be a reasonable metric.

2. Routing Techniques in WSN
Routing is a process of determining a path between source and destination upon request of data transmission. In WSNs, the layer that is mainly used to implement the routing of the incoming data is called as network layer [2]. When the sink is far away from the source or not in the range of source node, multi-hop technique is followed.

So, intermediate sensor nodes have to relay their packets. The implementation of routing tables gives the solution. This contains the lists of node option for any given packet destination. Routing table is the task of the routing algorithm along with the help of the routing protocol for their construction and maintenance.

WSN Routing Protocols can be classified in four ways, according to the way routing paths are established, according to the network structure, according to the protocol operation and according to the initiator of communications. Fig.1. shows the classification of WSN routing protocols. Routing paths can be established in one of three ways, namely proactive, reactive and hybrid. Proactive protocols compute all the routes before they are really needed and then store these routes in a routing table in each node. When a route changes, the change has to be propagated throughout the network. Since a WSN could consist of thousands of nodes, the routing table that each node would have to keep could be huge and therefore proactive protocols [3] are not suited to

WSNs. Reactive protocols [3] compute routes only when they are needed. Hybrid protocols use a combination of these two ideas. But in general, routing in WSN can be divided into three categories named as flat routing; hierarchical routing and location based routing depending on the network structure. In flat based routing, all nodes play the same role. In hierarchical based routing however, nodes will play different roles in the network. In location based routing, sensor nodes positions are exploited to route data in the network. Furthermore, these protocols can be classified into multi-path based, query based, negotiation based, Qos based, coherent and non-coherent based routing techniques depending on the protocol operation.

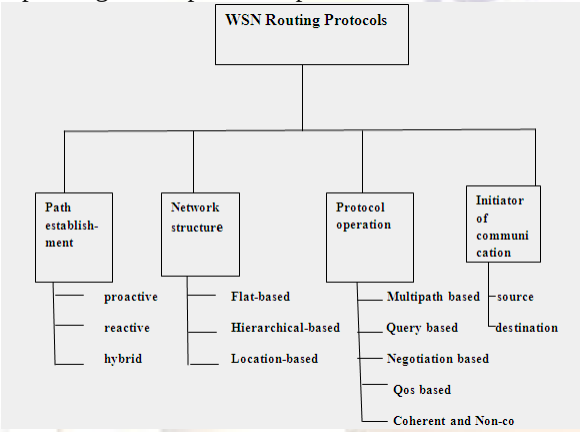

Fig.1.Classification of WSN Routing Protocols

But in this paper we are going to performing different proposed routing strategies on LEACH protocol. This protocol belongs to hierarchical based routing type. So we will concentrate on this kind only.

2. Objective

The objective of this research work is to propose different routing schemes for data gathering between sensor nodes and send that data to the destined base station in an energy efficient manner. Here the main objective is to improve the lifetime of the network and to maintain a balanced energy consumption of nodes.

3. Proposed work

In this paper we proposed three routing strategies and applied on LEACH protocol. Those routing strategies are given below.

- Clustered and Chain Based (CCB) routing scheme.
- Transmission Ranges and Chain Based (TRCB) routing scheme.
- GRAB (Gradient Based) routing scheme.

CCB Routing

In direct communication approach every node in sensor network directly communicate with the base station and sends its information directly to the base station in these scenario nodes lose its energy quickly. Because of this fact network lifetime will decrease. So we have to find an alternative for improving the network lifetime. This thing possible by the clustering approach. LEACH [4][5] protocol fulfill this kind of approach and improves the network lifetime compared to direct communication approach. But LEACH protocol is also having some open problems as we already discussed in chapter 2. To overcome the LEACH protocol problems the next existing protocol was PEGASIS [6] [7]. This is LEACH inspired protocol but not a cluster based protocol. PEGASIS is also having some problems. To overcome the problems in both LEACH and PEGASIS we propose a new kind of approach. That is Cluster and Chain based approach, this approach involves the both LEACH and PEGASIS [8] concepts. We know that in LEACH protocol every node in cluster transmits its information directly to the cluster heads and then after cluster heads send its information directly to the base station. Because of the direct communication of cluster heads with base station, cluster heads lose its energy quickly. To avoid this problem in this proposed approach we apply the PEGASIS protocol concept between the cluster heads. PEGASIS takes it further and reduces the number of nodes communicating directly with the base station to one by forming a chain passing through all nodes, where each node receives from and transmits to the closest possible neighbor. The data is collected starting from each end point of the chain until the randomized head node is reached. The data is fused each time it moves from node to node. The designated head-node is responsible for transmitting the final data to the base station. By using the formula(r mod n) we can choose the leader node and then after form the chain between nodes and finally transmit the fused data to the base station. Where r is the number of rounds and n is the total number of cluster heads.

In this approach an energy efficient cluster plus chain based routing technique is used for route the information to the base station. The aim is efficient transmission of all the data to the base station, so that the lifetime of the network is maximized in terms of rounds, number of nodes, and packet size. Where a round is defined as the process of gathering all the data from sensor nodes to the base station, regardless of how much time it takes.

TRCB Routing

The second proposed routing approach is Transmission ranges and chain based approach. In this approach node in the cluster transmits its information to the cluster heads by using its own transmitting ranges. After receiving the information from the all cluster nodes, cluster heads transmits this information to the base station by using the chain based concept as we discussed in the CCB routing approach. In this approach every node calculates distances from the all nodes and as well as distance from the cluster head in the cluster and store these

values in its memory. Every node is also having the information about the distances between cluster head to all remaining nodes. So, now every node transmits its information to the nearest neighbor node by using the above distance information and its own transmission ranges. Like this way every node in cluster transmits its information to the cluster heads. Then after cluster heads transmits their information to the base station by using the chain based approach as we already discussed in CCB routing approach. This proposed approach performs better than the previous proposed approach in terms of number of nodes, packet size, number rounds.

GRAB Routing:

In this proposed routing approach we implemented GRAB [9][11] Routing inside LEACH protocol and compare this proposed approach with previous two proposed approaches. This GRAB routing mainly works on cost field. The main aim of this routing is to address the problem of robust data forwarding to a data collecting unit (called the sink) using unreliable sensor nodes with error-prone wireless channels. The objects or events to be monitored are called *stimuli*. All the sensor nodes that detect the same stimulus collectively elect one node that generates a sensing report on behalf of the group. We call such a node a data *source*. When we apply this routing strategy inside LEACH protocol cluster head is working as a data *source*. The sink builds and maintains a cost field [10]. Each node keeps the cost for forwarding a packet from itself to the sink. Nodes "closer" to the sink have smaller costs and nodes farther from the sink having larger costs. Instead of a sender appointing specific receivers to continue forwarding, in GRAB each receiver decides whether it should forward a packet by comparing its own cost to that of the sender. As a result, sensing data follow the direction of descending cost to reach the sink. Since multiple paths exist between a source and the sink, a source assigns a credit to each report it sends out to control the degree of path redundancy. The credit is some extra budget that enables a packet to be forwarded over a mesh of interleaved paths, each of which has a cost not greater than the total budget of the credit plus the cost of the source. The amount of credit determines the "width" of the mesh.

Simulation Results

In the simulation environment, HWSN is constructed by using the following parameters which is explored in Fig.2. When these three different routing mechanisms applied inside a LEACH energy conservation is achieved.Fig.3.shows the energy consumption in terms of nodes and Fig.4.shows how the energy depletion occurred in the in the network.

Radio-propagation model	Propagation/Two-Ray Ground
Network interface type	Phy/wireless phy
MAC Type	MAC/802_11
Interface queue type	Queue/Droptail/Pri queue
Link layer type	LL
Antenna model	Antenna/Omni Antenna
Max packet in ifq	50
Routing Protocol	LEACH
Number of sink nodes	1
Topology width	1000
Topology height	500
Transmission power	1.6
Reception power	1.2
Idle power consumption	0.05

Fig.2.Simulation Parameters used.

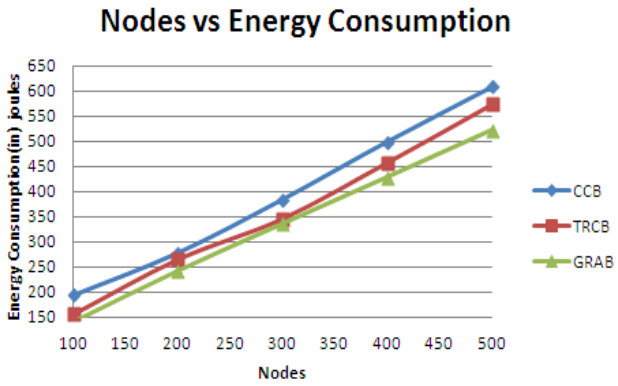

Fig.3.Results of Nodes vs. Energy Consumption

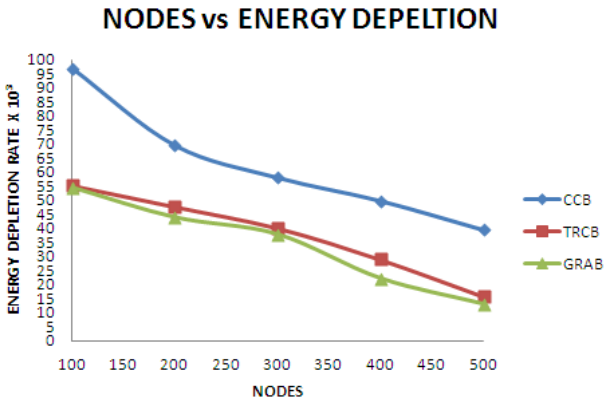

Fig.4.Energy depletion vs. Nodes

Conclusion:

In this research paper, we proposed the three proposed schemes (CCB, TRCB, and GRAB) which ensure robust broadcasted data over the large no. of unreliable sensor nodes. And error-prone wireless links. CCB efficiently transmission of all the data to the base station, so that the lifetime of the network is maximized in terms of rounds, number of nodes, and packet size. TRCB performs better than the previous proposed approach in terms of number of nodes, packet size, and number rounds. GRAB mainly suitable for large sensor networks and

maintain cost field for each destination and address the degree of redundancy.

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